Green Skills for Climate-Smart Agriculture

A Case Study of Poultry, Winter Grains and Deciduous Fruit Value Chains in the Western Cape

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Developing South Africa's GreenMatter®
Executive summary

South Africa’s National Development Plan aims to eliminate poverty and reduce inequality. It outlines the ambition to address the country’s high unemployment rate, while responding to development needs in a sustainable way in the face of challenges such as climate change (NDP, 2012). This ambition requires skilled citizens who are able to transform or create economic practices that use the country’s rich natural heritage sustainably. Thus ‘green skills’ can be thought of as those skills that can help South Africa transition towards a green economy “that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (UNEP, 2011). However, weaknesses in South Africa’s skill provisioning system present constraints towards achieving this ambition.

The Green Skills Project aims to strengthen the capacity of the national skills system to better integrate and plan for green skills development, with a particular focus on post-school skills development. The project focuses on developing methods for analysing green skill needs, and uses case studies in several sectors (e.g. mining and chemicals) to assess green skill needs and feed back to relevant stakeholders. This report captures the findings of a study that considered the green skill implications for transitioning towards climate-smart agricultural practice in the Western Cape, as part of the Green Skills Project.

Agriculture is a cornerstone of the South African economy and is vital for human and social well-being. Agricultural production is integrally tied to natural resources and systems, relying heavily on the availability of suitable land, soil, water, climatic conditions, and other ecosystem services (pollination, for example). At the same time, farming and food processing often pose a threat to biodiversity and ecosystem functions, while being threatened by shifting weather patterns and the impacts of climate change. Climate-smart agriculture (CSA) is a practice that can be applied at any stage in food production. CSA integrates the three dimensions of sustainable development - economic, social and environmental - by jointly addressing food security and climate challenges. It is composed of three main pillars: i) sustainably increasing agricultural productivity and incomes; ii) adapting and building resilience to climate change; and iii) reducing and/or removing greenhouse gases emissions, where possible.

The agricultural sector’s transition to CSA would benefit from the development of green skills. Green skills in the agricultural sector can assist the sector not only in creating and sustaining livelihood opportunities and building resilience to threats such as climate change and water scarcity, but also in making the sector a leading competitor in the regional and global market. The study thus used several conceptual frameworks to define green skills for climate-smart agriculture as the knowledge and ability to act on opportunities in the agriculture sector that:

- Reduce energy and water consumption;
- Reduce emissions, pollution and waste;
- Protect or restore biodiversity and ecosystems; and/or
- Enhance climate resilience.

This study started by looking at drivers and trends within the agricultural sector as a whole in the Western Cape, and then narrowed its focus to the value chains of three distinct commodities: poultry (broilers and eggs); winter grain (barley and wheat); and deciduous fruit (specifically pome fruit/apples and pears). These commodities were selected through a comparative review of different commodities in the province, which compared their employment potential, economic value, vulnerability to climate change and their social impact. The chosen three commodities were selected taking these factors into account, as well as the fact that they represent a range of types of farming practices (dryland, irrigated and livestock).
Within each commodity’s value chain, stages of production that appeared to have the potential for impactful positive change – or what the Green Skills Project considers to be ‘hotspots’ – were identified and explored further to help understand the skill implications for people working in occupations in that ‘hotspot’. In this way, the study attempted to identify a range of skill implications across different farming types and at various stages of production.

A review of grey literature on the sector as a whole and the selected commodities was conducted, using resources such as value chain reports by the Department of Agriculture, Forestry and Fisheries (DAFF), and commodity group reports. This data was complemented by interviews with key informants, thereby identifying several hotspot areas across the three commodities, which are indicated in the Table 1 further below. Due to resource and time constraints, site visits and further key informant interviews were conducted in the case of poultry (but not the other two commodities). These additional research steps in the case of poultry elicited more nuanced and richer information.

The review of trends and drivers within the agricultural sector and within the three specified commodity value chains revealed many opportunities for green enterprise development, green specialisms in occupations and green skills that could enable the agricultural sector to transition to greener and more resilient practices.

![Figure 1: Narrowing the study’s focus from the sector as a whole, to a commodity, to a hotspot in the commodity, to the green skill needs of people working in the hotspot.](image)

**Figure 2: Typology showing green skills and green occupations ‘nested’ within green enterprises**

- **New enterprise opportunities**
  - Demand for green services to support points along the value chain, green practices, green consumer products, green technology, or green types of farms.

- **New specialism opportunities**
  - Demand for people to work in green enterprises
  - Demand for new people who can identify, advise, support, research, create.

- **New skill opportunities**
  - Demand for ability to work in new enterprises and new occupations
  - Demand for ability to change existing occupation to a greener practice

**Examples from study**

- Pasture-raised poultry and eggs - Climate-smart abattoir
- Bio-dynamic poultry farmer - Climate-smart Abattoir Manager - Energy Systems Auditor
- Ability to reduce and manage wastewater - Understanding of no-till principles and practice
The new green enterprise opportunities, specialisms in occupations and skills identified across the different value chains have been summarised in the table below.

<table>
<thead>
<tr>
<th>Hotspot areas</th>
<th>New green enterprise opportunities, specialisms and skills</th>
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</table>
| **Poultry**   | **Inputs**: Alternative and local feed production  
**Primary production**: Training, support or extension services for rural, small-scale and/or emerging producers  
**Slaughter**: Green and equitable development of slaughterhouses  
**Across the value chain**: Energy efficiency and alternative energy sources; and opportunities for reducing or better managing waste and waste water. | **Enterprise opportunities**:  
- Mobile slaughtering facilities;  
- Climate-smart abattoirs;  
- Protein feed for livestock from food waste;  
- Alternative poultry feeds from indigenous crops.  
**Specialisms**:  
- ‘Outdoor’ or pasture-reared poultry farmers for broilers and/or eggs;  
- Climate-smart Abattoir Manager  
**Skill needs**:  
- Knowledge of and ability to implement sustainable mixed farming methods and land management;  
- Ability to design, audit and implement efficient energy, water and waste management systems, especially for abattoirs. |
| **Winter grain** | **Inputs**: Specialist machinery needed for conservation agriculture; and the development of bio-friendly fertilisers and pest management practices (i.e. that are not a risk to local ecology through run-off).  
**Primary production**: Training, specialist expertise support and research needs of conservation agriculture  
**Sale**: Developing new markets, products and alternative sources of income. | **Enterprise opportunities**:  
- Local CA machinery manufacture or adjustments,  
- Development of new bio-friendly inputs,  
- Diversifying income sources, e.g. day care services  
**Specialisms**:  
- Conservation farmers  
- Advisory services for new cover crops, new market opportunities and new income-generating activities (such as processing wheat or barley on-farm)  
**Skill needs**:  
- Knowledge of conservation agriculture principles and supporting practices, such as no-till, soil and water management, crop rotation, soil cover and cover crops.  
- Knowledge and understanding of agro-climatic conditions in area – soil type, climate, topography  
- Ability to deliver specialist training services for environmental issues associated with land management (incl. associated policy and regulations), such as fire, alien invasive plants, riparian zone management. |
| **Deciduous fruit** | **Inputs**: Technologies and tools for on-farm water use efficiency;  
**Post-harvest**: Energy consumption along the value chain but especially at packhouses and cold storage;  
**Waste**: Reducing and re-using solid waste along the value chain. | **Enterprise opportunities**:  
- Compost from pomace and on-farm solid waste;  
**Specialisms**:  
- Water pump efficiency engineers and auditors;  
- Energy efficiency auditors and energy systems engineers.  
**Skill needs**:  
- Ability to determine, implement and monitor energy management and efficiency plans;  
- Knowledge of and ability to implement water stewardship practices: measuring nutrient levels and sugar content, maintaining irrigation systems, knowledge and understanding of agro-climatic conditions in area – soil type, climate, topography – and and suitable cultivars. |
In addition to the above, across each of these value chains, extension services (i.e. Agriculture Consultants) repeatedly emerged as a critical occupation that requires training in CSA and green skills. Extension services are a valuable mechanism to bring new research and training on green practices to farmers and farm workers.

Importantly too, the skills and specialism for unlocking resilience and sustainability were found not only at the farm level, but spread across agricultural value chains, and in some cases exist in linked sectors – such as water and manufacturing.

The green enterprise opportunities, specialisms and skills identified in the study represent the demand for particular green skills and associated training and support inventions. In order to adequately capture the current green skills gap the study also briefly explored the supply of green skills – i.e. the different training opportunities available and the training and career pathways adopted.

In general, the supply system for climate-smart agricultural practices appears weak, notably with none of the agricultural colleges in South Africa offering courses in climate-smart agriculture, despite lecturers acknowledging the need. Those practitioners and producers who have adopted alternative greener practices are often informally or self-taught. The study showed the value of partnerships in unlocking and creating opportunity: whether these are public / private partnerships (i.e. government, commercial farmers, and agribusiness), mentor-mentee relationships, or large established farms supporting new micro-industries and small-holders.

Green skill training for climate-smart agriculture has potential to stimulate new enterprise growth and create employment opportunities while reducing or mitigating negative environmental impacts. This potential points to the need for different actors and agencies in the agricultural sector to work together to develop a more robust, needs-sensitive skills development system. More detailed and targeted recommendations can be found in each commodity chapter and in the concluding chapter. These recommendations can be summarised as follows, arranged by the stakeholders to whom they are primarily relevant:

**Sector Education and Training Authorities (SETAs)**

SETAs are critical for driving training in a sector. Key to driving green skills in the agricultural sector is the Agricultural Sector Education Training Authority (AgriSETA).

- **AgriSETA**: Communicate the need for CSA training options to training organisations and encourage the development of CSA courses focused towards specific commodities.
- **FoodBevSETA**: Assist in the development of new training courses for climate-smart or sustainable abattoir management, and in waste water management for food processors.
- **W&R SETA**: Help to raise awareness amongst large food retailers of the potential positive social, environmental and economic impacts of sourcing from small, local producers.
- **EWSETRA**: Support the development of training programs for water and energy-efficiency auditors and support research that helps to better understand options for bio-fuel and energy from waste.

**Commodity and sector bodies and associations:**

All commodity and sector bodies and associations (such as the South African Poultry Association and GrainSA) representing the interests of member stakeholders in a sector could assist in the dissemination of information amongst their members and the development of new training courses on climate-smart agricultural practices.

**Western Cape Department of Agriculture (WC DoA)**
The Western Cape Department of Agriculture (WC DoA) is in a prime position to mobilise other role-players and bring different stakeholders together. The WC DoA is also responsible for overseeing the training and supply of extension services through Elsenburg College. The WC DoA is well-placed to advocate for the integration of CSA into agricultural college curriculum, and strengthen extension services. The WC DoA is also best placed to work with development agencies, such as Casidra, to explore the feasibility of new employment and enterprise opportunities associated with each commodity in this study (e.g. the feasibility of mobile slaughtering services).

**Department of Higher Education and Training (DHET)**

The Department of Higher Education and Training (DHET) oversees universities and other post-secondary vocational education and training in South Africa, and maintains the Organising Framework for Occupations (OFO) to facilitate skills development planning. However, this study raised concerns over the efficacy of the OFO as a tool for green skills development planning, as the OFO often oversimplifies occupations or does not include green specialisms in occupations. It is recommended that the OFO is reviewed as a skill-planning tool, or substantial changes are made to update specialisms to include green specialisms in occupations. For example, the study identified the following green specialisms are currently not included in the OFO: Outdoor or pasture-reared poultry farmers, Climate-smart Abattoir Manager, Conservation farmers, Energy efficiency auditors and Energy systems engineers.

**Future researchers:**

The skill implications of a transition towards a green economy is a new knowledge field around which a community of interested researchers is developing. This study identified several new questions and areas for future research which may be pursued by post-graduate students and researchers in agricultural colleges and university departments.
# List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACDI</td>
<td>African Climate and Development Initiative</td>
</tr>
<tr>
<td>AFMA</td>
<td>Animal Feed Manufacturers Association</td>
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<tr>
<td>AgriBEE</td>
<td>Agricultural Broad-Based Black Economic Empowerment</td>
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<tr>
<td>AgriSETA</td>
<td>Agricultural Skills Education and Training Authority</td>
</tr>
<tr>
<td>ARC</td>
<td>Agricultural Research Council</td>
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<tr>
<td>BCCS</td>
<td>Baking, Cereals, Confectionary and Snacks</td>
</tr>
<tr>
<td>BFAP</td>
<td>Bureau for Food and Agricultural Policy</td>
</tr>
<tr>
<td>CA</td>
<td>Conservation Agriculture</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CSA</td>
<td>Climate-Smart Agriculture</td>
</tr>
<tr>
<td>DAFF</td>
<td>Department of Agriculture, Forestry and Fisheries</td>
</tr>
<tr>
<td>DHET</td>
<td>Department of Higher Education and Training</td>
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<tr>
<td>DPFO</td>
<td>Developing Poultry Farmers’ Organisation</td>
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<td>ELRC</td>
<td>Environmental Learning Research Centre</td>
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<td>EPI</td>
<td>Environmental Performance Index</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>FBMS</td>
<td>Food and Beverages Manufacturing Sector</td>
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<tr>
<td>FET</td>
<td>Further Education and Training</td>
</tr>
<tr>
<td>FoodBev SETA</td>
<td>Food and Beverages Manufacturing Sector Education and Training Authority</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GESF</td>
<td>Green Economy Strategy Framework</td>
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<td>GHG</td>
<td>Greenhouse Gases</td>
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<td>GM</td>
<td>Genetically Modified</td>
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<tr>
<td>GMOs</td>
<td>Genetically Modified Organisms</td>
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<tr>
<td>GrainSA</td>
<td>Grain South Africa</td>
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<tr>
<td>HE</td>
<td>Higher Education</td>
</tr>
<tr>
<td>HET</td>
<td>Higher Education and Training</td>
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<tr>
<td>HR</td>
<td>Human Resources</td>
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<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>ISL</td>
<td>Industry Statutory Levy</td>
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<tr>
<td>KZN</td>
<td>KwaZulu-Natal</td>
</tr>
<tr>
<td>MAFISA</td>
<td>Micro Agricultural Finance Institutions of South Africa</td>
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<tr>
<td>N₂O</td>
<td>Nitrous Oxide</td>
</tr>
<tr>
<td>NAMC</td>
<td>National Agricultural Marketing Council</td>
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<tr>
<td>NCCP</td>
<td>National Climate Change Response Policy</td>
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<tr>
<td>NFPM</td>
<td>National Fresh Produce Markets</td>
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<tr>
<td>NQF</td>
<td>National Qualifications Framework</td>
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<tr>
<td>NSDS</td>
<td>National Skills Development Strategy</td>
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<tr>
<td>OFO</td>
<td>Organising Framework for Occupations</td>
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</table>
QLFS  Quarterly Labour Force Survey
REAL  Research in Education and Labour
SAB   South African Breweries
SAPA  South African Poultry Association
SAPPO South African Pork Producers Organisation
SETA  Sector Education and Training Authority
SmartAgri Smart Agriculture
SMME’s Small Medium Micro Enterprise
SPCA  Society For The Prevention Of Cruelty To Animals
SSP   Sector Skills Plan
TVET  Technical and Vocational Education and Training
UK    United Kingdom
UNEP  United Nations Environment Program
USA   United State of America
W&R SETA Wholesale and Retail Sector Education and Training Authority
WC DoA Western Cape Department of Agriculture
WSPs  Workplace Skills Plans
WWF   World Wide Fund for Nature
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1. Introduction

1.1 Skills for Climate-Smart Agriculture

The South African agricultural sector exemplifies that ‘we live in an interconnected, and interdependent, world’ (WWF, 2014). Agricultural production is integrally tied to natural resources and systems, relying heavily on the availability of suitable land and healthy soil, water, climatic conditions, and other ecosystem services (pollination, for example). At the same time, farming often poses a threat to biodiversity and ecosystem functions, for example, through encroachment of farmland into sensitive ecosystems, cultivation of monoculture at the expense of biodiversity, and pesticide runoff. Agricultural production is also threatened by shifting weather patterns and the impacts of climate change. At different points along the value chain the production, transport and storage of agricultural commodities requires energy and other costly inputs, vulnerable to market fluctuations. The sector is fundamental to social wellbeing at different scales because of its role in livelihood/job creation, as well as to national and local food security (the stability, quality, availability, accessibility and utilisation of food). Additionally, agriculture is a cornerstone of the South African economy, through national and export markets. In this sense ‘[f]ood, water, energy – and the biodiversity and ecosystems upon which they depend – are closely intertwined, and fundamental for human existence’ (WWF, 2014).

New agricultural approaches and practices are emerging that will allow stakeholders in the sector to take advantage of opportunities arising from this complexity, to manage the significant risks posed by environmental and climate change, and to support sustainable, green development. An approach used to conceptualise this study is Climate-Smart Agriculture (CSA), which considers transformation of the sector across the whole agricultural value chain, incorporating farm-level approaches such as Conservation Agriculture. CSA integrates the three dimensions of sustainable development - economic, social and environmental - by jointly addressing food security and climate challenges. It is composed of three main pillars: i) sustainably increasing agricultural productivity and incomes; ii) adapting and building resilience to climate change; and iii) reducing and/or removing greenhouse gases emissions, where possible.

Shifting the South African agricultural sector towards a climate-smart approach requires a labour force equipped with the skills to enable this transition. This report demonstrates that particular skills are required to respond to the environmental and related socio-economic challenges faced by the agricultural sector. Yet what exactly these skills are is not well understood. New green specialisms will also need to be identified within the sector to capacitate emerging areas of work, such as ‘outdoor’ poultry and egg production. Importantly, the skills for unlocking resilience and sustainability are not only at the farm level, but are spread across agricultural value chains, and in some cases exist in linked sectors – such as water and manufacturing.
**Box 1: Important terms**

**What is the Organising Framework of Occupations (OFO)?**

The OFO is a coded occupational classification system. It is the Department of Higher Education and Training’s (DHET) key tool for identifying, reporting and monitoring skills demand and supply in the South African labour market.

The OFO identifies similarities in jobs in terms of tasks and skills, and categorises similar jobs into occupations. The OFO was established to add value to skill development planning and implementation by creating a common language and a hierarchical categorisation system. One purpose of this study is to make recommendations for how the OFO should be amended to include green skills specific to the agriculture sector, to better integrate green skills and plan for green economic development.

**What is a green job, specialism or occupation?**

A green job could refer to an opportunity created through a new green enterprise/opportunity (for example, non-specialist positions created through the construction of a wind farm or organic farm), or a position with specialist green skills required within a new or existing enterprise.

The OFO identifies similarities in jobs in terms of tasks and skills, and categorises similar jobs into occupations. A job can therefore be quite specific, whereas an occupation is a family of similar jobs. In this study, we are identifying jobs that have specialist green skills requirements, with a view to either adding to the list of existing jobs and specialisms listed under occupations within the OFO, or refining the descriptions to include green skills.

**What is a green skill?**

Skills in this context are the abilities or competencies required within particular jobs or occupations. While the term skill can very narrowly refer only to a technical ability to do something, here the use of the term ‘skill’ usually implies something broader – a combination of attitudes, values, knowledge and abilities. These skills are referred to in relation to particular occupations, as defined in South Africa’s Organising Framework of Occupations (OFO). In this study, green skills address opportunities to:

- Reduce energy and water consumption;
- Reduce emissions, pollution and waste;
- Protect or restore biodiversity and ecosystems; and
- Enhance climate resilience.

This definition of green skills incorporates and is aligned with the pillars of conservation agriculture and climate-smart agriculture, but is broad enough to apply across sectors. The study attempts to differentiate between low, intermediate and high skills, in alignment with definitions used by DHET (Reddy et al, 2016).

**What is an agricultural value chain?**

A value chain includes the whole range of goods and services necessary for an agricultural product to move from the farm to the final consumer, including the inputs required (for example, fuel for transporting goods to market). The value chain concept is used to describe the actors connected along different points in a complex chain that produces, processes and delivers goods to consumers through a sequence of activities (Herr and Muzira, 2009).
1.2 Purpose of the Study

This study forms part of the national Green Skills Project - a partnership between Rhodes University Environmental Learning Research Centre (ELRC), the University of Cape Town’s African Climate and Development Initiative (ACDI), the University of Witwatersrand Centre for Researching Education and Labour (REAL), and others. The Green Skills Project aims to strengthen the capacity of the national skills system to better integrate and plan for green skills development, with a particular focus on post-school skills development. The project includes a focus on developing methods for analysing green skills, and uses case studies in several sectors (e.g. mining and chemicals) to assess green skills and feed information back into the relevant Sector Education and Training Authority (SETA).

This study investigates the demand for and supply of green skills needed among farmers, farm workers, extension workers, food processors, researchers and lecturers and others along three commodity value chains. The study has identified the broadest range of skills possible within its scope, to inform national skills planning as well as other provincial or sectoral plans and policies, such as the Western Cape Agriculture Sector Climate Change Framework and Implementation plan (SmartAgri plan, 2016).

The study was guided by the following overarching research questions: Where is the biggest potential for greening in the value chain of a particular agricultural commodity, and what are the necessary skills for unlocking this potential?

The objectives of the study on green skills for CSA are as follows:

1. **To identify the demand for green skills in the agricultural sector in the Western Cape:** This was achieved through a review of the opportunities for green jobs and skills across the value chains of three agricultural commodities. Identifying the demand for green jobs and skills allows for recommendations to be made to the Western Cape Department of Agriculture (WC DoA) and the Agricultural Sector Education and Training Authority (AgriSETA) on the areas in agriculture where there are major opportunities for greening, linked to the skills needed in these areas.

2. **To support capacity development for green skills in the agricultural sector at a SETA level:** This was achieved by conducting a gap analysis of the skills, jobs, specialisms and occupations required to transition to greener practice that are not currently identified in the OFO. By identifying these gaps, the OFO can be strengthened by adding to the list of existing occupations, or refining the descriptions to include green skills.

3. **To develop and test green skills methodology:** The desktop review undertaken under objective 2 was complimented by targeted site visits and interviews to test the desktop findings, and pilot methodology that could be used in future studies.

4. **To extrapolate lessons related to the skills supply system:** Interviews under objective 3 included career and training pathways questions which provide some indication of the extent of formal and informal skills supply in relation to the green skills identified under objective 1.

1.3 Relevance for the Western Cape Agricultural Sector Climate Change Framework and Implementation Plan

This study is intended to contribute to a deeper understanding of green skills potential and needs within poultry, winter grains and pome fruit value chains. In order to have the largest impact possible this study was framed in consideration of the recently established Western Cape Agriculture Sector Climate Change Framework and Implementation Plan (widely known as the SmartAgri Plan). The SmartAgri Plan presents the “road map” for the
The agricultural sector of the Western Cape to travel towards a more productive and sustainable future, despite the uncertainties around specific climate projections. By exploring commodities that reflect different types of farming, and tracking the full value chain including inputs and processing, this study on green skills for CSA was designed to provide insights for potential skills barriers and opportunities for achieving the SmartAgri Plan’s ambition.

The SmartAgri project was initiated when the Western Cape Department of Agriculture (DoA) and the Department of Environmental Affairs and Development Planning (WC DEA&DP) recognised that an inclusive approach was needed to develop strategic and long-term resilience to climate change for the agricultural sector. The Western Cape Agriculture Sector Climate Change Framework and Implementation Plan (SmartAgri Plan) evolved out of a thorough status quo review and an intensive stakeholder engagement across all commodities, farming systems, and agro-climatic zones of the region, followed by the collaborative development of the Plan’s Strategic Focus Areas. This is the first provincial climate change response strategy for agriculture in South Africa. The project specifically focuses on food security and promotes climate-smart agriculture.

The SmartAgri Plan proposes a focus on four Strategic Focus Areas with the aim to:

1. Promote a climate-resilient, low-carbon production system that is productive, competitive, equitable and ecologically sustainable;
2. Strengthen effective climate disaster risk-reduction and management for agriculture;
3. Strengthen monitoring, data and knowledge management and sharing, and lead strategic research for climate change and agriculture; and
4. Ensure good, co-operative governance and joint planning for effective climate change response implementation for agriculture.

A critical prerequisite for the successful implementation of the SmartAgri plan will be the availability of particular skills that can assist in the roll-out and uptake of these and similar climate-smart agricultural initiatives. Quite a number of these skills can be categorized as green skills for climate-smart agriculture. The agriculture green skills study will therefore inform the skill needs of the SmartAgri plan. While the agriculture skills case study is limited to the Western Cape, the skills across value chains of the selected commodity value chains are applicable to other regions (and often to other crops) across South Africa.

The study takes the above concepts into account when defining what is meant by green skills for climate-smart agriculture. The research has identified the specialisms and related skills needed to ‘green’ the winter grain, pome fruit and poultry sub-sectors in agriculture, i.e. to improve ecological sustainability, protect biodiversity, and adopt the principles of climate-smart agriculture.
2. Methodology

2.1 Conceptual Frameworks

The study draws its approach from several related concepts to inform the methods adopted and the analysis of findings.

**Green economy**

The concept of a green economy has been gaining traction over the past twenty years, emerging as a central theme in the 2012 United Nations Conference on Sustainable Development. Though generally understood to be a transformed economy that promotes a transition towards more sustainable development practices, different sectors and international agencies have interpreted the term with different emphases. For example, a narrow interpretation of the green economy has been that of low-carbon or low emissions, essentially, a green (i.e. renewable) energy economy. The United Nations Environment Programme (UNEP, 2011) defines a green economy more broadly as “an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”. Given the imperative for economic growth in the South African context to redress injustices of the past, improve standards of living and level social inequalities while protecting and promoting the country’s rich biodiversity and ecological heritage, UNEP’s broader conceptualization of the green economy has been employed in this study.

**Value chain analysis**

The central approach to identifying areas of opportunity for greening in the agricultural sector is a value chain approach (Herr and Muzira, 2009). Food value chains are perceived as a relatively new model of organization within the agricultural business sector (Diamond et al. 2014). The development of food value chains is influenced by the increasing demand for additional processed, possibly specialized, and differentiated food products, and include packaging, distribution, and retail channels through supermarket chains and fast food outlets, resulting in heterogeneous commodity goods (Diamond et al. 2014). Economies at scale in processing, differentiation, and vertical integration\(^1\) suggest relative concentration at various stages of each product market’s value chain. In order to allow for retailers to standardize quality and reap scale economies, producers of high-value agricultural products are pushed towards vertical integration (Hellin and Erenstein 2009).

**Circular economies**

Linked to value chains, circular economy thinking is a conceptual framework to help identify opportunities for reducing waste, creating additional value and/or developing systems of value creation. Circular economies are regenerative and restorative economies that are underpinned on principles that waste is ‘designed out’, diversity is seen as a driver of versatility and resilience, energy is renewable, and prices reflect the full cost of externalities (Ellen MacArthur Foundation, 2015). The figure below illustrates these principles - a product, once used, is ‘circled’ back to a point in the value chain to be re-used, re-furbished, or recycled, or the biological components extracted and processed.

\(^1\) Vertical integration refers to when a company incorporates and combines two or more stages of production, which are normally operated by separate companies.
A life cycle analysis of a product or a commodity is a related methodological approach linking value chains and circular economies (e.g. Mulvaney, 2014). Various opportunities for linking value chains to improve environmental efficiencies are identified in this study, and the associated skills and enterprise opportunities outlined.

**Transformation**

This study attempts to go further than superficial attempts at greening. The spectrum of approaches towards ‘greening’ has been outlined as four different kinds of responses: denial (it's a hype that will go away), bolt on (add a ‘green aspect’ to a curriculum or programme), built-in (important enough to integrate in all we do) and whole system re-design (we need to re-think the very foundations of what we currently do). “It is the last response that suggests a paradigm shift and a transition towards doing better things differently (transformation) rather than doing what we do better (optimization)” (Lotz-Sisitka et al, 2015). It is the latter approach, of doing things differently, that this study most prioritises.
The importance of transformation in the agricultural sector – and the need to do things differently – is underscored by the growing pressure on agriculture to be more productive to alleviate the food security needs of a growing population, both within the confines of resource degradation and the impacts of climate change.

Transformation in the agricultural sector is also an issue of righting historic injustices and laying the foundation for a more equitable future, and thus it incorporates issues of social justice. As such the study attempts to look at the specific needs of emerging farmers, of land reform programs, of farm workers and of youth. An omission in these categories is that of women, who are underrepresented in South Africa’s agricultural sector.

Green skills are critical for the successful adaptation of the principles of climate-smart agriculture and the transformation to a circular green economy. While green skills in the agricultural sector refer to a diversity of knowledges, technologies and capacities, the overarching intention of this study is to identify emerging green enterprises (demand for green products, services, practices, types of farms), specialisms (demand for people to work in green enterprises and for people who can identify, advise, support, research, create) and skills (demand for ability to work in new enterprises and new occupations, and for ability to change current practice related to emerging occupations).

2.2 Methods

This study adopted a phased mixed methods approach, at the core of which was the application of a value chain analysis for distinct agricultural commodities to identify opportunities for greening, and job creation or skill training.

This study focused on specific commodity value chains – from inputs through to consumption and waste – and identified key drivers; priority areas or ‘hotspots’ in the value chain (points that acted as leverage points or that had the greatest impact); and the roles, activities and associated skill needs of those working in the ‘hotspot’ areas within the value chain. Each specific step in the study is outlined below:

**Desktop review of green skills in agriculture:** This phase included a desktop review of available green economy and green skills literature, in order to clarify the conceptual frameworks underpinning this study. Additionally, the climate-smart agriculture literature was reviewed in order to understand how this study could build on the outputs of the SmartAgri study.

**Selection of agricultural commodities:** An analysis was conducted of the primary agricultural commodities produced in the Western Cape to select three value chains for more focused study. A desktop review of multiple commodities in the Western Cape was undertaken, comparing the economic contribution, growth and employment potential, environmental impact, social impact, risk profile, mitigation and adaptation considerations. Information for these categories was drawn from commodity association and government commodity reports. The following commodities were compared: citrus; deciduous fruit; livestock; poultry; grain; micro-industries of cut flowers, honeybush, rooibos, and olives; and vegetables (specifically potatoes and onions to narrow the focus). This part of the methodology and the results of the analysis are described in Chapter 3 of this report.

**PESTLE analysis along value chain of three chosen commodities:** A desktop review was conducted of the political, economic, social, technological, environmental, and legal drivers affecting the demand for green skills in the value chains of poultry (broilers and eggs); winter grain (barley and wheat); and deciduous fruit (pome fruit/apples and pears). This information was drawn mainly from grey literature from industry or commodity associations and government reports, and to a lesser extent from academic literature. For example,
Department of Agriculture, Forestry and Fisheries (DAFF) has produced value chain reports for a number of agricultural commodities. Such documents and reports were used to map out the chosen commodity value chains, and to start capturing the activities at each point along this chain, and the skills needed to undertake these activities. The value chain should be extensive to include inputs such as consultancies and technological innovations, and agri-processing, through to consumption.

**Interviews with commodity association representatives:** Key informant interviews were held to deepen the PESTLE analysis and help to identify the ‘hotspots’ in the value chains (i.e. opportunities or leverage points for greatest impact in value chain). These include interviews with two experts for winter grains; one expert for pome fruit; and two (at the same time) for poultry. Interviews were structured to ask specifically about greening opportunities down the value chain. Information generated from the interviews was captured through detailed summary notes.

**OFO mapping:** The OFO database was searched, drawing out the relevant occupations along the commodity value chains with careful attention to the hotspot areas. Key occupations in the hotspots were assessed in more detail with suggestions given for how the occupational description or associated occupational tasks could be adjusted to reflect greener practice.

**Site visits and interviews at hotspots:** Different degrees of further analysis were pursued to help to understand constraints and opportunities at the hotspot.

- For pome fruit, a further interview with a professional working in a hotspot was conducted.
- For poultry, interviews were conducted with representatives and researchers (i.e. the supply side), and site visits and interviews were conducted at two linked hotspots sites. The site visits covered interviews with managers on their daily tasks and training, and those of all other employees on the site.

This range of approaches was adopted to allow for reflection on the efficacy of the methods, in terms of generating sufficiently detailed information about different occupations and skill needs.
3. Analysis of Contextual Drivers of Green Skills for Climate-Smart Agriculture and Commodity Selection

3.1 The South African Agricultural Sector in the Green Economy

The role of agriculture in the South African ‘green economy’

Globally, developing countries are facing economic, social and environmental challenges to achieving sustainable development, including crises related to food, water and energy security (UN, 2013). South Africa is characterized by high unemployment rates, and related issues of social justice, and poverty. At the same time, pressures on various economic sectors are intensifying in relation to environmental degradation, as well as the effects of current and future climate change. These challenges and pressures can also be seen as presenting opportunities for change. The idea of a ‘green economy’ has emerged as a means of conceptualizing the possible opportunities that arise from social and environmental challenges (Musvoto et al, 2014).

While multiple definitions for the term green economy exist, broadly speaking it refers to an economy that results in ‘improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities’ (UNEP 2010). Agriculture in developing countries is seen as a fundamental sector in contributing towards the green economy (FAO, 2012). It has also been identified as one of the crucial sectors that will contribute towards a South African green economy (Musvoto et al, 2014).

While agriculture presents opportunities for supporting green economic growth, there are a variety of challenges that must be acknowledged. These include: i) the limited availability of resources (arable land and quality water) that support agricultural production, particularly for poorer farmers; ii) the relatively low market values of agricultural commodities, and consequently the limited potential for low levels of agricultural production to impact on local economies; iii) the negative effects of agriculture on the natural environment; and iv) current and projected changes in climatic conditions (Musvoto et al, 2014). Attempts to increase the contribution of this sector to the economy – including the development of green skills – should take these challenges into account.

Agriculture is a diverse sector and is spread across: i) large-scale commercial agricultural enterprises; ii) emerging commercial farming; and iii) small-scale and subsistence farming. The sector’s contribution to the country’s Gross Domestic Product (GDP) has decreased significantly from 23% in 1920 to 3.1% in 2003 (SSA, 2005), declining further in 2009 to 2% (ERD, 2010). However, agriculture has strong linkages to the manufacturing sector, which makes a greater contribution to the economy. The agro-industrial sector comprises about 12% of GDP, and 20% of manufacturing employment (Baleta and Pegram, 2014).

Agricultural productivity is reliant on various critical inputs (indicated in bold). Approximately 13% of South Africa has arable soil, with only 3% considered to be high-potential agricultural land (WWF 2015:10). A large proportion of the country’s land surface has been degraded by overexploitation and improper and unsustainable farming methods (UNEP, 2013). The number of farms along with the land area being used for crop production in South Africa has declined considerably since the 1990s (WWF-SA, n.d.). However, the decline on
land area used had little effect on overall production. The World Wide Fund for Nature (WWF) asserts that this inconsistency points to an increase in production entailing increased water use for irrigation, increases in the use of fuel, agrochemicals, fertilisers and mechanisation, as well as a growing dependence on genetically modified seed. This intensification, particularly where it is not managed in a proper manner, results in cumulative damage to soil fertility, erosion, polluting water sources, producing toxic effects on biota and farm workers, weakening the resilience of ecosystems and contributing to the impacts of climate change (Musvoto et al, 2014).

Important inputs into the agricultural value chain are the skills required to undertake the work within and across different agricultural value chains. The Sector Education and Training Authority for the agricultural sector, or AgriSETA, notes that an expanded focus on sustainable farming practices “necessitates a growth in higher level knowledge (through research) and skills linked to developing and implementing green technologies that improve energy efficiency, reduce carbon emissions and advance resource sustainability” (AgriSETA, 2014). To transition the agricultural sector away from damaging practices requires identifying and developing the skills necessary for enabling greener agricultural practices within the spectrum existing jobs in the sector. New green jobs and opportunities also need to be identified where there are gaps. This process will help to unlock the potential for job creation and green economic growth that is latent in the agricultural sector, contributing to the green economy.

**Key drivers of change in the South African agricultural sector**

**Political, legal and regulatory drivers:**

Broadly, the sector is governed by a set of policies and strategies, including:

- National Development Plan (NDP)
- National Environmental Management Act (NEMA)
- New Growth Plan
- Agricultural Broad-Based Black Economic Empowerment (AgriBEE)
- Strategic Plan for DAFF
- Animal Improvement Policy
- Environmental Implementation Report
- Experiential Training and Internship Policy
- Integrated Growth Development Plan
- Land Redistribution
- Micro Agricultural Finance Institutions of South Africa (MAFISA) Credit policy
- Agricultural research and Development Strategy
- Pesticide Management Policy
- Integrated Food Security Strategy
- Trade Policy

The agricultural sector is governed by several acts, covering facets of production such as animal improvement; animal protection; fencing; fertilisers; genetically modified organisms (GMOs); marketing; agricultural pests; animal diseases and fire.

Two key themes within this policy environment that are particularly relevant to green skills:

1. **Regulating product ethics and safety:** Consumer demands for safe products produced with socially acceptable, environmentally friendly methods are on the rise, internationally and nationally – with implications for labelling and product traceability. (DAFF; 2014a). Producers are confronted with many regulations to control production from farm to fork. These include regulating the use and quality of
water, soil, air, and chemicals to manage product ethics and safety. It is important to consider what skills are required to implement these regulations at different stages of the value chain.

2. Land redistribution: A significant portion of public financial resources has been allocated to land reform and agricultural support programmes for disadvantaged farming communities. New programmes were introduced in 2005 with the objective of supporting the development of market-oriented family farms emerging from the land reform process, primarily through investment grants and provision of microcredit and retail financial services in rural regions. The Land Reform Programme has reduced social tensions in certain areas and has redressed previous injustices – however, progress has been slow and projects have shown a 90% failure rate, decreasing overall agricultural output in certain regions (WWF-SA, 2014). An emerging issue relating to land tenures is that investors are hesitant to invest in and expand agriculture on land that does not belong to them, as mentioned in the NDP (Musvoto et al, 2014). It is important to consider green skills in training programmes for beneficiaries of agricultural land reform processes, to support productivity and help farmers to access niche international markets with ethical/green products.

Economic drivers:

1. Cost of farm inputs: The most expensive farm inputs are animal feed, fuel and fertilisers. Retail prices of these commodities are linked primarily to the oil price and the rand/dollar exchange rate, both of which are out of the farmer’s control. This can lead to unanticipated price hikes in farm inputs. For example, in 2008 the global demand for fertiliser surpassed supply. This, combined with the escalating price of raw materials used in fertiliser production, the rising oil price, and increased shipping costs resulted in unprecedented international prices for fertilisers. A weakened rand against the US dollar further increased the prices of imported fertilisers such as nitrogen and potassium. Local fertiliser production is also influenced by international fluctuations and is under the control of a few large corporate companies (WWF-SA, n.d.). Farm-produced organic fertilisers and efforts to improve soil fertility have the potential to reduce input costs and the susceptibility of farmers to international price fluctuations (WWF-SA, n.d.). This economic opportunity to reduce an expensive input could be enabled by the development of green skills for the decentralised production of some of these inputs, where this is viable.

2. Changing retail environment: Supermarkets are a key driver of changing global dynamics in agro-food trade, production and employment. Supermarkets synchronize value chains that link production, processing, retail and consumers, leading to a decline in traditional wholesale and wet markets in a number of countries. They are focused on consumers, and on low cost and consistency, governing their suppliers through application of strict standards (Coe et al, 2009). This usually lowers the amount that farmers’ can charge for their products. Green skills are required in this part of the supply chain, especially in relation to procurement.

3. Energy use and carbon taxation: According to the South Africa Carbon Tax Policy (2013) the agriculture, forestry and land-use, and waste sectors will be excluded from the first five-year period of taxation. This is due to the administrative difficulties in measuring and verifying emissions. However, the intention is to include these sectors thereafter. In the interim, the agriculture sector continues to be vulnerable to hikes in the cost of electricity, putting particular pressure on crops that require a ‘cold chain’ (refrigeration, for example in storage, processing or transport). Energy efficiency is a cost reduction and risk management issue which can be supported by the development of green skills at various points along the value chain, including on-farm, cold transportation, storage, and retail.

Social drivers:

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2 A wet market is a market selling fresh meat and produce, distinguished from dry markets, which sell durable goods such as cloth and electronics.
A fundamental principle of nearly all government policy in South Africa is to address the past injustices of discriminatory policies and practices under Apartheid. This is reinforced by bringing the formerly excluded black majority into the mainstream economy by means of job creation and entrepreneurship. This has also been the case in the agricultural sector, a labour-intensive industry, in which policy reforms relate to a minimum wage for farm workers, agricultural support for disadvantaged farming communities, land reform, and a broad based programme of economic empowerment for the black population (De Villiers et al., 2009).

In practice, unskilled agricultural jobs can be problematic. The demand for agricultural labour varies seasonally, and this is reflected in the nature of the workforce. Hours of work tend to be extremely long during the planting and harvesting of seed and crop, and tend to be shorter at off-peak times. During rush periods field work can take place from dawn to dusk. The intensity of the work offers little chance for rest breaks, and the length of the working day offers very little time for recuperation. Payment systems can also encourage intensified working hours. As minimum wages for agricultural workers are low - and many casual, temporary or seasonal workers are paid based on daily performance (i.e. per kilo of crop harvested, row weeded, or hectare sprayed) - there is a strong financial incentive for them to prolong their working hours to the maximum so as to enhance their earnings (FAO, 2007).

Other social challenges related to the agricultural sector include drug and alcohol abuse, and social unrest within the labour force. This could be the driver of mechanisation in some value chains as farmers and business owners try to lessen the impact of labour instability on their operations. Some farm workers live in remote areas and do not have regular access to life skills training, or addiction support, further intensifying the vulnerability of farming communities.

To create resilience within the agricultural sector – as well as to contribute to local job and food security – it is critical that new and existing jobs take sustainable farming and climate change adaptation skills and practices into account.

**Technological drivers:**

There is a tension within the agriculture sector between mechanization and improved efficiencies on the one hand and labour shedding on the other. As described above, social instability can also speed up the need for mechanisation in some agricultural value chains. In other continents - particularly in the developing economies of Asia and Latin America - agriculture has been transformed in more recent years into a progressive commercial industry. In these areas, investment in agricultural mechanization has allowed farmers to intensify production and improve their quality of life along with contributing to national and local growth. The FAO asserts that increased levels of mechanization in Africa would nationally lead to improved land use, increased food production, enhanced rural prosperity, greater export potential and less reliance on imports (FAO, 2007). However, there are also concerns that mechanisation could make some jobs redundant, impacting on local wellbeing.

**Environmental drivers:**

South Africa ranks 128 out of 132 countries with regard to an Environmental Performance Index (EPI), based on a study done by Yale University (Western Cape Government, 2013a). This study considered air and water quality, loss of biodiversity, and eco-system, agricultural and fishery system deterioration (Western Cape Government, 2013). Farming is inherently and intricately connected to the natural environment, most notably in South Africa in the following key areas:
- **Water**: Agriculture is a water-intensive sector. South Africa is a water scarce country (although with distinct spatial and temporal variability of rainfall), with an east–west rainfall gradient, ranging from in excess of 1 000 mm to less than 250 mm of rainfall annually. Irrigation agriculture is by far the largest single surface water user, consuming ~ 60% of South Africa’s total water resources. An estimated 1.5% of the total land area is irrigated (DWAF, 2013). Skills are required both in the water and agricultural sectors for proper planning, management and utilisation of South Africa’s water resources for agricultural productivity.

- **Climate change**: South Africa is a water scarce, semi-arid country with a high degree of natural variability in its weather systems, and regular occurrences of flooding and drought (WWF, 2015). Climate is important in determining potential agricultural activities and suitability across the country, especially for small-scale producers and subsistence farmers (LTAS, 2013). Changes in climate will amplify the food production, water and energy challenges already facing South Africa. It is therefore critical to integrate climate change into sectoral planning, as well as into capacity building for the sector. For example, skills for advising farmers on how to adapt to climate change should be integrated into the agricultural extension curriculum.

- **Biodiversity**: South Africa is a biodiversity hotspot. Biodiversity is critical for ecosystem services, agriculture and agricultural tourism – the benefits of ecosystem services from biodiversity (such as clean, regular water supply, protection against floods, pollination and grazing) contributes ~ 7% to the GDP every year (Molewa, 2013). A third of the country’s ecosystems are under threat, together with the critical free services they provide to farmers. Without interventions, this threat will accelerate and negatively impact agricultural productivity and food security in the future (WWF, 2015).

- **Waste and pollution**: Herbicide, pesticide and fertilizer run-off pose a threat to South Africa’s water sources (ground and surface water). In addition to the health impacts of using contaminated soil and water for agricultural production, pollution presents a market-barrier for those focused on the export market, where health and safety requirements are more stringent.

- **Alien invasive species** and other land management issues: The uncontrolled spread of invasive alien plant species continues to outcompete indigenous plant species. It also impacts water supply, and drives wildfires. Given the scarcity of water and the sensitivity of local biodiversity, adopting appropriate land management practices is critical. Amongst these include the need to remove and manage invasive alien vegetation.

- **Land use change**: The Bureau for Food and Agricultural Policy (BFAP) estimates that with the current maize farming yields, approximately 447 600 tons of maize will be taken out of production in the future as a result of current and prospective mining operations. This will result in a 10% rise in the price of maize, with repercussions for local food security, particularly amongst the poor (AgriSETA SSP, 2015).

The drivers described above interact with and influence each other. Green skills development in South Africa – both in terms of new jobs and developing skills within existing jobs – has the potential to positively influence or change this complex sector towards greater resilience in the face of environmental and climate change, and towards a greater contribution to South Africa’s green economy.

### Skill needs in Agriculture in South Africa

A shortage of specialist skills is one of the biggest challenges in the agricultural sector, and in linked sectors such as manufacturing, retail and water. The skills requirements for agricultural value chains vary from skilled managerial and professional occupations to fairly low-level skills for agricultural labourers and entry-level workers in the agricultural value chain (AgriSETA, 2014). There is a particular shortage of technical specialists in the sector. For example, agricultural engineers, scientists and agricultural technicians are listed as occupations of high demand, making it easy for these specialists to secure working visas for South Africa (DHET, 2015).

In addition to these existing skills gaps, there are various opportunities for sustainable growth and increased efficiency in the sector that also require new green jobs and green skills. In the Industrial Development
Corporation report, ‘Green Jobs: An estimate of the direct employment potential of a greening South African economy’ (Maia et al, 2011), four broad areas of South Africa’s green economy potential are identified, namely: energy generation, energy and resource efficiency, emissions and pollution mitigation, and natural resource management. Across these areas, there are many opportunities relevant to the agricultural sector, including inter alia: biofuel development, carbon capture and storage, biodiversity conservation, and soil and land management. The GreenCape Market Intelligence Report for Agriculture (2016) identifies a similar set of green opportunities, including: energy efficiency and solar PV in the Western Cape’s agricultural sector; conservation agriculture; precision agriculture; water efficiency; the growing market for drone technology in agriculture as a means of monitoring climate and environmental trends; biological control; and bioenergy biogas from agricultural waste (GreenCape, 2016). Each opportunity for increasing profitability, sustainability and resilience in the agricultural sector should be considered in terms of the skills required, and the training and education opportunities that meet these needs.

Developing scarce skills for the South African agricultural sector can unlock opportunities that have been identified, and manage emerging environmental and climate risks to create resilience and conserve jobs and production in the sector. As such, an analysis of the green skills requirements in the various agriculture value chains is necessary to support green growth in the sector. This report is focused particularly on three agricultural value chains in the Western Cape.

### 3.2 Agriculture in the Western Cape

The Western Cape is an important region for agricultural production – most of South Africa’s agricultural export production takes place in this region, making a significant contribution to the National GDP (WCG, 2014; Wesgro, 2014). The agricultural sector is also currently the largest employer in the region (WCPG, 2013), and stability within the sector is therefore critical for supporting local economies, livelihoods and food security. For these reasons, the province was selected to focus on in this study on green skills in the agricultural sector.

The Western Cape agricultural sector is known for production stability, which is reinforced by well-developed infrastructure (GS, 2016). The variety of agricultural commodities cultivated contributes to this sustainability (Vink & Tregurtha, 2001). Deciduous fruit, poultry/eggs, winter grains, vegetables and viticulture together comprise over 75% of the total amount of commodities produced in the region, and micro commodities such as olives, cut flowers and teas are growing in popularity nationally and internationally.

The primary drive of the Western Cape Green Economy Strategy Framework (GESF) is ‘to position the Western Cape as the lowest carbon province in South Africa and the leading green economic hub on the African continent’ (WCPG, 2013, p. 8). Creation of green jobs is one of the three strategic priorities for achieving this goal. There is a particular concentration on agri-production as one of the drivers of a low carbon economy within the Framework. The Framework highlights sustainable farming procedures, energy and water efficiency, waste use and management (for example producing biodiesel from waste cooking oil), food security, and support for expanding value chains and markets (Musvoto et. al, 2014). The specific green jobs and skills needed to achieve this strategy have yet to be properly explored.

Maximizing the Western Cape’s adaptive capacity to the global threat of climate change will require planning, preparedness and innovation. The Western Cape is highly vulnerable to the effects brought about by climate change (WCG, 2013). Climate change models predict a warming of between 1.5 °C and 3 °C by 2050, reduction of winter rainfall, and an increase in variability of rainfall, the consequence of which would be higher evapotranspiration rates (Midgley, 2016). There will be winners and losers under the various climate scenarios projected (WCDE & WCDP, 2016j), some of which are explored in Section 3.3. Additional
pressures facing the agricultural sector of the Western Cape include resource constraints due to urbanisation and population growth, as well as negative effects of natural resource degradation (DWA, 2011; Midgley, 2016). New green skills and green jobs will be required to manage and adapt to these interacting social, economic and environmental drivers.

3.3 Comparing Agricultural Commodities in the Western Cape

At the beginning of this research, a comparative desktop research process was undertaken to select agricultural commodities and their value chains for more in-depth study. The purpose of this exercise was to identify activity hotspots in particular value chains that – if better understood – could unlock green jobs for the sector. The outcome of this process can be viewed in Appendix A. The agricultural commodities compared were primary crops grown in the Western Cape. These included: citrus; deciduous fruit; wine and table grape; dairy; poultry/eggs; livestock (pigs, cattle, ostrich, goats); grain (such as wheat); fynbos cut flowers; honeybush; olives; rooibos; and potato and onion. We clustered these commodities into broader categories of fruit, livestock, grain, micro commodities\(^3\), and horticulture.

The following indicators were chosen for the comparative desktop analysis of these commodities: environmental impact (any negative impact of commodity production on the physical environment); social impact (the impact on local people and communities); climate change risk profile (the degree to which the commodity could be effected by projected climate change); and growth potential and contribution to overall agricultural sector. A category was also created for other motivations for choice that did not fall within any of the formerly mentioned categories. The researcher then worked methodically through these categories for each agricultural commodity, using the relevant SmartAgri documentation and a desktop search for commodity-specific documents or industry news articles, or mentions of specific commodities in national documents such as the National Development Plan. Key insights derived from this analysis are presented below:

Environmental impact:

- An area of environmental impact identified across most of the value chains was *water usage*. Notable exceptions were the indigenous micro commodities, which require relatively low water usage unless farmed intensively. Additionally, these species often require less harmful agricultural inputs. For example, the natural predator-prey associations for the indigenous honeybush species dramatically reduce the need for chemical interventions for pests and diseases (WCDE & WCDP, 2016a). Irrigated and rain-fed agriculture have different impacts and vulnerabilities from a water usage perspective, which made it interesting to select one of each (deciduous fruit and wheat) for more in-depth analysis from a skills perspective.

- Cultivation of fruit and vegetables often takes place in *sensitive ecosystems*, which may have high conservation value. For example, regions suitable for citrus production have a high density and total area of important wetlands, many threatened by agriculture. Runoff from the use of chemicals and fertilizers on fruit and vegetable crops can encourage the growth of alien vegetation (WCDA et al., 2016). Other threats to ecosystems within or surrounding farmlands include destruction of riverbanks and wetlands, which act as flow regulators and drought buffers (WCDA et al., 2016). Considering the potential for reducing this impact through green skills development, it seemed wise to include a fruit crop as one of the value chains to look at in more depth for this project.

- Proper waste management is critical in livestock and poultry value chains due to the potentially hazardous and contaminating waste produced through the production and slaughtering process.

Social impact:

\(^3\) Niche commodities such as olives, specialty teas, and cut flowers.
• A useful metric for social impact is the number of jobs across an agricultural value chain. However, in most cases data is only available for farm-level jobs. The comparative analysis revealed that the deciduous fruit industry is a major national employer (~108 000 on-farm workers - converted to permanent equivalents (Hortgro, 2015)), followed by the citrus (60 000 on-farm workers (DAFF, 2014a)) and dairy industries (60 000 on-farm workers (DAFF, 2014b)), poultry (direct employment for over 56 000 (Moremi, 2013)), wine and table grape (~24 500 seasonal and ~7 300 permanent on-farm workers). Employment numbers in micro commodity production are relatively lower – an evaluation of the employment potential of the cluster of micro commodities in the Western Cape would be a useful exercise for motivating government investment in niche crops. The grain industry is also a low employer, due to high levels of mechanization (only ~10 000 ‘work opportunities’ for the wheat industry in the Western Cape (WCDE & WCDP, 2016c)) – however, the grain value chain is extensive.

• The current and potential involvement of emerging farmers in a particular commodity could be classified as a positive social impact, although in the case of citrus and deciduous fruit, the poor performance of new entrants is identified as a cause for concern (WCDE & WCDP, 2016d). The poultry industry in particular impacts positively, with over 80% of producers consisting of Small, Medium and Micro Enterprises, making it an interesting value chain to consider for this skills study. Approximately 2300 small-scale farmers from previously disadvantaged communities were reported to have been established by government. Extension support to emerging farmers is therefore clearly a fulcrum point across some agricultural value chains for increasing positive social impacts.

Climate change risk profile:

• Water stress is a concern for all agricultural value chains, to varying degrees (DWA, 2013). The greatest threat to irrigated agriculture may arise through malfunctioning water storage infrastructure and irrigation systems, as well as through increasing competition from other water users such as growing settlements, particularly in times of drought, which could lead to reductions in water allocations to farms (WCDE & WCDP, 2016f). For example, the greatest impact on potato production under projected climate change is likely to come from decreased access to irrigation water, putting plants under stress and reducing yields and tuber quality (WCDE & WCDP, 2016e). Water storage capacity and maintenance of infrastructure are also essential for wheat production. The protection and management of high-yielding catchments and flow-regulating wetlands and river banks upstream of farmlands is critical for the optimisation of water flows serving agriculture. Options to increase water supply, such as water conservation and demand management through improved irrigation efficiencies, will also need to be developed (WCDE & WCDP, 2016g). The climate change projections for the rooibos growing region are highly concerning since they include increased variability of precipitation, a possible increase in the length of dry spells, a possible later start to the winter rainfall season, heavier late summer rainfall (shifting season), higher temperatures and more frequent and intense heat waves (Lötter and Le Maitre, 2014). Current climate risks are expected to be exacerbated in a region that is already on the margins of viable farming livelihoods (WCDE & WCDP, 2016). Wine grape production in the Western Cape is sensitive to reduced seasonal rainfall and longer dry spells (WCDE & WCSP, 2016h). In terms of water stress, every commodity is vulnerable to some extent – we chose to include both an irrigated and rain-fed crop in order to capture the potentially different green skills hotspots required.

• Deciduous fruit production in the Western Cape is sensitive to high temperatures and heat waves (DEA & DAFF, 2013). The wine industry is also vulnerable to heat stress affecting grape quality - periods of high temperature during the summer berry growth and ripening stages in the western coastal areas of the

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4 Employment numbers are presented differently by various national reports or studies, and are often not available at a regional level.
province could change the berry aromatic profile and the style of wine from which it can be made (WCDE & WCDP, 2016h). Olive production in this region is sensitive to high temperatures and heat waves. Livestock, especially dairy cattle, cattle reared in feedlots and the Bos taurus breeds, are sensitive to heat stress which will become more frequent in future. In dairy cattle heat stress leads to reduced milk production and fertility (WCDE & WCDP, 2016c). Sheep and beef cattle could be at risk of reduced growth and reproduction performance, reduced meat yield and quality, reduced wool production and quality, and increased deaths and illnesses, due to heat and nutrition stress. These impacts are likely to be lower in sheep compared to cattle. Increasing winter temperatures and fewer cold days could be beneficial to livestock farming in the colder areas. Chickens are sensitive to high temperature (Burnett, 2014), however no localized analysis has been conducted for this value chain. As with water availability, every crop or livestock type in the Western Cape is vulnerable to heat.

- **Pests and diseases** are an ongoing risk for some agricultural value chains. For example, Citrus Black Spot has become a major problem for the industry with core markets having closed to citrus from some parts of South Africa (but not in the Western Cape) (WCDE & WCDP, 2016d). Climate change can change the distribution of pests and diseases that affect livestock, with implications for animal health and productivity. Many fynbos plants are prone to fungal soil-borne diseases (WCDE & WCDP, 2016g). Increases in heavy rainfall events brought about by climatic changes would lead to more severe waterlogging on the heavier soils and increases in these diseases (WCDE & WCDP, 2016g). Similarly, onions are highly prone to fungal diseases caused by high humidity. Wetter and more humid conditions in particularly sensitive periods of onion development would increase the incidence of diseases and fungal infection (WCDE & WCDP, 2016e).

**Growth potential and contribution to overall agricultural sector:**

- A useful matrix for gauging a commodities growth potential and contribution to the agricultural sector is one provided by the Bureau of Food and Agricultural Policy, reproduced below:

As this matrix shows, value chains that are both labour intensive and which have high growth potential include fruits grown in the Western Cape, such as table grapes, pome fruit, and citrus. Olives are also labour intensive.
intensive to produce, and are increasingly in demand locally and internationally, but production volume is much lower than fruit. Poultry is not labour intensive, but has potential for creating employment and livelihood security through emerging enterprises, and is therefore interesting from a jobs/skills perspective.

- The SmartAgri study revealed that there would be *winners and losers* under future climate change in the Western Cape. For example, there is the potential of new production areas opening up for the citrus fruit value chain under climate change, provided that there is sufficient access to irrigation water, and that pests and diseases can be managed (WCDE & WCDP, 2016). Potato has an exceptionally strong positive response to elevated CO2 (Haverkort et al., 2013). Conversely, this research shows that optimal areas for viticulture in the Cape could be reduced, with a shift to higher altitude and currently cooler locations such as southerly aspects and the southern Cape coastal region (SA). For the fynbos cut flower industry, commercial expansion will be limited, and conditions of gradual warming in established production regions is a growing risk (WCDE & WCDP, 2016).

- Although niche industries employ far fewer people than the more established value chains, there is significant growth potential for these value chains, with associated employment benefits. Micro commodities - such as olives, teas, strawberries, cut flowers and cherries - could create about 50 000 new on-farm jobs and 33 000 new jobs in the value chain (Phillips, 2012). Some of the niche commodities produced in the region cannot be grown elsewhere – for example, South Africa is the only exporter of rooibos tea and exports more than 6000 tons per year. (DAFF, 2015). For this reason, we suggest that a separate skills study be conducted to understand the green skills requirements in these value chains.

- There are various value chains that have been flagged as having particular growth potential, linked to increased national and international demand. For example, there is increasing demand for fresh fruit in Africa and potential for increased local market consumption. (NAMC, 2007). Demand for chicken is also rising in Africa. Expansion of commodities such as tomatoes, onions and carrots could reach roughly 60 percent over the next 10 years (NPC, n.d).

- Low cost imports present a risk to several value chains. For example, sporadic, low-priced imports of subsidized milk products are a challenge to local production. Recent trade agreements have resulted in the flooding of the South African market with cheap chicken imports, reducing the price that local farmers can get on the market for their chicken (TPS, 2016).

### Selection of focal agricultural value chains:

Based on the comparative exercise, it became clear that there were areas of potential growth, risk and opportunity within all of the agricultural value chains in the Western Cape. However, fruit and poultry stood out as being growth industries with high potential for job creation and related positive social impacts, while also being vulnerable to climate change, and with negative environmental impacts.

In the case of poultry, expansion is likely to be through emerging enterprises, leading to potentially significant food and livelihood security benefits. It is helpful to explore which green skills or new green jobs should be created in order to promote the social and environmental sustainability of emerging poultry operations.

Of the various fruit crops, pome fruit was chosen over citrus because of the particular economic and employment importance of the former to the Western Cape agricultural sector. It is therefore critical to ensure environmental sustainability – especially under conditions of climate change - to improve resilience and avoid job losses in the sector, as well as to identify new green jobs and skills to take advantage of emerging opportunities.

It was decided that winter grains should be analyzed as a third value chain, because of the strong links to national food security.
In addition to showing strong signals within the comparative study described above, these commodities present a spread across irrigated, intensive agriculture (deciduous fruit), non-irrigated, expansive agriculture (winter grains), and livestock farming with a strong emerging farmer involvement. This spread is useful because it gives rise to insights that are applicable to other, similar commodities.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous fruit, focusing on pome fruit</td>
<td>Irrigated, labour intensive, high growth potential</td>
</tr>
<tr>
<td>Winter grains, focusing on barley and wheat</td>
<td>Non-irrigated (rain-fed), expansive, low growth potential and low employment, but strong links to food security.</td>
</tr>
<tr>
<td>Poultry, focusing on broilers and layers</td>
<td>Livestock, emerging enterprise, high growth potential</td>
</tr>
</tbody>
</table>
4. Green Skills for CSA in the Poultry Value Chain

4.1 Contextual drivers in the poultry value chain, focusing on broilers and eggs

Overview of the poultry value chain in South Africa and the Western Cape

Contribution to the agricultural sector

The poultry industry is the largest agricultural sector in South Africa, contributing ~22% of South Africa’s agriculture income in 2012 (SAPA, 2012). The poultry industry is also important nutritionally to the South African population, providing around two-thirds of animal protein consumed (Roosendaal, n.d.; SAPA 2014). Across the southern African region, the animal feed to poultry value chain has seen rapid demand growth due to an increase in urbanization and a growing middle class, leading to higher consumption of poultry meat and eggs (WWF, n.d; SAPA, 2012). This rapid growth has been accompanied by an increase in coordinated investments by predominantly large South African firms throughout the region (Ncube, 2016). Since the 1970’s, South Africans have massively increased their annual consumption of chicken from 6kg to 27kg, and doubled their per capita egg consumption (WWF, n.d). As in many developing countries, the main demand is that the poultry meat is cheap. The market for organic chicken, which is typically more expensive, is comparatively small (Roosendal n.d.).

The poultry industry is an important contributor to job creation and formal employment opportunities: around 10% of all workers in agriculture are employed in the poultry sector. The poultry industry provides direct employment for over 56 218 people and indirect employment to some 108 000 people through, for example, distribution and feed-related industries. The industry is the largest consumer of maize, supports numerous peripheral businesses, and is a common platform for rural development as well as the government’s zero hunger ambitions (SAPA, 2012). However, it is important to note that with over 80% of producers consisting of Small, Medium and Micro Enterprises (SAPA, 2012), the industry impacts positively on the lives of so many more of the country’s people. For example, around 2 264 small-scale farmers from previously disadvantaged communities have been established by the government (SAPA, 2012).

The poultry value chain

The poultry industry consists of three distinct lines of production, namely: the day-old chick supply industry (i.e. hatcheries), the broiler industry, and the egg industry. Across these three lines of production, all poultry farmers (small-scale, emerging and large commercial poultry famers) are represented by the South African Poultry Association (SAPA) (SAPA, 2012) (DAFF, 2014a).

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5 Poultry breeding stock for the day-old chick supply industry in the broiler industry are for the most part procured from one of two international corporations, namely Aviagen Broiler Breeders and Cobb-Vantress Inc. (Ncube, 2016).
With Gauteng and KwaZulu-Natal, the Western Cape is one of the highest egg exporting South African provinces (DAFF 2014a). In South Africa, nearly 70% of the total broiler production is supplied by thirteen large producers, whilst a number of smaller production units and the informal sector are accountable for the remaining 30%.

Figure 4 (Adapted from DAFF 2014a: 20) shows the value chain of eggs in South Africa. It reveals the 5 stages of egg production: the importing of genetic stock (called grandparents)\(^6\); ‘parent’ stock which comprising of rearing chicks from grandparents stock; the breeding of parent stock to produce hatching eggs for day old chicks\(^7\) (called pullets); the production of eggs\(^8\) and finally the market outputs of the eggs industry which consists of eggs and spent hens. Market distribution of eggs is undertaken mainly by six large retailers, then Small Medium Micro Enterprises (SMME’s) and informal traders. Informal traders have

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\(^6\) All grandparent breeds are imported (DAFF 2014a) from either America or Europe.

\(^7\) The chick industry is valued at R 3.6 billion (2009) (Roosendal, n.d).

\(^8\) The egg production stage is dominated by 3 companies Nulaid, Eggber, and Highveld Co-op
a large role in distributing spent hens to consumers (DAFF 2014a). The value chain of egg production takes on average three years from the rearing of grandparents to the culling of a spent laying hen.

As illustrated in Figure 5 (DAFF 2014b), the South African broiler meat value chain consists of a primary sector of broiler meat farms, contract growers, feed companies and breeders. The secondary sector consists of abattoirs, importers, exporters and retailers (DAFF 2014b). There is a market for live broilers, and one for slaughtered broilers. The majority of broiler meat from the commercial sector is sold through abattoirs to processors and packers who then sell it to retailers and other processors and packers who ultimately distribute to the consumer. Small-scale operations sell the majority of live broiler meat.

Figure 5: The structure of the broiler meat market chain (adapted from DAFF 2014b)

Risks, opportunities and trends

The different stages in production (in bold below) have distinct risks, opportunities, trends and contexts that can shape or define activities at any particular point in broiler or egg production. These different stages in production are discussed further below. The risks, trends and opportunities posed by climate change are explored separately in the section that follows.
The poultry industry’s highest **input cost** is animal feed. Grain cost increases have been experienced globally due to the drought in the USA and other large grain-producing nations (e.g. in 2007-8 and 2011-12) with subsequent higher feed prices worldwide (SAPA; 2012). More recently the drought in southern Africa has raised costs for local producers. The main raw materials for feed are maize (59.3%), soya oilcake (16%), sunflower oilcake (5.6%) and wheaten bran (6.3%), with maize and soya oilcake making up 80% of broiler feed. All of these feed materials are sourced locally in South Africa apart from soya oilcake which is imported from Argentina and therefore vulnerable to the global market. There are alternatives to soya oilcake including fishmeal or using on-site poultry by-products from processing. The local protein feed industry has struggled to keep up with the pace of the growth in the poultry industry. However, new alternative protein sources are being explored including pests, new crops and food waste (Bezuidenhout, 2015). Dr Nkukwana of the ARC highlights the “gap between demand for poultry meat and its supply is anticipated to broaden more in the coming years, creating a compelling intention to explore the convenience of locally accessible, unconventional feedstuffs in poultry diet formulations” (ARC, 2014). Dr Nkukwana’s work entails looking at the viability of alternative crops that also serve as organic replacements for antibiotic growth promoters, such as rooibos, moringa and baobab (ARC, 2014). Another example of innovation in the poultry feed can be seen in AgriProtein, a bio-friendly locally-produced alternative to soya oilcake, though its cost could be prohibitive to small local producers (see Box 2). The high demand for feed, protein feed and alternative feed options present new opportunities.

**Box 2: AgriProtein**

AgriProtein is a Cape Town-based company founded in 2009, which converts food waste from restaurants and retailers in Cape Town to insect protein in the forms of fly larvae as a natural feed source for poultry. On a fast and industrial scale AgriProtein produce larvae cakes as “the world’s most sustainable and natural animal protein” (AgriProtein, 2016).

“A month ago we started feeding them [hens]... dried maggots from the genius at Agriprotein. These guys are taking 100 tons of Cape Town’s daily food waste and turning it into nutritious fly larvae. It will hopefully take the place of fishmeal, which is so widely used in animal feed, and hence reduce the pressure on already overfished oceans. These larvae don’t come cheap. In fact they are priced in Euros.” (Farmer Angus blog)
In the poultry industry there is the continuous threat of diseases, especially the new variant of Infectious Bronchitis (IB) prevalent in South Africa (DAFF; 2014b). Disease outbreaks can lead to public health scares (SAPA 2012) which affect the market, and cause animal death and therefore waste. There are several challenges and factors that can make it difficult for farmers to safe-guard the health of chickens at the point of rearing poultry (whether broilers or layers), which, if improved, could help reduce poultry death:

- There is a shortage of state veterinarians with experience and expertise in poultry (SAPA, 2012). Disease control experts are also required scarce skills (DAFF, 2014b). Some farmers lack the knowledge/expertise on handling diseases on their farms (DAFF; 2014b).
- There is a shortage of poultry nutritionists and local expertise on poultry feed nutrition (All About Feed, 2013). In large commercial operations, feed and nutrition can be adjusted according to the bird’s development, and optimised for their growth or laying (Phillips, 2014).
- Feed quality is important for poultry health. For example, fusarium mycotoxins found in growth maize and other grains is linked to several diseases in poultry (Roosendaal, n.d.). South African feed manufacturers are governed by the AFMA Code of Conduct, and must adhere to the strictest regulations and implement the necessary control measures to ensure safe feed.

A poultry farmers’ availability of choice to implement or respond to the considerations listed above are vastly different depending on the scale of the operation. For instance, a large-scale operation (of around 20 000 – 60 000 birds) is often highly mechanised and automated (Uys, 2015), with temperature control and timed changes in feed and nutrition corresponding to the bird’s stage of development. By contrast, small-scale and new entrants into the market do not have such automation and technology on hand, and face other challenges (see Box 3 for more information of challenges to transformation in the industry).

**Box 3: Challenges for small-scale enterprises, rural or emerging production**

Transformation is an important concern for the industry. In 2009, SAPA introduced an industry statutory levy (ISL) to create a funding mechanism to enable progress in transforming the industry for smallholder farmers, better industry training, development and research activities, as well dealing with the threats of meat imports and various legal challenges (SAPA, 2012). The Developing Poultry Farmers’ Organisation (DPFO), founded in 2003, has played a large role in supporting emerging poultry producers towards industry transformation (SAPA, 2012). However, despite billions of Rands invested into establishing black farmers in the poultry industry, and retailers’ interest in procuring products from black producers, there has been little significant return on these investments (Claassen, 2016). There are a number of barriers, such as:

- **Access to markets:** Most small-scale farmers rely on the live-bird market, which is sporadic. They are also issues for new market entrants providing products for retailers that are of “right quantity of the right quality and at the right time” (Nkuna quoted in Claassen, 2016).
- **False expectations:** The poultry industry has been portrayed as an “easy way” to make money (Claassen, 2016) which has not helped the transformation process, as most beneficiaries enter the poultry industry with little education and experience. Furthermore, small-scale farmers do not often meet requirements for financing set by banks (DAFF 2014b).
- **Access to training and development:** Small-scale farmers have a number of training and development needs, including farm management and administrative skills (SAPA, 2012), and nutrition and marketing (DAFF/SAPA, 2016).

Despite the challenges, an enabling environment can also be created through appropriate legislation and instituting protection measures and close collaboration between the government and the industry as well as larger poultry producers identifying empowerment opportunities (Claassen, 2016).

On the other hand, smaller scale rural producers, or ‘backyard producers’, who often use indigenous breeds, have cited “sub-standard housing, poor disease control and absence of organised vaccination and poultry extension services” as the main obstacles for chicken production problems (Mtileni et al. 2009). Appropriate interventions such as “disease prevention and control, predator control, suitable feeding and watering systems, improved poultry housing, genetic improvement and marketing of poultry products” could alleviate these problems (Mtileni et al. 2009).
Once reared to the point of sale, poultry is sold either live or slaughtered. There is a growing informal urban market for live poultry sales for home slaughter (Pather, 2016). Alternatively, poultry can be sold live to abattoirs who then market the slaughtered produce. In abattoirs culling must be carried out according to Society for the Prevention of Cruelty to Animals (SPCA) specifications. Transporting live birds to slaughter can contribute to the spread of disease.

**Imported frozen poultry** represents a threat to the industry. Higher volume of low quality, cheap imports put pressure on profit margins of local producers (Roosendal, n.d.). Imports in South Africa are largely exchange-rate driven while exports are constrained by sanitary rules that countries like EU and USA apply (DAFF, 2014:5). In 2016, a US trade agreement called the African Growth and Opportunity Act (AGOA) was passed, receiving media attention and concern in the industry. AGOA allows US poultry farmers to ‘dump’ by-products through export and sale to the South African market, with negative economic implications for local poultry producers because they are unable to compete with cheap imports.

There is a significant amount of **waste** in the poultry industry, which could be reduced, better managed, or processed further and sold. According to Kelleher et al (2002) the three waste types of primary concern in poultry production are: the bedding litter, manure and dead birds. In both the egg and the broiler industry, poultry farming causes landscape degradation of surrounding areas through soil and water pollution, as well as disturbances such as the increase in odours, flies and rodents. Improperly managed waste can result environmental and health hazards for humans and animals. Contamination of soil and water with nutrients, pathogens and heavy metals is essentially caused by inefficient manure-management and occurs where manure is stored. As such, waste from the industry, particularly manure, is a key issue in the industry (van der Merwe, n.d.). Apart from manure, poultry mortalities are also regarded as general waste from the industry. In the egg industry, rooster chicks, being useless, are disposed of. There are several methods available for disposal of poultry mortalities including burial, composting, incineration, removal to a rendering facility, or lactic acid or yeast fermentation (both emerging methods) (van der Merwe, n.d).

The large amounts of waste generated in the poultry industry are particularly concentrated around **slaughterhouses** (Malupo 2009). Lenntech (n.d.) identifies 5 main areas of waste that the poultry industry produces: waste water, carcasses and skeleton waste, rejected or unsatisfactory animals (one could add spent hens and male pullets to this), fats, oils and greases, and animal faeces, blood and eviscerated organs. The most significant environmental concern resulting from slaughterhouse operations is the discharge of wastewater into the environment (Verheijen et al, 1996). This is of particular concern to South Africa which is a water-scarce country already faced with significant water quality challenges.

During production and slaughter, particularly at scale, **waste water** becomes an important consideration. The meat industry generates wastewater with a high concentration of organic pollutants, impurities, blood by-products, manure, feathers and bones, as well as nitrogen, bacteria, parasites and cysts, and is the most difficult waste stream to treat (Lenntech, n.d.). While broiler production is the least water intensive animal protein to produce, water use is significant throughout the poultry production process (it typically takes 3,900 litres to produce 1 kilogram of meat) (Nunes, 2011). Nunes (2011) identifies several areas where water use is intensive in the broiler industry, including the washing and disinfecting of trucks and crates, the replenishing of stunning tubs, the use of water as a “broom” for cleaning, and the use of water in scalding tanks. For broilers, water is used to wash contaminants off carcasses. This takes around 1 litre of water per carcass. Water is also used in chilling carcasses, and indirectly in feed production for the poultry industry. Nunes (2011) writes that even when conservation of water is practised in poultry production, it is mainly due to water scarcity, cost and environmental regulations not environmental consciousness.

The stages in the value chain and associated drivers and regulations have been simplified in the following table, as a summary for easy reference.
**Drivers at different stages in poultry production**

<table>
<thead>
<tr>
<th>Planning to farm broilers, eggs or hatchlings</th>
<th>Regulatory or political drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available support, market conditions, risks, cheap imports</td>
<td>Import and export policy, government development programs in rural areas</td>
</tr>
</tbody>
</table>

**Inputs**
Animal feed, breeding stock, hatcheries, housing for poultry, energy (light & heat), ventilation, water, finance, expertise, marketing, veterinarians, nutritional experts

**Breeders and hatcheries**
Imports of genetic stock (grandparents), incubation and rearing to produce day old chicks (parents).

**Rearing point-of-lay-hens**
Parents reared to maturity and produce fertile hatching eggs (pullets). Pullets reared for 21 weeks to produce point-of-lay-hens (commercial eggs)

**Rearing broilers**
Day old chicks sent to broiler contact growers, rearing for 42 days, marketed live or slaughtered

**Producing Eggs**
Production of eggs in various sizes, grading, culling and selling spent hens (after a year)

**Slaughter incl. spent hens, male chicks**
Water use; waste: carcasses, skeleton, rejected pullet, manure, blood, eviscerated organs

**Packaging**
Packing, sorting, value addition, processing

**Wholesale & Retail**
Retailers, informal traders, SMME, warehousing, packaging, marketing

**Consumer and end of life**
Waste, re-use, and recycling

**Climate change threats, mitigation and adaptation**

Climate change poses a number of threats to intensive livestock commodities in the Western Cape. The Western Cape is expected to experience climate change related warming and changes in rainfall. These changes in climate have several potential impacts, both direct and indirect, on poultry farming. Indirectly, but importantly, changes in rainfall and temperature will affect the availability and price of feed, the greatest input to the poultry production value chain, raising costs, as seen in the recent drought in southern Africa (SmartAgri, 2016). Droughts and disruptions to water supply also pose a threat as rearing and processing poultry uses high volumes of water. Water quality is important in the poultry industry for meeting hygiene standards. Increased intensity of rainfall could lead to higher flash flooding risks meaning that poultry housing should be placed away from flood-prone areas (SmartAgri, 2016). Higher temperatures also pose a threat as they can negatively affect animal fertility, growth rates, meat yield and quality as well as increasing the risk of illness and death (SmartAgri 2016). Hotter days also mean that poultry, if housed in climate controlled units, will require more energy for production, thus increasing costs. Smaller producers without climate controlled units may struggle to keep their poultry at optimum temperatures, with the possibility of affecting the health of their birds.

Potential options for managing these risks to the poultry industry include using chickens of indigenous stock as sources of genes for hardier breeds that could be more resilient to the weather extremes and higher temperatures expected under climate change (SmartAgri 2016). Conserving water, managing water demand and re-using water should be supported to decrease vulnerability to water shortages. Exploring a
variety of alternative feed sources and ensuring that poultry housing is insulated properly are also valuable measures in reducing risk.

In terms of its carbon footprint, agriculture is responsible for 2% of energy use and 5% of greenhouse gas emissions in the Western Cape and of this the livestock sub-sector accounts for 16%, with the highest contribution from cattle (SmartAgri 2016). Chickens have a lower carbon footprint than cattle but still have a relatively high energy input in their production, slaughter, and refrigerated transport (Gerber, Opio & Steinfeld 2007). Gerber, Opio and Steinfeld (2007) identify the four areas where the poultry industry contributes towards greenhouse gas emissions:

- **On-farm energy consumption:** This includes direct and indirect energy inputs. Energy is used mostly in heating, ventilation and air conditioning systems, although there are other areas energy is used such as on-farm transport, feed preparation, cleaning, waste-burning and packaging. The main energy consumption usage is illustrated below in the table below, showing global energy consumption in poultry production.

- **Carbon dioxide (CO₂) emissions from slaughtering:** Poultry slaughtering in abattoirs is more intensive than other meat sectors. Fossils fuels are used for process heat, while electricity is used for machine operation and refrigeration.

- **Carbon dioxide emissions from international trade (transportation):** International trade in poultry meat has a high carbon footprint because of large distances and refrigeration of vessels. Local transportation, if done using energy inefficient vehicles can also increase the sectors greenhouse gas emissions. With chicken being imported into South Africa from places as far as the USA, Canada and Australia and international as well as local production of poultry increasing, transportation is an important potential area reducing greenhouse gases in the sector.

- **Greenhouse gases emissions from feed production (indirect contributor):** Feed for poultry production has already been described as the largest input in poultry production. Therefore it is important to consider the greenhouse gas emissions resulting from the production of feed. The main greenhouses gases resulting from feed production are CO₂, which is produced from burning fossil fuels when manufacturing fertilizer, and Nitrous Oxide (N₂O).

![Table](https://example.com/table.png)

**Figure 6: Table adapted from Gerber, Opio and Steinfeld (2007:17)**

Overall, global poultry production contributes around 0.3% of total anthropogenic greenhouse gas emissions (excluding land-use change and emissions from the transport of feed) (Gerber, Opio and Steinfeld, 2007:17).

Due to the fact that the poultry industry’s emissions are lower than that of ruminant (grazing animals), chicken production will likely be increased due to pressure to reduce methane and CO₂ in the animal
production (in addition to the existing rising market demand) (SmartAgri 2016). This increased production means that it is especially important to develop ways for the poultry industry to adapt to climate change and mitigate its environmental impact.

‘Hotspots’ at different stages in the broiler and egg value chains

Through the analysis of drivers in the value chain, climate considerations, skills audit reports and interviews with commodity association members and experts, several key ‘hotspots’ within the industry could be identified. These ‘hotspots’ show potential for simultaneously creating growth or developing new livelihoods, and stimulating more sustainable and climate-smart practice within the industry, through technical support and skill development. Importantly, across these hotspots, irrespective of scale or stage, is the need to reduce waste and improve resource efficiency.

1. Training, support or extension services for rural, small-scale and/or emerging producers

Poultry initiatives are a popular project choice for government rural development programs because of the high growth potential of the industry and the reasonably low cost. Unfortunately, for the many complex reasons outlined above, many small-scale producers struggle or fail. Relatively straightforward training programs and basic, yet continuous extension support could positively impact small-scale or informal producers. Therefore, in parallel with funding new poultry businesses, ongoing extension and training support is required (Nkuna and Mason, 2016).

Extension services are valuable to small or emerging producers, but the extension officers need to have poultry-specific training, and ideally need to spend a few months getting practical experiences (Nkuna and Mason, 2016). Training and extension support of small-scale and/or emerging farmers can help to improve efficiency, build resilience and reduce losses. Training could include:

- Simple adjustments and improvisations to basic housing such as insulation on corrugated metal structures can protect poultry better against extreme temperatures (Nkuna and Mason, 2016).
- The risks of not following adequate nutrition and disease prevention steps, as new entrants do not yet have the experience to weigh up the risks (e.g. whether to vaccinate or not) (Nkuna and Mason, 2016).
- Small producers need bio-safety training as the high bio-safety requirements of retailers is very costly (Nkuna and Mason, 2016).
- Small producers need business and planning skills. For example, day-old chicks can be delivered to your door with enough foresight and planning, but when they are collected from far away many can perish on the journey (Nkuna and Mason, 2016).
- Extension services should also, ideally, be able to support poultry producers and processors in responding to the risks and opportunities highlighted in the previous section, requiring appropriate green skills to reduce resource consumption and waste, protect biodiversity, and build climate resilience.

2. Green and equitable development of slaughterhouses

As discussed above, establishing new poultry enterprises is a popular mechanism for rural development. However, there are ample opportunities to establish or support black-owned enterprises in other areas of the supply chain (Nkuna and Mason, 2016). Slaughterhouses are potentially one such area. It is not feasible to keep establishing poultry producers in a community, as slaughterhouses need to be close by and these facilities are often hard to come by (Nkuna and Mason, 2016). For small producers, access to slaughterhouses can be a challenge. Slaughterhouses generally can only take certain (fixed) amounts of poultry, and consistent quality, as they cannot risk selling poor quality on to retailers who have strict criteria (Nkuna and Mason, 2016). Slaughterhouses and packaging facilities employ the most people within
the poultry value chain, though there is a high turnover of employees (Nkuna and Mason, 2016). There is a constant demand for poultry meat inspectors, and perhaps also a demand for independent meat inspectors (Nkuna and Mason, 2016).

Slaughterhouses are thus sites in the value chain with comparatively high energy and water use, which generate high volumes of waste and environmental contamination, have a high staff turnover and demand for staff, and can have an impact on small producers’ access to markets and services.

3. Alternative and local feed production

As already highlighted in previous sections, the poultry sector is vulnerable to hikes in feed price. The cost of feed is negatively affected by drought, of which there is an increasing risk under conditions of climate change. Recent threats to the poultry industry include unprecedented grain cost increases due to the drought in the USA and subsequent higher feed prices worldwide (Bolton, 2015). In addition, there is a growing consumer demand for poultry reared on ‘organic’ feed, free from glyphosates, hormones or antibiotics. Finding alternative sources for staple feed, as well as alternative protein sources from waste, pests, and new cultivars, could provide valuable opportunities for developing new enterprises in a green economy.

4. Energy efficiency and alternative energy sources

The feasibility of converting waste (such as poultry litter or abattoir waste) to biofuel needs further research for the sector (Nkuna & Mason, 2016). The higher energy requirements in slaughterhouses and in rearing poultry are opportunities to look at more efficient energy systems or renewable sources, in order to mitigate the impact of increased production.

5. Opportunities for reducing or better managing waste and waste water

Waste and waste water are produced at several stages in poultry production:

Waste water: In the washing and disinfecting of trucks and crates, more modern washers could be used as they save water through a multi-usage cycle in opposition to old washers which have a single-usage water cycle. In stunning tubs, recycled water could be used (for example rain-water). In cleaning the plants, rakes could in some instances be used instead of a ‘water broom.’ Scalding tanks, which are generally very large, consume significant volumes of water, and smaller tanks could be more efficient. Nunes (2011) maintains that educating plant personnel on water-saving protocols is important. In the chilling of carcasses, evaporative air chilling, which uses vastly less water than water chilling could be practiced. There are also opportunities for water re-use, for example using pre-chilled water to flush away offal and then feathers in abattoirs. This double usage would not only mean that less clean water is used, but has the added benefit of retaining/trapping fat and other materials from offal in feathers, which can reduce the load on waste-water treatment facilities (presumably because it can be thrown away instead of washed away).

Meat waste: Instead of being disposed of, there is an opportunity to raise rooster chicks and sell them with spent hens. DAFF (2014a) propose that this could also alleviate the current chick shortage in the broiler industry. While feet and intestines are sometimes regarded as waste materials, they are identified as edible products in South African legislation (Malapo, 2009) and can be processed, packaged and sold. The use of abattoir blood waste in animal feed could be scaled up (Malapo, 2009).

Manure: Materechera and Morutse (2009) found that chicken manure, as a source of phosphorous, can be used as a viable fertilizer. Although levels of phosphorus can raise some environmental concern, chicken manure could be used as an alternative to reduce reliance on chemical fertilizers.
Litter: As the demand for poultry intensifies the amount of poultry litter waste increases, presenting problems for its disposal. Dávalos et al (2002) suggest that apart from recycling the litter as compost (which can cause environmental problems because of phosphorous run-off) poultry litter could be used as an alternative, natural fuel source.

**Hotspot case studies**

1. **Farmer Angus and Farmer Rico’s outdoor broilers and eggs**

Angus McKintosh (i.e. Farmer Angus) rents land from Spier wine estate outside Stellenbosch for his beef and mobile egg operation. It is a 4000-hen operation where the hens nest in mobile egg units (see images below) which are moved daily around the farm, allowing the hens to feed off fresh pasture and insects while their droppings fertilise the land (which is grazed by cattle).

This method was adopted as part of a biodynamic approach to farming, with the intention of rearing healthier birds (through a more varied diet, free to roam, few chemical inputs) and thereby producing better eggs; as well as carbon capture through the grass, and use of manure as a fertiliser rather than a waste product.

The operation was set up seven years ago and the mobile units developed through trial and error. Angus believes himself to be the first to build mobile egg units in South Africa, adapted from a US design. Aside from layers, Angus also used to farm and slaughter broilers but the costs of running the slaughterhouse was too high. The slaughterhouse was designed to handle 2000 birds per day, but the farm was not producing that many birds making it not cost effective.

![Image 1](Image1.png)

**Image 1:** Four of the egg mobiles on the Spier farm. Each mobile unit has nesting boxes, feed and water troughs, and houses 280 laying hens.
On Farmer Angus’s farm, the following people are currently involved or employed in outdoor egg production: 4 people to oversee the egg mobile, 1 water or irrigation system manager with an irrigation team of 3 that rotates around the farm checking on irrigation system, an accountant, and a driver. More broadly, feed is sourced from an organic maize grower. For Farmer Angus and the team who rotate the egg mobiles, the work is 24/7 – collecting eggs three times a day, manually grading and packing the eggs, as well as checking the irrigation system and identifying (and isolating) sick birds. As farmer Angus says, the “chickens don’t do weekends”, and the job entails working in rain and heat. Solar panels are used to power lights to extend daylight hours in winter, as the hens are stimulated by light to lay. Angus sells eggs at local markets and a shop on the Spier farm, and always sells out his produce – there is a growing demand for ethically treated layers and for organic / low-input eggs.

Images: 2,3 and 4 The hens are free to peck through irrigated fields of grasses and legumes (which are also grazed by cattle on the farm); eggs are laid in the nesting boxes in the mobile egg units, and collected three times a day, cleaned and graded.

Initial and ongoing external support needs of the enterprise include poultry vets, advice relating to grading the eggs and mechanised ways to grade, and installing and maintaining the irrigation system.

Angus is now acting as a mentor for Farmer Rico of Boschendal wine estate, who worked on Angus’s farm for four years. Boschendal recently underwent a change in management, which corresponded to a new vision for the wine estate to produce as much of its consumables on-site as possible, including the food and produce used in the restaurant such as chicken and eggs. With Boschendal’s backing and support, Rico has more resources behind him than Angus, and he is using galvanized mobile egg users. Rico started his operation in Boschendal in October 2015, and currently has 1500 birds and employs two other staff. Rico is also producing broilers, housed indoors for the first weeks and then moved to an outdoor corrugated structure, and hopes to set up a slaughtering facility on site in future. Currently, the broilers are driven to a small slaughtering facility in Hopefield (1.5 – 2 hours away by car), which slaughters, quarters and packages the produce (see next Hotspot case below).

Both farmers are able to find markets to sell their eggs – Farmer Angus claims that the demand for this type of product is larger than what they can supply. Both Angus and Rico sell on their spent hens to buyers who buy the hens in bulk and sell them on individually in the informal market. Each reflected positively on the feasibility and
benefits of mobile abattoir facilities to service this market and/or to assist them with their own slaughtering needs for broilers (see Box 4).

**Box 4: Possible new enterprise opportunity: mobile abattoir**

Most spent hens are bought from egg producers and sold on informally in townships for meat, and are slaughtered at the home. Mobile slaughterhouses offer opportunity to provide better slaughtering facilities – i.e. for the ease of the consumers, better regulated in terms of health concerns, and better and more regulated waste management. Centralising slaughter could make it easier to compost the collective waste to form a carbon & nitrogen rich compost that can be used on local food gardens. Such units would need water and electricity access at each site.

2. **Hotspot case: Hopefield abattoir**

“Being a poultry farmer, your main thing is having a market and a slaughterhouse... unless you are going to sell it live. Our clients have built trust in us over the years. We are not as expensive as other abattoirs. They really trust us because they know that the facilities are clean, and they can leave with a good product [...]. The main thing is [...] we have a got a certificate to say that we are registered by the veterinarian, as well as Halal and Kosha certificates, so when their products leave the abattoir they can walk into any supermarket because they have proof that they have slaughtered at a registered abattoir.” (Essie, Hopefield Abattoir)

Hopefield abattoir is situated about 2kms outside of Hopefield in the Western Cape. It is managed primarily by Essolita (Essie) Poole with support from her husband and daughter, who also rear their own poultry. When they first started, 15 years ago, the abattoir ran for one day a week – but the business has grown to run throughout the week, with a capacity for 850 birds per day. The facility was recently granted support from Casidra⁹, for upgrades and extensions to the facilities and buildings, which are scheduled to start in late 2016.

Image 5: Staff in the second of three rooms at the Hopefield abattoir. The buildings are under plan for renovations and extensions.

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⁹ The ‘Cape Agency for Sustainable Integrated Development in Rural Areas’ (Casidra) is an implementing agency of the Provincial Government of the Western Cape.
Clients book in to use the facilities a week in advance so that the abattoir can schedule for the week ahead. The abattoir slaughters and they also process - cutting up or filleting. They charge R4.50 per bird, plus an extra R1 for cutting. They then pack and label, and freeze for 24 hours, and the product can be collected the next day. The abattoir has connections to local markets, and farmers can also sell their produce to the abattoir directly, who then sells it on to their markets. When there is a market for the intestines, the abattoir will clean, wash, pack and freeze them.

Essie receives frequent support and advice from a veterinarian from Elsenburg who is the facility’s inspector, and who comes once a month to check that everything is in order and that the abattoir is complying with regulations.

Essie feels her main problem is dealing with the feathers (which are wet – making them difficult to handle or process further). Feathers are put in a waste bin that the municipality empties regularly, but there is no lid (they try to keep a plastic sheet over it), and the neighbours complain about the smell. There is also a problem with flies on hot days. “We did enquiries about the Go-Green Bio bin machine where you can throw in the feathers, intestines and blood and it produces liquid fertilizer out of it. The machine costs about R50 000 so we said we will first focus on the extension and then look at that later.”

Another challenge is the drainage system, which at the moment does not have filters, though filters are planned under the new upgrade. The abattoir is also interested in solar energy/power as the facility has a very high electricity bill each month, but the costs of installing a whole solar system are restrictive. Essie says that they try to cut down on electricity use, but when the abattoir is running, everything has to be turned on. Essie is also always trying to get her staff to cut down on water use (e.g. using a hose to ‘sweep’ away a feather), but it is difficult. They also tried using water from the halaal meat (i.e. salted) in the garden but it was bad for plants. The new design of the abattoir will make it easier to redirect waste water onto the nearby gardens. The Casidra-supported renovations will also include a new shaded area for birds to be kept upon arrival while waiting slaughter during hot days - currently Essie has to try to keep them cool.

Hopefield Abattoir provides a number of employment opportunities: the abattoir manager (Essie), and her daughter who does the accounts; five people work in the first/starter room (slaughtering, dipping, operating the plucking machine, with two focused on manual fine plucking); in the second room, two people cut up the carcass and take out the intestines, one person checks and rinses; in the third room: two people perform quality control checks, pack and label; in the last room, the produce is packed into the freezer (and this employee also helps with loading and offloading). One day a week the abattoir processes kosher meat and so gets in an extra 12-15 women working because the Kosher process requires colder water which results in the need for more manual plucking (as fewer feathers come off compared to when using hotter water).
The training that Essie has received has mostly related to rearing poultry or come through poultry equipment expos, otherwise, training relating to the abattoir management or practices has mostly come through videos or has been shared by staff who have worked at another abattoir previously. Essie and her husband used to work as pharmacists but moved into poultry years ago. Essie has won a number of awards and certificates, including recently the DAFF Female processing entrepreneur of the year.

4.2 Occupations and Skills

Mapping OFO codes associated with the poultry value chain

A number of occupations were mentioned as either playing a critical or supportive role across the analysis of the poultry value chain, including the threats posed by climate change and the deeper exploration of two hotspot cases. A list of the various occupations associated across the poultry value chain are tabulated below as they are described in the OFO, with those that have been explicitly mentioned as important for driving green practice highlighted – as potential sites for green skills training.

<table>
<thead>
<tr>
<th>OFO Title &amp; 2015 Code</th>
<th>Occupation description and alternative titles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulators and Advisers (across value chain)</strong></td>
<td></td>
</tr>
<tr>
<td>Agricultural / Horticultural Produce Inspector: 325703</td>
<td>Conducts inspections of agricultural commodities, processing equipment and facilities, monitors conformance to standards and protocols to ensure compliance with regulations and laws governing health, quality and safety. <em>Alternative titles:</em> Dairy Product Inspector; Produce Inspector; Perishable Produce Export Assessor; Fruit and Vegetable Inspector; Meat Safety and Quality Controller; Dairy Quality Assurance Officer; Meat Inspector</td>
</tr>
<tr>
<td>Environmental Scientist: 213302</td>
<td>Studies and develops policies and plans for the control of factors which may produce pollution, imbalance or degradation of the environment. <em>Alternative titles:</em> Environmental Advisor; Climate Change Analyst; Environmental Waste Officer; Environmentalist; Environmental Auditor; Environmental Research Scientist; Environmental Consultant; Environmental Officer</td>
</tr>
<tr>
<td>Water Quality Analyst: 213306</td>
<td>Analyses and develops policies and plans for the control of factors which may produce water pollution. <em>Alternative titles:</em> Hydrographical Technical Officer; Hydrological Technical Officer; Waste Water Treatment officer/ Technician; Water Quality Technician</td>
</tr>
<tr>
<td>Role</td>
<td>Code</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Agricultural Consultant</td>
<td>213201</td>
</tr>
<tr>
<td>Poultry Farmer</td>
<td>612201</td>
</tr>
<tr>
<td>Veterinary Public Health Professional / Practitioner</td>
<td>225102</td>
</tr>
<tr>
<td>Veterinarian</td>
<td>225101</td>
</tr>
<tr>
<td>Poultry Slaughterer</td>
<td>681105</td>
</tr>
<tr>
<td>Operations Manager</td>
<td>134915</td>
</tr>
<tr>
<td>Wholesaler</td>
<td>142102</td>
</tr>
<tr>
<td>Importer or Exporter</td>
<td>142101</td>
</tr>
<tr>
<td>Retail Manager (General)</td>
<td>142103</td>
</tr>
</tbody>
</table>
Greening of occupations and skills in poultry hotspots

One of the case studies shows that there is a market for poultry and eggs reared by ‘outdoor’ or ‘pasture-reared’ farming in which chicken are humanely and organically raised in open pastures. Therefore, an emerging specialism or alternative title that will differentiate them from other normal poultry farmer should be included in the OFO (for example, Outdoor poultry farmer and Outdoor poultry farm assistant worker).

<table>
<thead>
<tr>
<th>Occupation name: Poultry farmer</th>
<th>Alternative titles: Poultry Farm Production Supervisor; Poultry Farm Foreman</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFO major group (code) (2015)</td>
<td>OFO sub-major group (code)</td>
</tr>
<tr>
<td>6</td>
<td>61</td>
</tr>
<tr>
<td>Segment of the value chain</td>
<td>Skills band (high/ intermediate/ low)</td>
</tr>
<tr>
<td>Production</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Occupation description and purpose (from OFO)</td>
<td>Plans, organises and performs farming operations to breed and raise poultry.</td>
</tr>
</tbody>
</table>
| Key Occupational Tasks (from unit group with occupation specific drawn from job descriptions/research) | • Storing and carrying out some processing of produce  
• Mixing feed and feed additives and filling feed and water containers  
• Training and supervising workers in poultry production procedures, maintenance duties, and health and safety precautions, and hiring and discharging workers and contractors  
• Vaccinating poultry via drinking water, injection, or dusting of air  
• Arranging the sale, purchase and transportation stock, produce and supplies  
• Monitoring and examining poultry to detect illness, injury, or disease, and to check physical condition, such as rate of weight gain, and removing weak, ill and dead poultry from flock  
• Determining sex of chicks and facilitating breeding, artificial insemination, and hatching of eggs  
• Slaughtering and dressing poultry for sale or delivery to market  
• Growing and purchasing feed and other supplies needed to maintain appropriate nutritional levels and condition of poultry  
• Renting or investing in and maintaining and cleaning farm buildings, machinery, equipment, and structures  
• Monitoring market activity, planning and coordinating production accordingly, maintaining and evaluating records of farming activities  
• Collecting and storing eggs and packaging them for sale delivery to market |
| Key Areas for Greening the Occupation | • ‘Greening’ poultry production procedures relating to the following critical areas in order to reduce the high volumes of resources used in the industry:  
  – Waste efficiency, including better management of waste water |
and solid waste
  – Energy efficiency, including solar power or better insolation of housing for improved energy efficiency
  – Sustainable water and land management practices
• Training new small-scale farmers in low cost measures to reduce poultry mortalities, such as optimal housing in weather extremes, vaccines and balanced feed
• Reducing poultry farmers vulnerability to volatility in feed availability and prices arising from climate impacts and global market trends, and instead building capacity to source healthier, local and perhaps indigenous, and more affordable feed options
• Reducing poultry farmers vulnerability to water shortages, which may increase in regions under condition of climate change

<table>
<thead>
<tr>
<th>Greening the occupation recommendations</th>
<th>Technology, tools and machinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field of knowledge required</td>
<td>Sustainable water management practices, such as collecting rainwater, reducing water usage where possible, and redirecting waste water where it is safe and feasible to do so</td>
</tr>
<tr>
<td></td>
<td>Growing and purchasing alternative feed options and how to source these, such as protein feed from fly larvae or indigenous grains</td>
</tr>
<tr>
<td></td>
<td>Sustainable land management practices, particularly relating to mixed farming methods that allow poultry to roam and feed off pasture and cover crops</td>
</tr>
<tr>
<td></td>
<td>Sourcing and rearing alternative breeds, including indigenous poultry, which may be more adapted to hotter and/or drier climates</td>
</tr>
<tr>
<td></td>
<td>Obtaining and reading climate information to better understand and plan for future trends in a particular region</td>
</tr>
</tbody>
</table>

Changing the types of technology used on a poultry farm can have a significant impact on its environmental impact. For example,
• Using renewable energy, such as solar powered lighting, or improving energy efficiency
• If the farm uses irrigated pasture, ensuring the water efficiency of the irrigation system

New specialisms, such a pasture-reared poultry, requires mobile housing units for the birds to rest and rest in

| The kinds of goods & services produced | Pasture-reared eggs and poultry meat |

Emerging specialisms or alternative titles
Outdoor poultry farmer; Biodynamic poultry farmer; Pasture-reared poultry farmer; Organic poultry farmer
Through the value chain analysis and interviews with various poultry members and experts, it was found that one of the main "hotspots" within the value chain are the slaughter houses or abattoirs as they pose significant negative impacts to the environment, have high staff turnover and can impact the success of small or new producers. The operations manager or abattoir manager (134915) has intermediate skills that support strategic business management through efficient and effective abattoir operation, striving for best practice in all areas with particular focus on animal welfare, hygiene, and health and safety as well as reducing negative environmental impact. Furthermore, they develop a competent, multi skilled abattoir team.

The occupation can be greened mostly through waste, water and energy management skills training in order to adapt and build resilience to climate change. Such training could be provided SAPA and AgriSETA – provided that these organisations themselves contain these skill sets and expertise. The study also found that there are new innovative and hygienic mobile slaughterhouses which could ensure hygienic facilities and dispose of waste safely, including through recycling. DAFF and WC DoA can play a lead role in rolling up these facilities to create more business opportunities, increase employment and the number of hygienic slaughterhouse facilities in the province. This could lead to new specialisation or alternative title for Operations Manager (134915) to that of Mobile Abattoir Manager. Adding new Occupational Tasks relating to waste, water and energy management (as these should arguably be standard best practice), is another mechanism for greening the occupation.

<table>
<thead>
<tr>
<th>Occupation name: Operations Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative titles:</strong> Abattoir Manager; Mill Manager; Abattoir Veterinarian; Farm Produce Packhouse Manager; Sugar Mill Manager; Fresh Produce Packhouse Manager; Pet Food Mill Manager; Seed Processing Plant Manager; Food and Beverages Processing Manager; Feed Mill Manager; Field Production Manager (Seed); Farm Produce Processing Manager</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OFO major group (code)</th>
<th>OFO sub-major group (code)</th>
<th>OFO unit group (code)</th>
<th>OFO occupation code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>1349</td>
<td>134915</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Segment of the value chain</th>
<th>Skills band (high/intermediate/low)</th>
<th>Shade of green (dark/light/tint)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing</td>
<td>Intermediate</td>
<td>Tint</td>
</tr>
</tbody>
</table>

**Occupation description and purpose (from OFO)**

Plans, organises, directs, controls and coordinates the operations activities of a non-manufacturing organisation including physical and human resources.

**Key Occupational Tasks (from unit group with occupation specific drawn from job descriptions/research)**

- From unit group: Professional Services Managers - 1349
  - Controlling administrative operations such as budget planning, report preparation, expenditure on supplies, equipment and services
  - Developing, implementing and monitoring procedures, policies and standards for staff
  - Directing, supervising and evaluating the work activities of professional technical, clerical, service, maintenance, and other personnel
  - Monitoring and evaluating resources devoted to the provision of services
  - Overseeing the selection, training and performance of staff
  - Coordinating cooperation with other service provision agencies in the same or related fields
  - Planning, directing and coordinating the provision of services
Providing overall direction and management for a service, facility, organization or centre
Managing budgets, controlling expenditure and ensuring the efficient use of resources

- Providing training and supervising staff in poultry slaughtering procedures relating to the following critical areas, in order to reduce the high volumes of resources used in the process:
  - Waste management, including of waste water and solid waste
  - Energy efficiency and savings
  - Reducing water consumption and waste water, for example, by not using water as a ‘broom’ unless necessary
- Improving and upgrading facilities to be more efficient and less resource intensive:
  - Reducing waste and implementing best practice waste management procedures for managing waste and avoiding contamination. Where feasible and safe, solid waste could be redirected to convert to compost or as a resource for producing protein feed from fly larvae
  - Quality drainage systems would minimise the amount of water required for cleaning, create more hygienic facilities and could direct waste-water away for recycling where it is safe to do so
  - Reducing energy use, using renewable energy and improving energy efficiencies (e.g. by better insulating facilities)

### Key Areas for Greening

### Greening the occupation recommendations

#### Field of knowledge required
- Sustainable water management practices, such as collecting rainwater, reducing water usage where possible, and redirecting waste water where it is safe and feasible to do so
- Waste management practices, including converting solid waste to compost or protein feed from fly larvae
- Energy efficiency mechanisms and renewable energy sources
- Monitoring water and energy resource use

#### Technology, tools and machinery
- Solar panels
- Composting bins
- Water storage, filters and drainage systems
- Rain-water harvesting
- Mobile slaughtering facilities

#### The kinds of goods & services produced
- Compost made form waste materials
- Fly larvae as animal feed
- Ethical poultry slaughtering
- Energy efficiency
- Mobile slaughtering facilities

### Emerging specialisms or alternative titles
Mobile abattoir manager
4.3 Supply

In the Western Cape, Stellenbosch University and Elsenburg College are the most prominent agricultural training institutions – including livestock and meat production training. Stellenbosch University offers qualifications at NQF level 7 and above, and undertakes research. Elsenburg College provide agricultural training through learnerships, short courses, higher certificates, diplomas and Degrees. Other key training institutions include:

- SAPA
- Agricultural Research Council (ARC)
- AgriSETA
- South African Abattoir Association (SAAA)

SAPA has been successful in getting the small farmers started because it is not very expensive to start off with a small number of birds (Hoffmann, 2016). They usually deliver training quarterly in each province. However it has been challenging for SAPA to get accreditation for their training (Hoffmann, 2016).

In 2012, SAPA conducted a national poultry skills audit. The audit found that training in the industry is difficult to access due to financial constraints, and that small-scale farmers rely heavily on government and SETA-funded interventions to develop new skills (SAPA, 2012). The audit found that emerging farmers are specifically interested in management and administration skills. In contrast, commercial farmers and processors prioritise training interventions related to compliance and regulations, and provide their own internal training relating to re-enforcing standard operating procedures (SAPA, 2012).

As is the case for many commodities, large, well-established companies employ people who are highly qualified to do the extension services for their clients. Smaller producers rely on governmental extension services, which are currently only provided to emerging/black farmers. While extension services in the Western Cape are better than in some of the other provinces, they are still of poor standard and often do not have the right skills. The Western Cape Department of Agriculture have extension services workers who work with well-qualified scientists, which is working very well in the Western Cape compared to other provinces.

South African Abattoir Association provide training for abattoir managers but otherwise there is no formal training besides in-house training (Hoffmann, 2016). Only the abattoir inspectors can obtain training through a university. For managing waste on abattoirs, most abattoir managers bring in advisers to help them develop waste management plans. Though very few have waste management plans, most take their waste to the landfill and some have good composting systems (Hoffmann, 2016). The better practice rather is converting the waste into fly larvae which can be used as animal feed (Hoffmann, 2016). The biggest problem is finding funds to support the training and plans (Hoffmann, 2016). We need more mentors (well established famers) to guide and argue for prices/costs on behalf the emerging farmers (Hoffmann, 2016).

The SETAs work with unit standards – they develop qualifications for a specific job or to produce something. SAPA is the first body to develop a qualification (at KZN) in ‘Poultry Farm Worker Supervisor’, and have piloted the 6-week course (Nkuna & Mason, 2016). SAPA is also developing an abattoir qualification.

The hotspot case studies confirmed that there is little formal training available in the province for producers who want to adopt non-conventional practices. For example, Farmer Angus was self-taught (online and books) combined with the support of a mentor (a commercial producer who could not mentor on Angus’s methods, but could provide business advice and support), and through trial and error. Farmer Angus in turn trained and is mentoring Farmer Rico, who spent four years working on Angus’s farm. Both are willing to be trainers for
anyone interested in this kind of farming. Angus claims to have offered to run training courses for SAPA (if his time for it is covered), but the offer has not been taken up.

“I’m not completely self-taught, because I had a lot of mentors and help along the way. But I didn’t go to university, there is no university that teaches you this.” (Angus)

Essie, the manager of Hopefield Abattoir, received much of her training from her own staff – namely a family who worked on another abattoir previously – as well as through SAPA, from the vet, and through watching videos. Essie then trains her own staff. Essie’s husband, a poultry farmer, is a mentor at SAPA for poultry farmers, and Essie would be open to providing training for aspiring abattoir managers:

“I always tell people that I am open to share my knowledge that I have got here and I would like to help others. In 10 years’ time I would like people to duplicate my abattoir in smaller areas so that people won’t have to drive so far to slaughter. They need to have their own abattoirs and I can teach them.” (Essie)

4.4 Key Findings and Recommendations

Summary of key findings

Poultry is a growing industry in South Africa, and is forecast to continue to grow to meet a rising consumer demand, coupled with demand for meat with a lower carbon footprint. The industry is a popular development enterprise, but is often misconceived as a quick and easy way to make money - rearing poultry can be lucrative, but small and emerging farmers often need training and support (or mentoring), and access to slaughtering facilities and markets. There are also other side-line industries and other points in the value chain that could be developed, to the benefit of small and emerging poultry farmers and associated employees.

Key opportunities for green occupations and green skills relate to climate change impacts, water, energy and waste. Climate extremes in the Western Cape may add to the difficulty of rearing poultry outdoors and worsen the threat of drought and water shortages – critically threatening feed availability (particularly maize). There is a high usage of water and energy in slaughtering, together with high volumes of waste generated. However, there are alternative uses of waste across the value chain – for example, manure from rearing and all slaughtering by-products could be converted to compost and biofuel (though not always viable), or for fly larvae for protein feed (thereby feeding back into production as an input and creating a circular economy).

Through this analysis, the following opportunities were identified for supporting or creating new green enterprises or new green occupational specialisms, with associated green skill implications:

- ‘Outdoor’ or pasture-reared poultry farmers for broilers and/or eggs;
- Mobile slaughtering facilities;
- Green or Climate-smart abattoir manager;
- Protein feed for livestock from food waste;
- People auditing and designing efficient energy, water and waste management systems for abattoirs; and
- Producers of alternative poultry feeds from indigenous crops.

There are very few formal and customised training opportunities related to the skills needed to take advantage of these opportunities. In fact, there is little training available even for conventional practice in the case of abattoir management. But many who are willing to try and adopt greener practices are also willing to be mentors or trainers for others. This is a great opportunity to coordinate and establish green skills training
programs in the relevant training organisations to help to strengthen the viability of the poultry industry and to drive growth in a green economy in the Western Cape.

**Recommendations**

The findings above have raised new questions and highlighted areas where support is needed to actualise the opportunities identified. Thus, the recommendations that follow target particular role players and stakeholders who are best placed to take these forward.

**Recommendations for future research for the poultry industry:**

*These recommendations could be taken forward by Elsenburg College, Stellenbosch University, University of Pretoria and/or SAPA and other universities specialised in poultry studies.*

- Feasibility studies need to be conducted for potential enterprise models (e.g. mobile abattoir facilities) to validate this finding, which could potentially be an innovative enterprise for generating new jobs; and
- The resilience of indigenous breeds of poultry to environmental stress, including climate change, needs to be better understood, and analysed against their productivity, in order to determine whether switching breeding stock is viable and lucrative at different scales of production.

**Recommendations for improving the OFO:**

*These recommendations should be taken forward by Department of Higher Education and Training, which manages the OFO.*

- Existing descriptions are not useful for planning or designing ‘green’ training, and should be expanded.
- The OFO provides a narrow or overly simplistic view of a poultry farmer. Refining the occupational specialisms, descriptors and occupational tasks for the Poultry Farmer so that the occupation integrates tasks related to greening outlined above is necessary for planning or designing climate-smart training.
- Abattoir Manager falls under Operations Manager, yet Abattoir Managers must arguably be more adept at managing water, waste and energy at their facility than other types of managers, owing to the high volumes of resources used and waste produced. Refining the occupational specialisms, descriptors and occupational tasks for the Operations Manager so that the occupation integrates tasks related to greening outlined above is necessary for planning or designing climate-smart training.

**Recommendations for skills planning and training providers:**

*These recommendations could be taken forward by SETAs (particularly the AgriSETA), Elsenburg College, Stellenbosch University, the University of Pretoria, DAFF and/or SAPA and other universities specialised in poultry studies.*

- CSA and related practices related to conserving water and energy resources, reducing waste, adapting to changing climate conditions, and improving productivity, should be integrated into poultry, abattoir and extension services training curriculum.
- Provide a mechanism for identifying and responding to skill needs. For example, by creating a reporting mechanism whereby veterinary inspectors report back on the skill and capacity gaps they identify on inspections (i.e. not only on compliance with regulation).
- Local veterinarians need specific poultry training to support better provision of veterinary services in the Western Cape (thereby reducing avoidable waste).
Recommendations for stimulating new enterprise development:

*These recommendations could be taken forward by the WC DoA, Casidra, DAFF and/or SAPA.*

- Improvements for support and extension services are needed to facilitate a transition to climate-smart agricultural practices. For example, the veterinary support provided to Hopefield has been very beneficial – this can be replicated and improvements made (e.g. include CSA into vet training).
- Create mechanisms for vets/inspectors to report back to training providers on the skill needs, contexts and difficulties experienced by small/independent producers or enterprises in meeting regulatory requirements or otherwise.
- Create short courses – create a network of practitioners and leverage off people in the network willing to act as mentors and trainers.
- Integrate green principles into training (e.g. fly larvae to protein feed; composters; energy and waste; climate change – rising temperatures and water scarcity, impacts on housing needs, fuel and feed prices) – esp. abattoir course under development.
- Make available information on extension services, climate risks, business development options and financial support.
5. Green Skills for CSA in the Winter Grain Value Chain

5.1 Contextual Drivers in the Winter Grain Value Chain

Overview of the winter grain value chain in South Africa and the Western Cape

Contribution to the agricultural sector

Winter grains include barley and wheat, which are the primary grains in South Africa used to produce bread, animal feed and beer. The annual average gross value of wheat for the five years up to the 2012/13 season totals ~R4.3 million, in comparison to ~ R19 million for maize (the most significant field crop in South Africa). Based on value of production, wheat is the third most important field crop in South Africa and the most important small grain. Of the total area planted with wheat in South Africa (~500 000 ha), ~310 000 ha (60%) is in the Western Cape, ~ 90 000 ha (20%) is in the Free State province (DAFF, 2013) with the rest of the production taking place in the Northern and North West Provinces. Yet South Africa is not self-sufficient in wheat production, and ~50% of local consumption is imported (GrainSA, 2015). These imports contribute to higher bread prices than would be the case if local production could keep up with the increasing local demand (GrainSA, 2015).

In the Western Cape, barley and wheat production are expansive and rain-fed (dryland), whereas in other parts of the country production is irrigated. Given the similarity in growing conditions and production of these two crops, many farmers grow both or rotate the two crops. As the Western Cape predominantly receives much of its rainfall during the winter season, wheat is planted mostly between mid-April and mid-June, and is harvested during November to January. Barley varietals are planted mainly from early April until early June, and harvested four months after sowing. Wheat farmers in the Western Cape provide employment opportunities for ~9800 people in the Province. The South African milling industry accounts for the employment of ~3800 people (DAFF, 2012a). The turnover of this industry is estimated at R22 billion nationally.

After wheat, barley is the most economically important small grain in South Africa. The Western Cape is the largest producer of barley in South Africa (during 2011-2013, barley production in the Western Cape Province was more than 200 thousand tons (DAFF, 2014). However, national barley production does not currently meet demand, and an average of about 120 thousand tons of barley is imported per annum (DAFF 2014). South African farmers have not been able to respond and meet the local demand mainly due to the fact that dryland barley production can only be practiced in the Western Cape Province where climatic conditions are suitable (DAFF, 2014a:8).

The wheat and barley value chains

Moloisane (2003) undertook a detailed value chain analysis for the process of turning wheat into bread, to develop a strategy for the long term sustainability of the wheat industry. Figure 6 captures this chain in detail, showing farm production, storage, milling, baking and retail, with side production lines such as

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10 A small grain is a cereal (such as wheat, oats, barley, rye, rice) with relatively small kernels or sometimes a relatively small plant as distinguished from a plant or cereal with large kernels (such as corn or sorghum).
animal feed and other wheat-based products (in addition to bread). According to Moloisane (2003), this value chain provides substantial employment directly and indirectly for thousands of people through a complex supply chain, including farmers, silo operators, traders, manufacturers, bakers, retailers, input suppliers and support services.

Figure 6: Wheat into bread value chain (Moloisane, 2003)
Figure 7 is a simplified overview of the barley value chain, showing its various uses. In South Africa barley is produced mostly for malting (i.e. beer production), then animal feed, and as pearl barley for human consumption to a lesser extent (van der Vyver, 2013). Barley differs from most other agricultural commodities in that there is only one major barley buyer in South Africa, the SA Maltsters, who supply their one major stakeholder, South African Breweries (SAB) Ltd, with malted barley (van der Vyver, 2013).

![Barley value chain](image)

**Source:** Alberta Barley Commission

**Figure 7:** Barley value chain showing uses (DAFF, 2014)

### Risks, opportunities and trends

Both the wheat and barley industries are under pressure in South Africa to become more competitive and profitable, and to increase production to keep up with increasing local demand (ARC, 2014). Yet soil health in the Western Cape is deteriorating and farmers are faced with more erratic rainfall and more frequent drought. In response to these and other pressures, many farmers in the Western Cape are adopting new farming practices and technologies to differing degrees. These and other contextual drivers impact the activities of farmers and other enterprises operating at different points in each of these value chains, which are discussed in this section. The risks, trends and opportunities posed by climate change are explored separately in the section that follows.

There are a number of drivers that may influence the farmer’s **decision to cultivate wheat or barley.** This is particularly true for new and emerging farmers, who face more barriers to establishing their enterprise amidst increasing concentration in production. Drivers affecting the decision to farm these crops include market limitations: for barley, there is only one major buyer (SA Maltsters) and farmers may find it too risky to participate in such a market since they are aware that failure to meet SAB quality requirements would mean either a narrow or no market for their products (DAFF, 2014 – barley). Since the deregulation of the South African wheat industry in 1997, the only protection for the local wheat production industry is in the form of import tariffs. The South African wheat industry is currently one of the most free in the world, putting pressure on local producers in terms of pricing (Moloisane, 2003:21).
The inputs needed to farm barley or wheat include land, seed, fertiliser, lime, fuel, pesticides, and farming equipment, as well as knowledge (such as research into new cultivars or farming systems) and expertise (such as soil health experts). In the Western Cape high cost items include seed, fertiliser, chemicals, fuel and maintenance of equipment, compared to the Northern Cape and North West Province in which water and electricity are additional cost drivers, due to irrigation requirements (BFAP, 2007:11). In terms of inputs, the following drivers can be influential:

- **Prices on global markets and import costs:** Most of the raw materials used for synthetic fertilisers are imported (BFAP, 2007:11). Increased fuel prices increase the cost of running farm machinery and equipment, as well as the transportation of agricultural produce. In 1985, ~80% of grain produce was transported by train. Now, due to poorly functioning rail services, only ~30% of this produce is transported by rail. The majority is transported by road, and the cost of delivery is therefore contingent on the price of fuel.

- **Choice of cultivars:** The majority of wheat produced in South Africa is *Triticum aestivum* (bread wheat), with minor quantities of *Triticum turgidum* (durum wheat) produced in certain regions (DAFF, 2013). For both wheat and barley, the choice of cultivar is critical. Some cultivars may lack in competitive yields or ability to produce yields in varying climates (Burger, 2014:3). In the Southern Cape, certain barley cultivars are infected by various fungal diseases more often than in other areas, depending on environmental conditions (Burger 2014:79).

- **Availability of new technology and machinery:** Most machinery is imported to South Africa – especially specialist machinery such as precision planters used in conservation agriculture (see Box 5 below). These new technologies, such as precision irrigation and drones, shift traditional farming practices.

During the first phase of production, i.e. **farming barley or wheat**, there are a number of decisions relating to the extent or approach to planting, tillage, pest, disease and weed control, and crop rotation practices (see Box 5 for outline of conservation agriculture). For dryland farming, such as in the Western Cape, a critical risk during planting is a lack of rain. A farmer’s decision to adopt a particular approach to agriculture – such as conservation agriculture - may be affected by the condition of land, soil type and quality, climate, and access to resources and specialist machinery, as well as by the farmer’s knowledge and area of expertise. The traditional fallow system of farming, where land is ploughed and tilled but left unseeded for a growing season, has led to degradation of soils due to decreased organic carbon (humus), and increased soil acidity and soil erosion. Increased disease occurrence and decreased water availability makes it increasingly difficult to get a good barley or wheat yield from land that has been farmed in this way over time. For these reasons, most farmers in the Western Cape are adopting the principles of conservation agriculture to different degrees: incorporating ‘no-till’, cover crops, crop diversity, and soil cover practices into their production. These practices help to build up soil health and reduce run-off.

After **harvesting**, grain is often put into **storage** before being transported for milling or other processing. The limited number of mills available to process grain increases the cost of transporting the produce over long distances. SAB are opening up more malters to make it easier for barley growers to bring their goods to where they can be processed.

During the **processing of wheat** (milling and baking) by-products are produced, which can be directed towards animal feed. In some instances by-products are made into mats, carpets, and baskets and used for packing material, cattle bedding, and paper manufacturing. Most of the wheat produced in South Africa is bread wheat, with small quantities of durum wheat produced in certain areas and for use in pasta production. In South Africa, wheat is mainly used for human consumption (bread, biscuits, breakfast cereals, rusks, etc) and the remainder is used as seed and animal feed. There are other non-food uses such as production of alcohol for ethanol, absorbing agents for disposable diapers, adhesives and industrial uses
as starch on coatings. DAFF (2014b:1) estimates that there are ~3 800 to 4000 wheat producers. Drivers affecting wheat processing include:

- **Growth in small industries**: growth in small bakeries; although new entrants face high startup input costs and are often uninformed and inexperienced (Moloisane, 2003).
- **Declining number of mills**: From 1992 to 1998 employment has decreased by 25% in the milling industry as a result of improved efficiency and milling units being closed. The new small entrants into the market are creating new employment opportunities, but from a low base. This is not sufficient to counter the negative impact of the losses at the large mills. (Moloisane, 2003)

### Box 5: Conservation agriculture amongst winter grain farmers in the Western Cape

Conventional grain production (i.e. fallow system farming) is associated with high input costs and a weakened natural base through input run-off and degradation. By contrast, conservation agriculture (CA) offers an alternative production system which allows for agricultural intensification while improving soil health. CA builds on three cornerstones:

1. **Minimal disturbance of the soil (i.e. 'no-till')**: No-till refers to the sowing of seeds directly into the soil, without tillage to form a seedbed. This helps to retain moisture and carbon in the soil, and ensures that the habitat for micro-organisms in the soil remains intact. No-till requires planters that apply direct-seeding, and disc-drilling.

2. **Maximum diversity in crops grown, including cover crops**: Diversity in crops and crop rotation enhances the biodiversity on top of the soil and below. This biodiversity increases biological regulation functions (i.e. soil-based ecosystem services), resulting in improved soil health. Healthy soils hold and filter water better, and have a richer microbial life, to the benefit of the plant’s growth and health.

3. **Maximum cover on the soil, either with living plants or with plant residues**: Organic cover on top of the soil protects the soil against sun and rain, and regulates soil temperature. Organic cover also provides nutrients for soil organisms that help sequestrate carbon, and builds soil structure leading to better soil fertility. For every 1% of added carbon to the soil, the water-holding capacity of that soil doubles. Furthermore, cover can also reduce soil erosion.

Between 75 - 80 % of grain farmers in the Western Cape adhere to these core CA practices, but to different extents. The strong research base driven by the WCDoA & Agricultural Research Council (ARC) has been instrumental in encouraging farmers to adopt the CA approach. CA is very knowledge intensive (e.g. a farmer must tailor his or her approach based on the soil type, soil health, and choose appropriate cover crops) and requires patience, as the benefits accrue in the longer-term. This is particularly true for the Western Cape, where soil conditions are poor as a consequence of past management practices and natural conditions, and soil fertility will not re-establish very quickly. The high upfront investment for purchasing CA equipment such as a new planter is also a barrier for uptake of CA practices. In addition, it is important to note that CA needs to be complemented by other known good practices, such as integrated pest, nutrient, weed and water management. *(Smart Agri CA case study, 2016)*

Once ready for processing, barley is mostly malted or milled. For malting, the kernels are soaked, germinated and dried (DAFF, 2014a: 8) before being brewed. Milling barley requires crushing and grinding of the kernels to make flour or bran. Other processes include cracking or rolling the grain to produce feed for cattle, hogs and/or chickens, and separating out barley straw for use in beds for livestock, building material, paper or fibreboard. Barley can also be fermented for beef and dairy cattle feed.
SAB Miller in partnership with WWF recently developed a checklist for good farming practice as part of their Better Barley, Better Beer campaign, in an effort to improve the sustainability and reduce the negative impacts or barley farming. The checklist includes economic, social and environmental principles, each with their own criterion and indicators (see Box 6 for an overview of the criterion in the checklist). The checklist is intended as a decision-making tool. This would affect the farmer’s activities earlier on in the value chain.

**Box 6: SAB and WWF Better Barley, Better Beer criterion form a checklist for barley farmers. Indicator/s are available for each criterion.**

**Economic criterion:**
- The agronomic, livestock, veld and forage resources and mechanisation practices of the farm are integrated with the climate, soils, water and topography to maintain or enhance an optimum and sustained economic return for the farmer.

**Social criterion:**
- The right to fair labour practice is upheld.
- A working environment that is safe and without risk to the health of employees is provided and maintained.
- The right for security of tenure of labour tenants and farm occupiers is upheld.
- The development of farm labour skills is promoted.
- Contribution towards the local economy can be demonstrated.
- Landowners provide accommodation and related basic services to farm workers and tenure residents.
- Product safety and hygiene standards are controlled.
- Prevention of cruelty to animals is actively promoted.

**Environmental criterion:**
- Biodiversity assets and ecosystems are conserved.
- Critical ecosystem services and processes are maintained and protected.
- Natural agricultural resources (soil, water and vegetation) are protected and/or sustainably used.

The stages in the value chain and associated drivers and regulations have been simplified in the table on the following page, as a summary for easy reference.
Climate change threats, mitigation and adaptation considerations for winter grain

The SmartAgri study suggests that breeding wheat varietals for high-yield potential should be a priority over the next few decades, as the planting area for wheat crop is not likely to increase in the Western Cape. Future projected risk patterns for wheat production are likely to remain close to those currently experienced; however agro-climatic zones which are already considered to be risky and marginal for wheat production are likely to experience increasing risks (WCDP, 2016c).

Grain farmers in the Western Cape will increasingly face the impacts of climate change. The SmartAgri case study explains that:

“Climate change projections for the Western Cape suggest that we will experience continued warming (e.g. more hotter days). Projections also suggest changes in the quantity, intensity and distribution patterns of

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11 There are other, less widely used ways of processing barley and wheat, such as for converting to biofuel, or using the starch to make biodegradable plastics (DAFF 2014a: 9).
12 Organic beer, once relegated to speciality food and organic restaurants, is now become more mainstreamed (SABBI n.d: 2), resulting in an increased number of microbreweries.
rainfall – for example, failure of sufficient autumn rain, higher frequency of heavy rainfall and flooding, a higher frequency of heavy, or late spring rainfall. The resulting heat and water stress will have a negative impact on yield and on the quality of grain.” (SmartAgr, 2016c).

Over the past five years, variability in rainfall has caused fluctuations in wheat and barley quality and yields in South Africa (DAFF, 2014a:12). A direct threat is posed to grain production through changes in frequency and severity of intense rainfall events or drought. In addition, significant threats of climate change to grain production are likely to lie in changes to the distribution and intensity of pest species, the spread of diseases and growth of weeds, about which very little is known (SmartAgri, 2016d). These threats require adaptive responses if farmers are to avoid or reduce losses to their production and to increase production to meet domestic demand.

Grain farmers must also adopt approaches for mitigation. Grains and field crops contribute 28% of the Western Cape Province’s agricultural emissions and wheat is the highest contributor of these crops (SmartAgri, 2015b: 12). Conservation agriculture is a farming practice that reduces emissions, by sequestering carbon in the soil and reducing the use of fossil fuels (needed for fertilising and ploughing). According to a recent study in Nature, enhanced carbon storage in the world’s farmland soils could reduce greenhouse gas concentrations by between 50 and 80 percent (Paustian et al, 2016). The long-term mitigation strategy for the Western Cape, developed by DEA&DP, lists CA as a core mitigation strategy for the agricultural sector (SmartAgri, 2016c). Greenhouse gas emissions are also reduced through the significant decrease in fuel (diesel) use by farmers adopting no- or zero-till practices (SmartAgr, 2016c).

SmartAgri recommends the following actions to increase resilience for wheat: i) best practice management of soil fertility, restoration of degraded soils and rangelands, and conservation of soil resources; ii) improved management of surface water and groundwater resources; iii) strive for the optimum balance between crops and livestock, and manage this balance flexibly depending on the local climatic conditions and capacity of the land; iv) pro-active risk management should be practiced by farmers as natural hazards and pest and disease outbreaks pose a high risk in some parts of the region; and v) take an active part in skills development and on-farm research relevant to farming in this region under conditions of climate change. Many of these actions require green skills to implement.

‘Hotspots’ at different stages in the winter grain value chains

Winter grains offer a great window of opportunity to start developing and scaling green skills due to the proven benefits (e.g. better yield in times of low rainfall years) and the rising commitment and support by producers, as well as stakeholders within the industry and government. Training and support services for on-farm conservation agriculture is thus a key hotspot in the winter grain value chain, owing to the need for context-specific and technical expertise to transition to the new farming approach, which has skilling implications. In other words, on-farm practices of no till, crop diversity and cover crops, and organic soil cover are key greening opportunities, but the shortage of trainers that train farmers in these practices is an associated, underlying hotspot.

In addition to the job, skill and training opportunities directly linked to the practices associated with conservation agriculture, there are other emerging green opportunities indirectly linked to conservation agriculture. For example, designing and manufacturing appropriate specialised machinery (planters); identifying suitable cover crops that also have a market potential (and developing the market for the sale of these); and research and development of bio-friendly fertilisers and pesticides. Furthermore, as farmers struggle with the costs of converting to conservation agriculture, and as farmers in general in the sector often struggle resulting in fewer farmers/ more consolidation, diversifying on-farm practices on grain farms can help to build farmers’ resilience. This means introducing mixed crop and livestock systems, as well as
getting more value-added production processes on to the farm (i.e. milling / brewing and retail) and other lines of income and occupations (for example, nursery schools; training courses).

**Training and support needs of conservation agriculture:**

The training needs for farmers who wish to shift their practice to conservation agriculture are varied, and highly context-specific, as each location has its own considerations and each farmer has their own training or support needs (Strauss, 2016). For instance, farmers may need the advice and expertise of agronomists, soil scientists, and agricultural researchers in general on how to reduce carbon, what cover plants to plant, support for growing other crops, what the legislation means and how to comply, and/or how to improve biodiversity and create corridors (Strauss, 2016; Coetzee, 2016). Training or extension services need to have a good understanding of CA and good context knowledge. They ideally need to be able to look at a farming practice, identify what the needs of the farmer are, and put a response in place that adds efficiencies and savings, and help with training farm workers to implement it or identify suitable trainers for niche areas (Coetzee, 2016). For example, how to protect soil so that in a flash flood the cover crops hold back the soil and reduce erosion. This also requires niche training for farm workers that would improve their skills and allow them to ask for better pay, which would be possible through the savings generated by these initiatives (Coetzee, 2016). Such ‘stewardship’ training programs could cover fire, erosion, water and alien invasive plants management, covering legislations all the way to best practices.

**Developing new markets, products and alternative sources of income:**

Diversity and access to alternatives are important for building on-farm resilience in the face of uncertainty. Linked to the training and support needs of farmers discussed above, is the need for trainers to make farmers aware of new market opportunities – and how to act on these quickly to cultivate new crops in dryland conditions (Strauss, 2016). It is also important to identify alternative markets for crops – for example, barley has one main buyer (SAB) and there is insecurity over the looming purchase of SAB Miller by AB InBev. An alternative market that could be explored is the growing craft beer market (Strauss, 2016). Wheat has a similar situation where there is a concentration of buyers, and farmers must often trade-off quality for quantity to suit this situation (Strauss, 2016).

Land reform beneficiaries are said to struggle to succeed in this context, partly because there are often too many beneficiaries on one plot. Diversifying farm activities may be one way to help support families in cases where there are too many beneficiaries to be supported off a single farming enterprise (Coetzee, 2016).

There are also opportunities for shortening the value chain, and reducing the number of middle-men by moving more processes on-farm – such as getting farmers involved in milling/malting and baking/brewing, and selling these new produce directly to the consumer (Strauss, 2016). Additionally, farms could diversify their income by becoming involved in agri-tourism or in running small social services / business in their community, such as creches and day care facilities. Farmers could also benefit from understanding opportunities to develop their own energy on-farm, such as through biogas fermenters – a practice not currently widely seen in South Africa (Strauss, 2016).

**Machinery:**

Currently all specialist machinery needed for conservation agriculture (e.g. precision seeders) are imported, but it may be possible to make adjustments to existing machinery or to build these locally. However both of these would require new local skills to be developed, and timing is a barrier: it takes a while to build locally
and it is easier to import (Strauss, 2016). There are some exceptions / success stories, for example Equalizer has starting to export to Australia (Strauss, 2016).

**Developing bio friendly inputs:**

There are also different degrees of conservation agriculture, and a need to move from high input conservation agriculture to low input conservation agriculture, through exploring alternatives such as different varieties of cover crops (Strauss, 2016). Fertilisers and pesticides also need to be more bio-friendly (not necessarily organic, as organic inputs can also be destructive).

### 5.2 Occupations and Skills

**Mapping OFO codes associated with the winter grain value chain**

Across the analysis of the barley and wheat value chains in the Western Cape and the threats and opportunities posed by climate change, a number of occupations emerged as being critical. In this analysis, conservation agriculture was emphasised. As this is a knowledge-intense farming practice that requires specialist advice and expertise, advisory services have been emphasised in the occupations featured across the value chains. A list of the various occupations associated across the barley and wheat value chains are tabulated below as they are described in the OFO, with those that have emerged as being important for driving green practice highlighted – as potential sites for green skills training.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Conservation Scientist: 213301</td>
<td>Develops and implements programs and regulations for the protection of fish, wildlife and other natural resources.</td>
</tr>
<tr>
<td>Environmental Scientist: 213302</td>
<td>Studies and develops policies and plans for the control of factors which may produce pollution, imbalance or degradation of the environment.</td>
</tr>
<tr>
<td>Agricultural Consultant: 213201</td>
<td>Advises farmers, agricultural businesses, rural industries and government on the production, processing and distribution of farm products</td>
</tr>
<tr>
<td>Water Quality Analyst: 213306</td>
<td>Analyses and develops policies and plans for the control of factors which may produce water pollution</td>
</tr>
<tr>
<td>Role</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Agricultural Scientist: 213202</td>
<td>Studies commercial plants, animals and cultivation techniques to enhance the productivity of farms and agricultural industries</td>
</tr>
<tr>
<td>Food and Beverage Scientist: 213205</td>
<td>Studies the physical and chemical properties of food and beverages and develops new and improved food and beverage products, and sets standards for producing, packaging and marketing food and beverages</td>
</tr>
<tr>
<td>Earth and Soil Scientist: 213304</td>
<td>Analyses the composition, structure and other physical attributes of soil.</td>
</tr>
<tr>
<td>Agronomy Farmer</td>
<td>Plans, organises and performs farming operations to grow annual and perennial crop such as cotton, grain, maize</td>
</tr>
<tr>
<td>Crop Production Farm Worker / Assistant 821101</td>
<td>Manually plants, cultivates, and harvests vegetables, fruits, nuts and field crops.</td>
</tr>
<tr>
<td>Miller: 313909</td>
<td>Monitors and controls mechanical and operational efficiency of production facilities, equipment, plant and related resources in the bulk handling and storage of cereals, milling of cereals and extraction of starch</td>
</tr>
<tr>
<td>Grain Handling Operator: 716113</td>
<td>Receives, ships, and handles grain and perform preventive maintenance and cleaning as needed</td>
</tr>
<tr>
<td>Cereals, snacks, pasta and condiments machine process operator: 716116</td>
<td>Operate machines and performs routine tasks to make cereals, snacks, pasta and condiments</td>
</tr>
<tr>
<td><strong>Brew house Process Machine Operator:</strong> 716117</td>
<td>Operate machines and performs routine tasks to make beer; Operating machinery to crush, mix, malt, cook and ferment grains and fruits to produce beer, wines, malt liquors, vinegar, yeast and related products</td>
</tr>
<tr>
<td><strong>Confectionary Baker:</strong> 681201</td>
<td>Prepares and bakes bread loaves and rolls, including specialty breads. <em>Alternative title:</em> Cake / Bread Baker; Dough Maker</td>
</tr>
<tr>
<td><strong>Food and Beverage Technician:</strong> 311903</td>
<td>Tests new and existing engineering technologies relating to agricultural, food or beverage products, analyses test data and carries out technical functions in support of food and beverage scientists. <em>Alternative title:</em> Sugar Laboratory Technician; Brewmaster / Master Brewer; Dairy Laboratory Technician; Food Laboratory Technician; Milling Laboratory Technician; Distillery Technician; Beverage Laboratory Technician; Fermentation Technician; Gas Chromatographic; Brewery Technician; Food Science Technician</td>
</tr>
<tr>
<td><strong>Food and Beverage Factory Worker:</strong> 832904</td>
<td>Performs routine tasks in manufacturing food and beverages. <em>Alternative title:</em> Valve Controller; Winery Worker; Silo Worker; Line Attendant; Bread Room Hand; Biscuit Factory Hand; Perishable Produce Packhouse Worker; Beer Brewer; Grain Dryer Attendant; Baking Factory Worker; Winery Cellar Hand Brewer; Beer Production Worker; Brewery Worker</td>
</tr>
<tr>
<td><strong>Wholesaler:</strong> 142102</td>
<td>Plans, organises, directs, controls and coordinates the operations of a wholesale trading establishment. <em>Alternative title:</em> Wholesale Merchant</td>
</tr>
<tr>
<td><strong>Importer or Exporter:</strong> 142101</td>
<td>Plans, organises, directs, controls and coordinates the operations of an importing or exporting establishment. <em>Alternative title:</em> Export Manager; Import Manager</td>
</tr>
<tr>
<td><strong>Retail Manager (General):</strong> 142103</td>
<td>Organises and controls the operations of a retail trading establishment. <em>Alternative title:</em> Shop Owner; Shop Manager; Retail Store Manager</td>
</tr>
</tbody>
</table>

**Case study: Occupations and skills in a winter grain hotspot**

The Agronomy farmer (611101) is responsible for planning, organising and managing the day to day farm operations and facilities. They can implement and monitor sustainable farming management practices such as conservation agriculture as well as water, soil and biodiversity management.
### Key Occupational Tasks

**Unit group: Field Crop and Vegetable Growers- 6111**
- Storing and carrying out some processing of produce
- Inspecting, cleaning, grading, packaging, storing and loading crops for sale or delivery to market
- Tending working animals and maintaining farm buildings, structures, equipment and water supply systems;
- Monitoring market activity and conditions, determining types and quantities of crops to be grown, and planning and coordinating production accordingly
- Maintaining crops by cultivating soil, by transplanting, pruning or thinning plants, and by setting up and operating irrigation equipment
- Preparing soil by hand or machine, and spreading fertilizers and manure
- Promoting and marketing products, arranging the sale, purchase and transportation of produce and supplies and maintaining and evaluating records of farm activities and transactions
- Training and supervising workers in crop production, maintenance duties, and health and safety precautions and hiring and discharging workers and contractors
- Harvesting crops and destroying diseased or superfluous crops
- Controlling weeds, pests and diseases, by applying herbicides and pesticides
- Selecting and sowing seeds, and planting seedlings

### Key Areas for Greening

- Align the above tasks include sustainable land management practices such as fire and veld management, and managing and removing alien invasive plants especially those in riparian zones
- Expand the above tasks to include conservation agriculture principles (such as no-till, crop diversity and soil cover), and monitor the effects on soil quality and moisture
- Practices or support for studying a farm's crop production in order to discern the best ways to plant, harvest, and cultivate the plants, regardless of the climate
- Implement and monitor adaptive management practices as they are implemented, as these are context specific and must be refined over time
- Enhance biodiversity through crop rotation and diversity
- Build resilience to drought through conservation agriculture and through developing alternative sources of income (such as through mixed farming methods, value-added processing, or entirely new ventures such as agri-tourism)

### Greening the occupation recommendations

**Field of knowledge required**
- Theory and practice of conservation agriculture, including no-till, crop diversity and soil cover through cover crops or mulching. Understanding crop diversity includes different types of cover crops
- Water conservation and management, especially in riparian zones. This includes identifying and appropriate removal methods of alien invasive plants
- Reading weather and climate forecasts and understanding the agro-climatic conditions in
area (such as the soil type, climate, topography) in order to make seasonal and long-term decisions on the type of crops grown and farming method.

- Value-add production methods of alternative sources of income, e.g. for producing stone-ground flour or craft beer.

| Technology, tools and machinery | Precision planters for low- and no-till  
Cover crops and mulching  
Biofriendly herbicides and pesticides, or alternative means of managing pests  
Machinery for producing value-added produce, such as brewing equipment or stone mills |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The kinds of goods &amp; services produced</td>
<td>No tillage practice, growing cover crops and surface mulch, crop rotation</td>
</tr>
</tbody>
</table>
| Emerging specialisms or alternative titles | Conservation farmer  
Stewardship farmer |

### 5.3 Supply

Within the industry and in industry bodies such as GrainSA, there is a big emphasis on education, particularly for schooling programs for children who live on farms. The sector is also strongly in support of upcoming farmers, but land reform is not always successful for this type of expansive farming as there are often too many beneficiaries on a plot of land that is too small, and insufficient support (Strauss, 2016).

Training for CA is currently driven through a farmer-to-farmer extension process or support, facilitated through the CA Association in the Western Cape, and combined with self-tuition or research. Dr Johann Strauss, senior researcher and CA expert at WCDoA, has helped to develop a CA course through Villa Academy (http://www.villaacademy.co.za/) that was first presented in September 2015, but to date there have been low numbers attending (Strauss, 2016).

Perhaps the best way to support training and support related to conservation agriculture and sustainable land stewardship practices is to get different stakeholders around a table – such as businesses, banks, legislature officials, agricultural colleges and farmers. In the past, agri-banks would offer extension services to farmers because it was in the agri-banks interests for farmers to perform well (Coetzee, 2016). Today, training should be supported by businesses and banks, as they are stakeholders who benefit from success of farmers and because government no longer has the time or budget to lead such initiatives (Coetzee, 2016).

### 5.4 Key Findings and Recommendations

#### Summary of key findings

As dryland crops in the Western Cape, wheat and barley are vulnerable to changes in rainfall and temperature under conditions of climate change. Farmers currently do not produce enough to meet the domestic demand, and there is a concentration of buyers for each grain. Conventional farming practices strip the soil and lead to soil nutrient and input run-off. This combination of factors points to the need for more diversity on farms in
terms of the variety of crops grown and income-generating activities undertaken, and the need for more environmentally sensitive farming and processing practices. Each of these has an associated need for training or support, as they require a change in practice, or specific, and often tailored, expert knowledge and advice.

Through this analysis, the following were identified as opportunities for new green enterprises or new green specialisms or jobs, with associated green skills implications:

- Conservation Farmer;
- Stewardship Farmer;
- Advisory services for new cover crops, new market opportunities and new livelihood or income-generating activities (such as processing wheat or barley on-farm);
- Specialist training services for environmental issues associated with land management (incl. associated policy and regulations), such as fire, alien invasive plants, riparian zone management;
- Enterprises that manufacture or service Local CA machinery; and
- Enterprises that develop (new) bio-friendly inputs.

Recommendations

The findings in this chapter highlighted that further support and research is needed to actualise the opportunities identified. Thus, the recommendations that follow target particular role players and stakeholders who are best placed to take these forward.

Recommendations for future studies and research:

These recommendations should be taken forward by the WC DoA, ARC, Elsenburg College, Stellenbosch University.

- Improving climate forecasts and improving understanding of the agro-climatic conditions in specific areas (such as the soil type, climate, topography) in order to advise farmers on seasonal and long-term decisions on the type of crops grown and farming method.
- Continuation and expansion of existing work and research relating to bio-friendly inputs, resilient strains / cultivars, and suitable cover crops.

Recommendations for changes to the OFO:

These recommendations should be taken forward by the DHET, which manages the OFO.

- Winter grain farmers which fall under the broad occupation of Agronomy Farmer (611101) under the unit group of Field Crop and Vegetable Growers. This conflation does not distinguish the practice of a farmer practicing conservation agriculture. Refining the occupational specialisms, descriptors and occupational tasks for the Agronomy Farmer so that the occupation integrates tasks related to greening outlined above is necessary for planning or designing climate-smart training.
- In contrast, there appears to be a lot of overlap in the occupational specialisms, descriptors and occupational tasks relating to Agricultural, Conservation, Earth and Soil Scientists and advisors. These occupations are important for advising farmers practicing conservation farming.

Recommendations for improved training services and support for conservation agriculture and land stewardship practices:
These recommendations should be supported by WC DoA, ARC, and GrainSA and taken forward by DAFF and AgriSETA.

- The new CA course at Villa Academy should be promoted amongst extension services to improve their ability to support farmers and farmworkers to implement conservation agriculture practices; and
- A network of trainers / extension services for niche environmental services should be identified and approached to offer advice to farmers and farmworkers. These niche environmental services include fire and veld management, alien invasive species removal, and producing new crop varieties as cover crops or for new on-farm enterprises.
6. Green Skills for CSA in the Deciduous Fruit Value Chain

6.1 Contextual Drivers in the Deciduous Fruit Value Chain

Overview of the deciduous fruit value chain in South Africa and the Western Cape

Deciduous fruit collectively comprises stone fruit (such as apricots, peaches, nectarines) and pome fruit (apples and pears). During the 2010/11 season, the gross value for deciduous fruit production in South Africa was ~R 9.4 billion. Exporting of deciduous fruit is a key earner of foreign exchange in the country. Within the 2012/13 season, ~49 % of deciduous fruit produced was exported (amounting to ~885 tons) and nearly 78% of the total output from deciduous fruit arose from foreign exchange support earnings.

The deciduous fruit industry creates employment for almost 100 000 individuals (converted to permanent equivalents) throughout the whole of South Africa. Permanent labourers are predominantly employed to perform tasks such as harvesting, supervision, operational duties in pack houses, irrigation management, and insect and disease management, and - on a seasonal basis - tractor and forklift driving. Seasonal labourers are largely employed on a contract basis with the main purpose of harvesting the crop and/or fruit packing. This is low-skilled work and tends to be vulnerable to problems associated with poor levels of education and literacy, and social problems such as absenteeism, alcohol abuse and family strife, and poor health (WCPP, 2014).

During the last decade, deciduous fruit has undergone consolidation and integration into the value chain: producers do not only grow fruit, but have also been extensively involved in value-adding (packaging) and marketing endeavours (DAFF, 2014). Larger producers that have upgraded in the value chain have more resilience to vagaries of price and weather, have finance investment in new varieties, supply larger quantities to meet supermarket buying programmes, and obtain efficiencies through better downstream linkages in the value chain (Barrientos and Visser, 2012). Following de-regulation of the industry in 1997 (dissolution of export marketing board), the bargaining position of producers diminished (Barrientos and Visser, 2012) and South Africa fell behind in a number of crucial functional areas which contribute to the sustainability of any given fruit industry. These include research capacity, transfer of technology, market discipline, promotion and productivity at ports (NAMC, 2007). That said, the industry still appears relatively advanced in these areas compared with other (predominantly non-export) commodities, such as poultry and winter grain.

In South Africa, the Western Cape has the largest concentration of deciduous fruit growers, with nearly 2 500 growers covering more than 80 000 hectares (HortGro, 2015). Of the total area of deciduous fruit production, around 45% is pome fruit. All commercial pome fruit production in the Western Cape is under irrigation (DAFF, 2014).

Apples are one of the most economically significant deciduous fruits grown in South Africa, considering their foreign exchange earnings, employment creation and connections with support institutions (DAFF, 2011). There has been an over-all increase in the volume of apples exported by South Africa within the last decade. The quantities exported have increased from 244 819 tons in 2001 to 306 324 tons in 2010, an increase of nearly 25% (DAFF, 2011). The Western Cape Province accounts for more than half of all the apples produced within South Africa (DAFF; 2014a).
A simplified value chain for deciduous fruit is shown in Figure 7. The figure illustrates the stages of fruit production from initial inputs (including research), to production, picking, packing, logistics and distribution through to final retail at fresh produce markets or export markets, or alternatively, directed on to processing. The supply chain is a complex relationship of various production and operational role-players (Barrientos and Visser, 2012). Further key stakeholders are producer organisations, organised labour, NGOs, financial institutions and the government.

Figure 7. Simplified value chain of the deciduous fruit and table grape supply value chain in South Africa (DAFF, 2012)

Risks, opportunities and trends

The different stages in production in the deciduous fruit industry in the Western Cape have distinct risks, opportunities, trends and contexts that can shape or define a producer’s activities. These different stages in production are discussed further below. The risks, trends and opportunities posed by climate change are explored separately in the section that follows.
Fruit farming is a large user of **specialised inputs** and sophisticated agricultural chemicals, and so input and capital costs for farming deciduous fruit are relatively high (NAMC, 2007). There are a number of inputs to consider when farming deciduous fruits, particularly: fertilizer, water, pesticides, herbicides and insecticides. If a farmer is developing an orchard from scratch, nursery trees need to be sought. The choice of which input to use is informed by extensive research in the industry.

**Box 7: FruitLook**

The Western Cape Department of Agriculture (WCDoA) is offering a state-of-the-art online tool, called FruitLook, to deciduous fruit and grape farmers in the Western Cape. FruitLook allows these farmers to improve their water use efficiency by using information from spatial data derived from remote sensing. FruitLook provides weekly, semi-real time information on crop growth, evapotranspiration deficits and crop nitrogen status for irrigation blocks in orchards and vineyards in key growing areas of the Western Cape. This quantitative, spatial information on water, vegetation and climate assists farmers to better understand the effects of their water use and crop management decisions, and to reduce costs by saving on inputs (such as water, fertilisers and electricity). Through the spatial identification of problems or unusual events, the technology can also improve the quantity and quality of yields and therefore increase profit. To have access to the technology, farmers and other interested parties have to register on the FruitLook web portal (www.fruitlook.co.za). On the portal farmers can demarcate their irrigation blocks, analyse crop growth and water status over time during the growth season (October to April), as well as compare crop development for different growing seasons. (SmartAgri, 2016e).

The deciduous fruit industry in South Africa is also a very research or knowledge intensive industry, with advanced dedicated research associations relative to other (non-export) commodities. For example, research is ongoing into finding the best performing cultivar to use in particular agro-climatic regions and soil types, and combined with different root stocking, irrigation schedules, and/or fertiliser application methods (HortGro, 2015). The research intensity of the sector suggests a high demand for and concentration of skilled researchers. The rich research landscape also suggests that farmers must be adept at finding the latest research and integrating it into their practice, in order to remain competitive.
The production potential of pome fruit in the Western Cape is primarily limited by the need for cold winters and availability of water.

- As an irrigated crop, deciduous fruit production is both vulnerable to water scarcity and drought, and accountable for the protection and responsible use of water resources. The 2015/16 drought in South Africa was estimated to result in a direct loss of R720 million for the deciduous fruit industry of Wolseley, Tulbagh, Ceres, Berg River and the Northern Cape (BizCommunity, 2016). Because of this critical dependency on water resources, WWF South Africa led a water stewardship program amongst deciduous fruit producers in the Western Cape (see Box 8), focusing on stone fruit. It is recommended that farmers develop drought management plans (see next section). The SmartAgri pome fruit case study highlights that the protection and management of high-yielding catchments and flow-regulating wetlands and river banks upstream of farmlands is critical for the optimisation of water flows serving agriculture. Options to increase water supply, such as water conservation and demand management through improved irrigation efficiencies, are also recommended (Midgley, 2016).

- In the warmer production regions the winter climate is seldom cold enough to provide sufficient chilling for the trees to emerge from dormancy in spring. Rest-breaking chemical agents are used to ensure strong flowering and fruit set. According to SmartAgri, ‘under climate warming, accumulation of chill units will decrease, eventually reaching a critical threshold at which apple production would no longer be commercially sustainable in the warmer areas’ (Midgley, 2016).

Having established an apple or pear orchard, a pome fruit farmer’s next phase of production is the ongoing water, soil, disease and pest management during the growth of the crop. Crops have to be sprayed with weed killers and fungicides during the numerous growing stages to prevent weeds from ‘stealing’ essential nutrients and sunlight that crops would typically absorb, and to prevent fungi from destroying the fruit (Ortmann, 2005). There are a number of risks and opportunities at this phase of production, such as:

- **Preventing pollution:** By international law, farmers must use an expert to determine the farm’s fertilizer needs in order to prevent the polluting of underground water and streams (SA Orchard, 2014).

- **Disease prevention:** At certain times of the year, farmers must check for fungal and bacterial diseases that affect fruit, such as apple scab and powdery mildew. Bacterial diseases can only be treated using antibiotics, which is illegal for most export markets. Rather, a farmer has to prevent bacterial disease by building up the immune system in the tree by feeding and watering it well (SA Orchard, 2014).

- **Managing water pump efficiency:** Fruit farmers can optimise their water pump efficiency in their irrigation systems by making improvements at four levels, namely i) pump the correct amount of water and not waste water through poor infrastructure; ii) set the pump energy efficiency so that it is a balance between the flow or pressure that is being produced by the electrical motor in a pump and the needs of the irrigation system; iii) improve the irrigation system design and align the settings of the pump accordingly (e.g. the settings for upstream compared to downstream pumping); and iv) have a distribution network systems of upstream and downstream dams (mostly for larger farms) (Bouwer, 2016).

- **Decline in pollinators:** Managed honeybees perform a critical service to farming in this region – beekeepers provide essential pollination services to fruit farmers by renting out their hives during key pollination periods. However, current disease pressures on hives and insufficient forage sources could become worse under the additional stress of climate change. Farmers can actively provide honeybees with additional sources of forage and take action to help contain the current disease problem (SmartAgri, 2016b).
Box 8: WWF and Water Stewardship for Stone Fruit Farmers in the Western Cape (ref WWF report)

Nine stone-fruit farmers in the Breede catchment in the Western Cape took part in the water stewardship initiative (2013-2014). The initiative was led by WWF South Africa, WWF United Kingdom (UK), Alliance for Water Stewardship, Marks & Spender, and Woolworths. The WWF Five Water Stewardship steps (see below) were interpreted and applied onto a farm’s particular context.

WWF Five Water Stewardship Steps

The nine farmers went through a guided six-step process to identify water stewardship opportunities, and for continued improvement. Three of the nine found that various supporting technologies were key to water stewardship but could be costly. The following are examples of water stewardship activities and steps taken as a result of involvement in initiative:

- Shifting from time-based to flow-based irrigation, by using flow metres and soil moisture probes (an IT measure that sends continuous data stream via radio to a centralised system, which farm managers can interpret on their cellphone);
- Measuring water quality (nutrient levels) to test that fertilisers are not running off and causing eutrophication downstream (this also saves money through reducing waste of fertiliser);
- Re-designing and maintaining the irrigation system;
- Knowing the soil type and irrigating accordingly, and planting the correct cultivars for their soil and climate;
- Testing the sugar content of fruit, as water-stressed fruit will have a higher sugar content than overwatered fruit
- Looking after local tributaries - checking livestock and clearing alien invasive species


To harvest pome fruit, farm workers carefully pick the ripe fruit from the trees. The fruit is placed into bins (as carefully as possible, to avoid bruising) where sorters separate the lower class 3 fruit (for juicing) from the higher class 1 and class 2 fruit (for the international and local markets respectively). Approximately 65 billion pieces of fruit are picked annually in South Africa. The fruit has to be handled carefully and picked by hand to avoid bruising or other damage, meaning that on-farm mechanisation is not feasible for pear and apple farmers. This means that the industry will remain labour-intensive to keep the standard of the fruit high, and producers will have to find alternative methods of managing orchards optimally to increase
labour productivity (NAMC, 2007). For example, farmers could adopt harvest platforms that more time and fuel efficient that the conventional ladders, bins and trailers (Kriel, 2015).

The bins from harvesting are then transported by a tractor to a loading area, and loaded onto vehicles for transportation to either the cold storage or pack house facilities. There are two types of cold storage – namely those with regulated or with controlled atmosphere. Both types of cold storage have lowered temperatures, but controlled atmosphere also has measured oxygen levels so that the apples cannot respire, making them last longer. Stone fruit should be placed in cold storage within eight hours of being packed, while pome fruit are allowed to remain at ambient temperatures for 24 hours before they must be packed in cold storage (Ortmann, 2005). Apples can remain in for controlled atmosphere for up to 12 months. Suitable post-harvest infrastructure is essential in meeting market requirements regarding supply continuity and grading, and for reducing waste through spoilage. Packhouses and especially cold storage units are areas of high energy consumption in the pome fruit value chain (see next section).

The export market accounts for more than 50% of the income derived in the South African fresh fruit industry. Owing to the importance of cooling to the industry’s export market, much research has been done on the design of fruit packaging (e.g. Defraeye et al, 2014; Pathare et al, 2012). The high export value and high numbers of direct employment in the deciduous fruit industry have led to the establishment of the Post-Harvest Innovation Programme (see Box 9) as the industry strives to remain profitable, sustainable and internationally competitive.

**Box 9: Post-Harvest Innovation Programme (PHI)**

The Post-Harvest Innovation Programme (PHI) is a public-private partnership between the Department of Science and Technology (DST) and the Fresh Produce Exporters’ Forum (FPEF), with the FPEF as the implementing partner. PHI is directed at developing innovative technology in the postharvest leg of the fresh fruit value chain, to develop and maintain the global competitiveness of the South African fresh fruit industry. The DST’s premise for initiating and supporting the PHI Programme, launched in 2007, was based on the need to address the innovation challenges for building a competitive and sustainable fresh fruit export industry. Find out more at: [http://www.postharvestinnovation.org.za/](http://www.postharvestinnovation.org.za/).

There are three distinctive sales channels for exporting deciduous fruits: i) one can sell directly to an importer with or without the help of an agent (typically larger, more established commercial operations); ii) one can supply a fruit combined, which will then contract importers/marketers and attempt to take advantage of economies of scale and increased bargaining power (combined fruits might also supply large retail chains); or iii) one may also be a member of a private or cooperative export organization which will find agents or importers and market the produce jointly (DAFF, 2011). Mostly, export organizations will enter into collective agreements with freight forwarders, negotiating better prices and services.

Besides supermarkets, there are various other domestic sales channels for fresh fruit and vegetables to be sold locally, including: (i) hawkers and wet markets; (ii) independent supermarkets; and (iii) into the food service industry, such as hotels and restaurants (Barrientos and Visser, 2012). The rise of supermarkets has contributed to a decline in the quantity of produce going to traditional wholesale markets during the past 15 years. There are 18 National Fresh Produce Markets (NFPM) in South Africa with the four largest (Johannesburg, Tshwane, Cape Town and Durban) representing nearly 74% of NFPM turnover and volume. Annually, in excess of 2,860,000 tonnes of fresh produce is traded through these markets. Since 1996, NFPMs have shown minimal growth at a time when the production of fresh produce in the country has increased drastically (Tregurtha et. al, 2010). The local market is served nearly exclusively by small growers, with fruit of a lower quality that is not accepted on the export market, or fruit produced in small quantities
that are challenging to aggregate into deliveries for export (minimum of 20 tons, the size of a refrigerated truck) (USAID, 2013).

Alternatively, fruit can be sent to a **juicing or processing** facility. Approximately 25–35% of processed apples (dry mass) end up as waste. The solid waste, often called pomace, is the portion of the fruit that is not used, such as skins, pips and fibres. The pomace has a high lignocellulose content and does not degrade easily. Additionally, large volumes of liquid waste are generated through washing within the processing (canning, juicing and drying) phases (Khan et al, 2014). Burton et al carried out a viability study on the potential for energy generation from wastewater. They identified the fruit industry generated wastewater as one of three sources with the greatest potential as a source of renewable energy. Fruit processing in South Africa includes canning, juicing, winemaking and fruit drying. Large volumes of water are consumed during these processes (7 – 10.7 m$^3$/tonne of raw produce) and the wastewater generated usually comprises of particulate organics, suspended solids, various cleaning solutions and softening or surfactant-active additives. A compositional analysis of wastewater from an industrial fruit processor in the Western Cape Province has shown that fruit-processing wastewater could be a feasible feedstock for the production of bio-ethanol and biogas (Khan et al, 2014).

The pome fruit value chain has been simplified below:

<table>
<thead>
<tr>
<th>Steps in the value chain</th>
<th>Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning to farm apples and pears</strong></td>
<td></td>
</tr>
<tr>
<td>Support available, market, risks, consolidation, export infrastructure</td>
<td></td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
<td></td>
</tr>
<tr>
<td>R&amp;D, expertise, finance, land, (GM) seed, fertiliser, herbicides, pesticides, fuel, labour, farming equipment, irrigation equipment, water monitoring technology, drones, marketing, pollinators, nursery trees</td>
<td>Soil, air, water, chemical/fertiliser use</td>
</tr>
<tr>
<td><strong>Cultivation</strong></td>
<td></td>
</tr>
<tr>
<td>Cultivar selection; water, pest and soil management; diversification; marketing; monitoring</td>
<td>Casual labour</td>
</tr>
<tr>
<td><strong>Harvesting</strong></td>
<td></td>
</tr>
<tr>
<td>Seasonal labour; picking; platforms; sorting; precooling</td>
<td>Export market – consumer demand</td>
</tr>
<tr>
<td><strong>Precooling, Controlled atmosphere (CA) storage, and Cold storage</strong></td>
<td>Processing</td>
</tr>
<tr>
<td>Energy use and efficiency</td>
<td>Juicing, Canning, Drying</td>
</tr>
<tr>
<td><strong>Packhouses</strong></td>
<td>Waste from processing</td>
</tr>
<tr>
<td>Energy use and efficiency</td>
<td>Pomace, waste water</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td></td>
</tr>
<tr>
<td>Rail, truck, container ships, flight</td>
<td>Perishable Product Export Control Board</td>
</tr>
<tr>
<td><strong>Sale</strong></td>
<td></td>
</tr>
<tr>
<td>Export, procurement, sales agents; local markets: hawkers and wet markets; independent supermarkets, food service industry</td>
<td>Labelling and safety</td>
</tr>
<tr>
<td><strong>Wholesale &amp; Retail</strong></td>
<td></td>
</tr>
<tr>
<td>Informal traders, food service industry, warehousing, packaging, marketing</td>
<td></td>
</tr>
<tr>
<td><strong>Consumer and end of life</strong></td>
<td></td>
</tr>
<tr>
<td>Trends, uses, waste</td>
<td></td>
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</tbody>
</table>
Climate change threats, mitigation and adaptation considerations for deciduous fruit

The production of pome fruit is highly dependent on climatic conditions that can only be partially manipulated through irrigation (DAFF; 2014a). Climate change is a threat to pome fruit agriculture, particularly in the water stressed region of the Western Cape. Projected decreases in winter and annual rainfall and possibly more frequent and/or severe droughts, and the resultant decline in water availability could put orchards under stress, reducing yields and fruit quality. Extreme events such as hail storms and flooding also increases the risks of orchard damage.

Weather data already shows that warming has occurred over the last 50 years with future increased temperatures almost a certainty (SmartAgri, 2016b). Warming poses a serious risk for deciduous fruit production, as fruit requires a minimum threshold of 800 Daily Positive Chill Units (DPCUs) during autumn and winter. Very warm post-bloom spring temperatures can lead to smaller fruit (SmartAgri, 2016b). Sunburn damage poses another risk. Already, sunburn damage in the Western Cape can amount to 20-30 % of the fruit cull in the orchard and up to 10 % rejection of packed cartons thereafter (SmartAgri, 2016b). High temperatures are also associated with insufficient red colour in blushed cultivars.

To respond and adapt to these new conditions, deciduous fruit growers in the Western Cape could adopt heat-tolerant fruit types and cultivars, and new farming practices such as soil management, best practice Integrated Pest Management and new technologies such as shade netting (SmartAgri, 2016b). Innovative collective and collaborative protection and management over the quality of water resources amongst farmers in catchment areas should also be considered. On an individual farm level, precision irrigation guided by satellite imaging (’FruitLook’) to reduce water use and costs (SmartAgri, 2016b).

Aside from the practices the pome fruit industry can implement in response to the impacts of climate change, there are also steps that can be taken to reduce the contribution made in terms of emissions. This is particularly pertinent as the drier and hotter climate will inevitably lead to rising water and energy demands for irrigation as well as higher energy demands for the cooling and storage of produce. (SmartAgri, 2016c). The Confronting Climate Change Project, an initiative of the fruit and wine industries in South Africa, is responding to the high carbon emissions associated with the industry.

Box 10: Confronting Climate Change Project

The Confronting Climate Change (CCC) Initiative is a carbon footprinting project, developed to support the South African fruit and wine sectors through identifying and responding to the risks and opportunities associated with carbon emissions. The CCC carbon footprinting tool has been independently audited by the Carbon Trust, and has been endorsed as a reliable and credible resource for measuring the carbon footprint of South African wine and fruit-related products. The initiative hopes that through use of the online carbon footprinting tool, the industry can create benchmarks. Currently, about 2 – 3 % of producers use CCC (e.g. Villiera, Backsberg) and these producers tend to benefit from integrating their carbon reduction efforts into their marketing.

Visit http://www.climatefruitandwine.co.za for more information.
In an analysis of electricity use across the fruit value chain, Bouwer (2011) found that cold storage was “the most energy intensive process and also showed the greatest potential for energy efficiency improvement in the short- to medium term. Energy efficiency improvements lie primarily in the management practices applied and the control of major refrigeration units like compressors, condensers and fans.”

Figure 8: Electricity use on fruit farms (Bouwer, 2011)

A similar trend was found in a study by the Confronting Climate Change initiative (see Box 9), which compared the emissions generated at different stages in the pome fruit value chain.

Despite the industry’s vulnerability to climate change and contributions to greenhouse emissions, relatively few of the projects, guides and research of the Post-Harvest Innovation Program relate to reducing energy, water or improving resiliency, but rather focus on efficiency, quality and loss reduction. Some exceptions include:

- Tools to calculate solar savings potential
- Optimisation of cold storage transport facilities
- Energy efficiency audits in the cold storage chain

‘Hotspots’ at different stages in the pome fruit value chains

Owing to the value of the export market, the deciduous fruit industry invests relatively more into research and development (R&D) to improve efficiencies and yields, reduce losses and remain internationally competitive. The international market is increasingly demanding more sustainable farming practices, putting pressure on the industry to reduce its carbon and water footprint, and to produce high-quality pest-free organic produce (Campbell, 2016). This has caused a shift in focusing on not what one produces, but rather on how one produces with a huge amount of new associated technologies. This can appear as an ‘information overload’ to farmers, who need to have a diversity of knowledge across the value chain as it becomes increasingly vertically integrated (Campbell, 2016). To assist with this, 80-85% of production is serviced by technical expert consultants or advisors (Campbell, 2016). This intensity together with growing concentration and vertical integration makes it difficult for new entrants and emerging farmers in this sector; it is difficult to start without sufficient funding meaning that emerging farmers need grants to support their enterprise. Government- and industry body-driven development should also look to support other black owned enterprises across the value chain, and not just focus on farmers. While the industry conducts R&D into new cultivators, and the international market puts demands on water and energy
efficiencies, social upliftment of farmworkers, waste produced during juicing and canning and impacts on biodiversity receive relatively less attention.

Technologies and tools for on-farm water usage

As an irrigated crop in a water scarce country, pome fruit farmers must adopt water optimisation, saving and water quality protection measures. The industry is constantly developing new technologies and tools for these, such as precision irrigation, a variety of technologies to monitor water in soil such as stick poles which can be checked through a mobile phone; mulching techniques; different rootstocks; using shade-cloth rather than water spray to avoid sunburn and reduce wind (evaporation); new online tools like Fruitlook. Water optimisation is also achieved largely through design, for example, in integrating irrigation system efficiencies or in the choice of cultivar (76 new cultivars are being bred to be climate adaptive).

Energy consumption along the value chain but especially at packhouses and cold storage

The international market is ‘forcing producers to go green’, and one of the early main areas under scrutiny is the carbon-footprint of production, though recently the push has been towards sustainability more broadly (Campbell, 2016). This has led to a drive to get producers to measure their energy consumption and a drive to establish industry benchmarks at different stages in the value chain. On farm, this would mean benchmarks in the diesel or energy used per hectare and checking the energy efficiency of water pumps. These analyses have found large discrepancies in energy usage amongst producers, showing that there is room for improvement. Along the pome fruit value chain, about 10% of the energy consumption occurs in packhouse, and 80-90% in cold storage for typical pome fruit. But there are usually around 2 -3 people working in cold stores and 100 people working in the packhouse – i.e., employment numbers are disproportionately to energy usage (Bouwer, 2016). Areas in the value chain of high energy use, such as packhouses, could also consider solar and other forms of renewable energy which currently have a payback of around 11 years.

Initiatives analysing packhouses have found that 30-35 % savings are possible, just by running the infrastructure differently (Campbell, 2016). There are a few areas for reducing energy consumption in a packhouse: lighting (e.g. switching off in the day, only using good lighting at inspection where it is necessary); fans, conveyors (some use water conveyors which then also has pump). “A few conveyers, pumps and lights cannot take a lot of energy, most of them have already converted their lights to energy saver, and there is really not a lot in there” (Bouwer, 2016). Energy efficiency and reduction really only comes into play in terms of design – more compact facilities need fewer lights, shorter conveyors and fewer pumps. In general, efficiency is out of the hands of the operator, it is built into the design and the choice of machinery and only minor changes can be made at operator level – such as switching lights off at tea-time, but most packhouses encourage this already (Bouwer, 2016).

It is a similar case for cold storage: reducing emissions through by reducing the amount of total energy used ultimately comes down to efficiency, which can be broken down to:

- The efficiency of the equipment used;
- The efficiency of the building design (e.g. materials used for insulation, thickness of the tunnels, walls, roof and floor);
- Installing alarms to warn if a door is left open;
- Packing cold rooms optimally to fill all of the space, and optimising packing within a container by using pallets designed for box shipping; and
- Having a central control system to maintain temperatures, monitor suction pressure levels, and control fan speeds (Bouwer, 2016).
Reducing and re-using solid waste along the value chain

The above two hotspots relate to water and energy waste in the value chain. The industry does not generate a large amount of solid waste: on farm cuttings and prunings are generally used on the farm as mulch, and weeds are collapsed to also form mulch. Fruit that is not of suitable quality for the export or local market goes to juicing – but within the juicing and canning industry, it is not clear how the pomace and other solid waste generated are used.

The industry takes effort to reduce wasted fruit, which is a loss. Fruit can be wasted through bruising, and so caution starts on the farm at picking. Tech tools are available to monitor where the fruit experiences bumps and shocks as it moves through picking to sorting and along conveyor belts, to reduce bruising (Bouwer, 2016). Wastage can occur during transport, often with faults in equipment, for example, sometimes a container arrives overseas having been transported at the wrong temperature, which can ruin the whole container (Bouwer, 2016).

6.2 Occupations and Skills

Mapping OFO codes associated with the deciduous fruit value chain

The analysis of occupations in the OFO against the deciduous fruit value chain reveals a relatively more developed or detailed list of occupations in relation to the other commodity chains. This is a reflection of the relatively more advanced state of development of the commodity and value of the industry, as an export crop.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Scientist: 213301</td>
<td>Develops and implements programs and regulations for the protection of fish, wildlife and other natural resources. Alternative title: Conservancy Advisory Scientist; Ecologist; Fish and Games Officer; Ecological Researcher; Water Conservation Scientist; Animal Ecologist; Soil Conservationist Forestry Conservationist; Fisheries Advisor; Conservation Officer; Species Protection Officer</td>
</tr>
<tr>
<td>Environmental Scientist: 213302</td>
<td>Studies and develops policies and plans for the control of factors which may produce pollution, imbalance or degradation of the environment. Alternative titles: Environmental Advisor; Climate Change Analyst; Environmental Waste Officer; Environmentalist; Environmental Auditor; Environmental Research Scientist; Environmental Consultant; Environmental Officer</td>
</tr>
<tr>
<td>Water Quality Analyst: 213306</td>
<td>Analyses and develops policies and plans for the control of factors which may produce water pollution. Alternative titles: Hydrographical Technical Officer; Hydrological Technical Officer; Waste Water Treatment officer/ Technician; Water Quality Technician</td>
</tr>
<tr>
<td>Agricultural Scientist:</td>
<td>Studies commercial plants, animals and cultivation techniques to enhance the productivity of farms and agricultural industries</td>
</tr>
<tr>
<td>Code</td>
<td>Title</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>213202</td>
<td><strong>Agriculture Consultant: 213202</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative titles:</strong> Animal Husbandry Consultant / Advisor; Agriculture Field Officer; Farm Economic Techniques Advisor; Agriculture Mentor; Vegetable Consultant; Field Husbandry Consultant / Advisor; Horticulture Consultant / Advisor; Landcare Officer; Orchard Consultant; Agriculture Advisor; Farm Consultant / Advisor; Agriculture Extension Officer; Pasture Consultant; Agriculture Economic Advisor; Floriculture Consultant / Advisor</td>
</tr>
<tr>
<td>213304</td>
<td><strong>Earth and Soil Scientist: - 213304</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative titles:</strong> Veterinary Epidemiologist; Veterinary Parasitologist; Animal Doctor; Veterinary Pathologist; Veterinary Surgeon</td>
</tr>
<tr>
<td>684301</td>
<td><strong>Crop Produce Analyst: 684301</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative titles:</strong> Agronomy Production Supervisor; Agronomy Farm Foreman; Field Crop Famer</td>
</tr>
<tr>
<td>821101</td>
<td><strong>Crop Production Farm Worker / Assistant: 821101</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative title:</strong> Agronomy Farm Worker / Practitioner; Crop Farm Assistant; Ornamental Horticultural Farm Worker; Horticultural Farm Worker / Practitioner; Mixed Crop Worker; Crop Farm Worker (Any Commodity); Crop Worker</td>
</tr>
<tr>
<td>611202</td>
<td><strong>Horticultural Farmer: 611202</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative titles:</strong> Horticultural Production Supervisor; Horticultural Farm Foreman</td>
</tr>
<tr>
<td>862916</td>
<td><strong>Farm Maintenance Worker: 862916</strong></td>
</tr>
<tr>
<td>821104</td>
<td><strong>Harvester / Picker: 821104</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative titles:</strong> Nut Picker; Vegetable Picker; Haymaker; Picker Quality Controller; Mushroom Harvester / Picker; Hops or Tea Picker; Flower Buncher or Picker; Grape Picker; Fruit Picker</td>
</tr>
<tr>
<td>681401</td>
<td><strong>Fruit or Vegetable Preserver: 681401</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Alternative title:</strong> Dried Fruit Maker; Chutney Maker; Fruit / Vegetable Picker</td>
</tr>
<tr>
<td></td>
<td><strong>Environmental and Occupational</strong></td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td><strong>Code</strong></td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Health Inspector:</td>
<td>325701</td>
</tr>
<tr>
<td>Agricultural / Horticultural Produce Inspector:</td>
<td>325703</td>
</tr>
<tr>
<td>Fruit and Vegetable Processing Machine Operator:</td>
<td>716101</td>
</tr>
<tr>
<td>Fresh Produce Packing Controller:</td>
<td>313906</td>
</tr>
<tr>
<td>Juice Extraction Process Controller:</td>
<td>313910</td>
</tr>
<tr>
<td>Warehouse Manager:</td>
<td>132404</td>
</tr>
<tr>
<td>Forklift Driver:</td>
<td>734402</td>
</tr>
<tr>
<td>Packing Machine Operator:</td>
<td>718302</td>
</tr>
<tr>
<td>Packer:</td>
<td>832101</td>
</tr>
<tr>
<td>Wholesaler:</td>
<td>142102</td>
</tr>
</tbody>
</table>
Case study: Occupations and skills in a deciduous fruit hotspot

A Warehouse manager (132404) can influence the operational practice that take place within the pack house. They can initiate an analysis of the energy management system to find the critical operating parameters in the pack house. They can implement and monitor energy, water and waste management plans.

<table>
<thead>
<tr>
<th>Occupation name: Warehouse Manager</th>
<th>Alternative titles: Coolstore / Packhouse / Stockroom / Storeroom Manage; Storage and Warehousing Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OFO major group (code)</strong></td>
<td><strong>OFO sub-major group (code)</strong></td>
</tr>
<tr>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td><strong>Segment of the value chain</strong></td>
<td><strong>Skills band</strong> (high/intermediate/low)</td>
</tr>
<tr>
<td>Cold storage and pack house</td>
<td>High</td>
</tr>
<tr>
<td><strong>Occupation description and purpose (from OFO)</strong></td>
<td>Plans, directs, and coordinates the storage and distribution operations within an organization or the activities of organizations that are engaged in storing and distributing materials and products.</td>
</tr>
<tr>
<td><strong>Key Occupational Tasks (from unit group with occupation specific drawn from job descriptions/research)</strong></td>
<td>From the unit group: Supply, Distribution and Related Managers - 1324</td>
</tr>
<tr>
<td></td>
<td>• Preparing and implementing plans to maintain required stock levels at minimum cost</td>
</tr>
<tr>
<td></td>
<td>• Monitoring and reviewing storage and inventory systems to meet supply requirements and control stock levels</td>
</tr>
<tr>
<td></td>
<td>• Liaising with other departments and customers concerning requirements for outward goods and associated forwarding transportation</td>
</tr>
<tr>
<td></td>
<td>• Determining, implementing and monitoring purchasing, storage and distribution strategies, policies and plans</td>
</tr>
<tr>
<td></td>
<td>• Negotiating contracts with suppliers to meet quality, cost and delivery requirements</td>
</tr>
<tr>
<td></td>
<td>• Establishing and directing operational and administrative procedures</td>
</tr>
<tr>
<td></td>
<td>• Overseeing the recording of purchase, storage and distribution transactions</td>
</tr>
<tr>
<td></td>
<td>• Planning and directing daily operations</td>
</tr>
<tr>
<td></td>
<td>• Operating recording systems to track all movements of goods, and ensuring</td>
</tr>
</tbody>
</table>
re-ordering and re-stocking at optimal times
• Establishing and managing budgets, controlling expenditure and ensuring the efficient use of resources
• Overseeing the selection, training and performance of staff

Key Areas for Greening

- Providing training and supervising staff in packhouse procedures relating to conserving resources:
  - Waste management, including fruit solid waste
  - Energy efficiency and savings
  - Reducing water consumption and waste water, for example, by not using water as a ‘broom’
- Improving and upgrading facilities to be more efficient and less resource intensive particularly by reducing energy use, using renewable energy and improving energy efficiencies (e.g. by better insulating facilities)
- Determining, implementing and monitoring energy management and efficiency plan
- Optimising packing in transport, storage and coldstorage facilities
- Ongoing liaison with transport re optimal temperatures

Greening the occupation recommendations

<table>
<thead>
<tr>
<th>Field of knowledge required</th>
<th>Technology, tools and machinery worked on / with</th>
<th>The kinds of goods &amp; services produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy auditing and management, energy systems, renewable energy.</td>
<td>Renewable energy such as solar panels</td>
<td>More efficient energy systems, water usage and reduction in waste produced</td>
</tr>
</tbody>
</table>

Emerging specialisms or alternative titles

Energy-efficient packhouse manager

Another key occupation in this hotspot is that of the Mechanical Engineer (214401), who can play a critical role in the design and structure of the pack house as well as the operation machines designs used within the pack house. They may design more electrical and water efficient machines.

6.3 Supply Side

Training within the pome fruit industry is not as integrated as the citrus industry – for example, South Africa has a Citrus Academy\(^\text{13}\) supported by the Citrus Growers Association (Campbell, 2016). HortGro is about to embark on survey on all training courses relating to pome and other fruit production, which will look at different NQF ratings (Campbell, 2016). The Koekedou training facility is an AgriSETA training provider, which producers paying the SETA levy can access. Koekedou trains 10 000 people a year, with a focus on labour and middle management (Campbell, 2016).

Training in the industry tends to target high skill levels. As 80-85% of production is serviced by technical consultants and advisors, there is a demand to at least hold a Masters degree. The sector needs to include

\(^{13}\) [http://citrusacademy.org.za/](http://citrusacademy.org.za/)
soft skill training for all advisors as they tend to not have extension skills, only scientific skills, and also needs more black Masters-level technical advisors (Campbell, 2016).

Operator and sometimes manager-level training is often provided by the designer or supplier of the equipment – for example, for optimising cold storage and packhouse efficiency there is often equipment for central monitoring and control for which there is tailored training in some instances.

An important training provider in South Africa for efficiency and optimisation in different sectors is the National Cleaner Production Centre14. The NCPC is funded by DTI and hosted by CSIR and their training focuses on energy, waste, production efficiency and reducing waste. They are a registered training provider at SAQA. Most of their training, for example, around energy management systems, is aimed at managers and senior level staff, as the content is very technical. There is no training at present that targets more at the operator level. The reason for that is “before you can train the operator on how to be more energy efficient you must find out where you are in terms of your management system or energy system” (Bouwer, 2016). Similarly, when considering the training needs for improving water pump efficiency “skill training should go to design engineers because the operator just presses the switch on or off; he is not making a choice on which sprinkler to use because it is already installed.”

6.4 Key Findings and Recommendations

Summary of key findings

The Western Cape’s pome fruit industry, as with most of South Africa’s deciduous and citrus fruit production, is export-driven with a strong investment in research and development in order to remain competitive in international markets. International consumers and markets are also demanding more sustainable practices which farmers must adopt to remain competitive, most notably relating to carbon footprint, but also increasingly to sustainability more broadly.

Through the analysis across the pome fruit value chain, the following were identified as opportunities for new green enterprises or new green specialisms, with associated green skill implications:

- Energy efficiency auditors and energy systems engineers;
- Water pump efficiency auditors; and
- Recyclers of pomace for compost.

Recommendations

The findings in this chapter highlighted that advanced research and training is needed to develop highly-skilled technical specialisms and opportunities. Thus, the recommendations that follow target particular role players and stakeholders who are best placed to take these forward.

Recommendations for changes to the OFO

These recommendations should be taken forward by the DHET, which manages the OFO.

14 http://ncpc.co.za/
The occupational specialisms, descriptors and occupational tasks of a Horticultural Farmer description (the occupation that encompasses a deciduous fruit farmer) do not adequately capture the range of expertise that the occupation must draw from to compete effectively in this market;

- Packhouse and coldstorage managers fall within the Warehouse Manager occupation; however, the descriptors and occupational tasks need to include energy efficiency as high energy consumption at this stage in the value chain are a concern to international markets wanting low carbon footprints
- ‘Energy systems’ engineer and energy auditors are currently not included as specialisms in the OFO; however, there is increasing demand for these scarce specialists and their associated skills in the deciduous fruit industry.

**Recommendations for raising awareness with other sectors**

*These recommendations should be taken forward by WC DoA and FruitGro, HortGro Science, SAAPO, and others who communicate with and connect stakeholders beyond the sector:*

- Research relating to energy and water efficiency that is relevant to other sectors should be shared, particularly those sectors where there is no market pressure to adopt energy and water efficiency systems. Information and training on energy and water efficiency could be of great benefit to abattoirs, breweries or millers, for example.
7. Overview of the CSA Skills Provisioning System in the Western Cape

7.1 Overview of Relevant SETAs

The Western Cape Government has committed to climate-smart agriculture through the Western Cape Climate Change Response Strategy for Agriculture, acknowledging that sustainable agriculture plays a critical role in transitioning the region towards a green economy. However, without the right skills set and adequate skills base this strategy for the Western Cape will not be implementable, and potential job opportunities will not be realised. As highlighted through this study, many of the required skills are green skills. Farmers and other stakeholders in the agriculture supply chain cannot rely on self-taught skills to bridge this skills gap, and there is therefore a critical role for training institutions to play a training provision role for the sector.

The Sector Education and Training Authorities (SETAs) were established in 2005 with the mandate to help implement the National Skills Development Strategy (NSDS) by promoting and facilitating the delivery of education, training and development to enhance the skills required in different sectors (ETDP SETA, 2010). SETAs are entities of the Department of Higher Education and Training – there are 21 SETAs, each servicing a specific economic sector of South Africa. In each industrial sector, SETAs prepare and implement a Sector Skills Plan (SSP), covering 5-years. SSPs can be reviewed and updated annually by the SETA, thus informing the education and training providers, employers and workers as well as the communities of primary critical skills required in different sectors.

In each sector, companies with staff registered on PAYE and with an annual payroll exceeding R500 000 must pay a skills development levy to the SETA, under the Skills Development Levies Act (1999). These companies can claim 20% in levies contributed to the SETA in Mandatory Grants, which must be used towards training their staff. Companies can also apply for Discretionary Grants, which are specifically allocated for addressing scarce and critical skills shortages. Small companies, which have not paid the levy, can be assisted to apply for either grant at no cost (FoodBev SSP, 2008). The coordinating role that the SETAs play and the resources provided through the SETA system make them a primary driver of green skills development in South Africa.

Agricultural Sector Education and Training Authority (AgriSETA)

The Agricultural Sector Education Training Authority (AgriSETA) is responsible for the provision of skills required in the agricultural sector. AgriSETA is broken down into a number of subsectors, namely: seed; pest control; fibre; tobacco; poultry; aquaculture; milling, pet food & animal food; sugar; horticulture; grains and cereals; red meat. A new sustainability subsector comprising members across all of the other groups is under development.

Each year AgriSETA stakeholders can apply for skills development training in the sector. The learnership programmes are closely aligned to the requirements in the workplace. Artisans are in high demand in South Africa, therefore an artisan development programme was implemented by AgriSETA, providing a national qualification through workplace-based learning. AgriSETA also provides bursaries to those who would like to enrol at a higher institution of learning, encouraging more learners to study for agriculture careers. Internships and graduate placements are provided for those who have completed studies in scarce and critical skills but who do not have work experience. Other certified training is mostly done in Further Education and Training (FET) Colleges, Colleges of Agriculture, universities and universities of technology where students get certificates.
Food and Beverages manufacturing Sector Education and Training Authority (FoodBev SETA)

The Food and Beverages Manufacturing Sector Education Training Authority (FoodBev SETA) is highly reliant on outputs of the agricultural sector - a reduction in production within the agriculture sector leads to a reduction in the labour demand in the food and beverages manufacturing sector (FoodBev SSP, 2008). FoodBev SETA comprises five sub-sectors operating under its supervision (FoodBev AP, 2014):

- Baking, cereals, confectionary and snacks (BCCS);
- Beverages manufacturing sub-sector produces mineral water, spirits, malt, beer, wines and soft drinks;
- Dairy Manufacturing sub-sector manufactures dairy products such as fresh milk, cheese and ice cream;
- Manufacture of food preparation products that are used in making a meal or beverage (noodles, sauces and spices); and
- Processed and preserved meat, fish, fruits, vegetables, oils and fats.

Throughout these sub-sectors there is a wide range of occupations\(^{15}\) that need to have high skills levels (NQF level 5 and above) in line with the technical requirements of the sector. As a result, the sector is currently in collaboration with FET, Higher Education and Training (HET) and Technical Vocational Education Training (TVET) Colleges to provide the necessary training. Training and Skills development can also be accessed through FoodBev SETA’s bursaries scheme, which sponsors both students (from rural areas and urban townships) and employees that want to upskill themselves within the industry (FoodBev AP, 2008). There are also learnerships and artisan development programmes that the youth can participate in in order to obtain skills that are required within the Food and Beverages Manufacturing Sector.

Other SETAs relevant to the greening of the agricultural sector

Wholesale & Retail SETA (W&R SETA): Includes the wholesale trade in food and beverages, and the retail trade of fresh fruit and vegetables, meat and meat products, bakery products, and beverages.

Chemical Industries SETA (CHIETA): ‘Fertilisers’ is one of the nine sub-sectors in the chemical industries sector which falls under the coverage of CHIETA.

Local Government SETA (LGSETA): The scope of the LGSETA covers many local and municipal services which overlap, impact or relate to agricultural production, such as land use planning, refuse and sanitation, community work, and parks and gardens, amongst others.

Energy and Water SETA (EWSETA): The coverage of EWSETA includes the generation, production, collection and distribution of energy; gas manufacture and distribution; and water collection, purification and distribution. Water covers public water enterprises, private water companies and irrigation boards.

Education Training and Development Practices SETA (ETDPSETA): The ETDPSETA facilitates skills development in the education, training and development sector in order to create employment opportunities.

7.2 Overview of CSA Training and Research

Key training institutions in the Western Cape

\(^{15}\) Including inter alia: clerical and admin workers, community workers and labourers, machine operators and drivers, skilled agriculture, professionals, sales and services workers, senior officials and managers, technicians, engineers and trade workers (FoodBev SSP, 2008),
Training institutions are critical for developing a critical mass of people with the skills to support climate-smart agriculture in different positions in the sector, as well as to specialise within particular agricultural value chains. Chakeredza et al (2008) note that graduates in agriculture should be competent to analyse and solve climate change related problems, to anticipate and prepare for future climatic challenges, as well as to create and seize opportunities to apply their knowledge to a specific individual localised situation. Although this study was not able to undertake a comprehensive assessment of training institutions and their outputs, the desktop research and the case studies indicate that Stellenbosch University and Elsenburg Agricultural College are key institutions for education in agriculture in the Western Cape. The section below briefly outlines the courses that they have on offer:

**Elsenburg Agricultural College** offers undergraduate and postgraduate agricultural training, including:
- B. Agric Degree (specialising in: plant and animal production, cellular technology, extension and plant production, and extension and animal production);
- Higher Certificate in Agriculture (specialising in: animal and vegetable production, pomology and viticulture, animal production and agronomy, extension, cattle and small stock science, extension and agronomy and vegetables, extension and viticulture, and extension and pomology);
- Diploma in Agriculture;
- Diploma in Extension; and
- Equine Studies.

**Stellenbosch University** offers various undergraduate and postgraduate agricultural courses, including:
- Agricultural Economics and Management (BAgric Admin and BScAgric; BScAgric (Hons) MscAgric);
- Animal Production Systems (BScAgric: Animal Production Systems; Postgraduate Diploma, MScAgric);
- Conservation Ecology (BSc: ConsEcol; MSc Sustainable Agriculture; MSc);
- Food and Wine Production Systems (BScAgric: Viticulture and Oenology; BSc: Food Science; MSc: Food Science; MSc: Food and Nutrition Security; BScHons: Wine Biotechnology; MSc, MScAgric);
- Forestry and Wood Sciences (BScFor; Postgraduate Diploma: Forestry, and Wood Sciences; MScFor: Forestry and Natural Resource Science, and Wood and Wood Products Sciences); and
- Plant and Soil Sciences (BScAgric: Plant and Soil Sciences; Postgraduate Diploma: Agronomy; BScHons: Plant Pathology, and Applied Plant Pathology; MSc: Entomology, and Plant Pathology; MScAgric: Agronomy, Genetics, Horticultural Science, Soil Science, and Viticulture and Oenology).

The **Cape Peninsula University of Technology** (CPUT) has an Agriculture Department under the Applied Sciences Faculty, undergraduate and postgraduate agricultural courses include:
- National Diploma in Agricultural Management;
- National Diploma Agriculture: Crop Production;
- National Diploma Agriculture: Animal Production;
- BTech: Agriculture; and
- MTECH: Agriculture.

In addition to these four higher education institutions, there are a number of smaller training providers, such as the South African Agri Academy (SAAA), a non-profit capacity development agency in Stellenbosch. The AgriSETA website lists over fifty training provider institutions in the Western Cape. 

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16 Stellenbosch University struggles to attract South Africans into its Masters in Sustainable Agriculture: 70% of enrolment in the course is from outside South Africa, perhaps pointing to the poor perception of farming as a career path amongst the youth in South Africa (Campbell, 2016).

Other important CSA training and research institutions in South Africa

Outside of Western Cape, there are a number of key training and research institutions for the sector, most notably the Agricultural Research Council (ARC), but also the University of KwaZulu Natal, the University of the Free State, the University of Pretoria, the University of Fort Hare, and other universities with agricultural departments. Other established training centres in South Africa targeting emerging or new farmers, include the Dicla training centre (http://www.diclatraining.com/) which has poultry broiler courses amongst its training, and Delmas Farmer’s academy (http://buhle.org.za/).
Without prior agreement with the Department of Higher Education, universities are only allowed to offer training at National Qualification Framework (NQF) levels 7 to 10. NQF levels 5 – 7 are the focus of college diplomas and technical qualifications, while levels 1 – 4 equate to high school vocational training. There are 12 agricultural colleges in South Africa delivering training at NQF levels 5 – 7, namely:

- Eastern Cape: Fort Cox College of Agriculture, Grootfontein Agricultural Institute, Tsolo Agriculture and Rural Development Institute;
- Kwa-Zulu Natal: Cedara College and Owen Sithole College;
- Western Cape: Elsenburg College;
- Free State: Glen College
- Mpumalanga: Lowveld College that also has a satellite campus called Marapyane Campus.
- Limpopo: Madzuvhandila and Tompi Seleko Agricultural Colleges
- North West province: Taung College and Potchefstroom College of Agriculture
- There are no agricultural colleges established in Gauteng and the Northern Cape (AgriSETA 2014; DAFF 2010, van Staden, 2016)

None of these agricultural colleges offer a specialised qualification in climate change or sustainable agriculture (AgriSETA 2014; DAFF 2008 & 2010; PCA 2014; TAC 2014; van Staden, 2016). Efforts are being made to address this gap. Before 2005 the agriculture curricula were mostly based on teaching commercial agriculture and production as this addressed the needs of the Agriculture Sector at that time (AgriSETA 2014; DAFF 2008; DoA 2005a). In 2005, the Department Agricultural, Forestry and Fisheries (DAFF) developed the Agricultural Education and Training (AET) Strategy which focused on providing quality agricultural education and training services that is aligned with key challenges in the sector, namely: sustainable agriculture and development, land care, household food security, water harvesting and rural wealth creation (DAFF 2008; DoA 2005a; van Staden 2016). However, an evaluation of the agricultural education and training curricula of South Africa during 2008 indicated that the curricula of the agricultural colleges addressed none of the key challenges related to climate change within their formal education programmes and struggled to implement the AET within the curricula (DAFF 2008; van Staden, 2016).

In a recent study, findings indicate that practical integration of the CSA approach into teaching was found by lecturers to be a complicated and a slow process (Van Staden, 2016). Lecturers emphasised that they require training as many of them felt that they lack sufficient knowledge relating to CSA. Concerns about the practical application and demonstration sites to demonstrate concepts related to CSA with the little resources available to the colleges were also raised (Van Staden; 2016). Furthermore, interviews with students and other relevant participants revealed that they found it difficult to grasp the localised relevance of CSA (Van Staden; 2016). It would therefore be useful to provide training for educators and lecturers on climate-smart agriculture (i.e. train the trainers) to integrate into existing courses as first step in curriculum innovation. In time, this could lead to the development of a new curriculum in CSA or green skills for agriculture.

In conclusion, the existing skills provision system is not going far enough to develop the green skills required by the agricultural sector. Coordination and collaboration between training institutions is required, to develop new curriculum that mainstreams green skills into agricultural professions. Additionally, new training courses are required to develop specific professions, such as outdoor poultry farmers and enginery auditors, as identified in Chapters 4 through 6.
8. Summary of Findings and Recommendations

8.1 Summary and Discussion of Key and Cross-Cutting Findings

The analysis of the green skill opportunities in the agricultural sector in the Western Cape suggests that there are a number of new green enterprises, occupational specialisms, jobs and skills developing to support the sector’s transition towards a green economy and towards a climate resilient agricultural sector. These appear to be driven by the demand – whether from consumers, financial or legislative pressure, or the need to build resilience in the face of a changing climate – to adopt ‘greener’ practices.

The demand for green technologies, services and products, and more sustainable types of farming has led to the creation of new occupational specialisms (e.g. a green/ sustainable abattoir needs a green abattoir manager; an outdoor poultry farm needs an outdoor poultry farmer). New niche specialisms are also emerging from more traditional occupational groups (e.g. water efficiency experts; CA scientist and advisor at WC DoA; facilitators to negotiate between different sector groups). At the same time, plenty of opportunity exists to “green” already established occupations that have a long history in South Africa (e.g. packhouse/cold storage operators can be more water-wise or conserve electricity). Important to note is that these occupational specialisms – whether new or old or whether they are situated in new or existing types of enterprises - require a different set of skills (see Figure 9 for a graphical representation).

As chapters 4, 5 and 6 demonstrate, specific new green enterprises, occupational specialisms and skills can be identified within each commodity. The investigation into the three commodity value chains brought about several additional emerging themes and considerations which are discussed below.
High demand for specialists and managers along different stages

The need for green skills at the management level or with a high degree of specialisation was emphasised by informants in all three value chains. This could be an indication of how industry tends to view green work – as a specialism. This emphasis could also stem from a bias in the methodology: interview candidates were often experts. Additionally, interview questions related to systemic changes in an enterprise, which requires a shift in the practice or structure of the operation as a whole and therefore critically need buy-in from a higher level in the first instance. In other words, a fruit packer or poultry slaughterer may not be directly involved in putting green practices in place in an enterprise.

Despite this bias, the findings of this report suggest that farming and food production is expertise- and knowledge-intensive. The demand for specific knowledge and expertise is also highlighted through the fact that Conservation Agriculture, when applied to any horticultural or grain production, is very context specific, and thus needs advice that is tailored to that particular context (e.g. agro-climatic zone, soil type, cultivar, topography). This may mean seeing expertise as an input along different stages of the value chain, and bringing in specific specialised experts. This has concerning implications for emerging farmers, who may not have the wealth of capital and social networks that are available to established, multi-generational commercial farmers. This also speaks to the shortage of, yet need for, quality extension or consultant services.

There also appear to be distinct differences in the existing capacities and expertise between commodities. This is linked to the amount and intensity of research endeavours, which corresponds to whether the industry is established or emerging, or is export-oriented, or primarily servicing the domestic market. For example, the fruit industry has very advanced research initiatives (such as HortGro Science which is a division of HortGro, one of several fruit associations; the Post-harvest Innovation program is a DTI-backed research program focusing on the fruit export market) compared to the poultry industry.

Green skills as a Life Skill

By contrast, the green skills potential for low-skilled occupations, such as farm workers, received little attention in interviews and literature. Certain green skills and concepts could contribute towards more general life skills training and assist farm workers to better manage and economise their household resources and expenditure – such as personal household waste management, water use, and electricity use, which all have potential savings.

“’When we go to farms I always offer farmers and managers training session for their workers to save energy at home. If they do that at home they will also do it at work, and you can also help them understand what is happening at home with the light, geyser, kettle - which uses the most energy and how can you reduce that. They then do the same thing at work. That for me is the most valuable training you can give people, and its saves people money’ (Bouwer, 2016).”

The general impression from the interviews with key informants in different commodity groups is that the farmer or manager is responsible for providing training for their staff in line with their duties and for integrating greener practice as part of this. However, more could be done to support the professional training of farmworkers, particularly around entrepreneurship and identifying green enterprise opportunities.

Building on extension services

The agricultural sector provides employment across all skill levels – from low-skilled labour though to highly specialised technical experts. Many producers, farmers or even small-scale managers are self-trained or informally trained, often with inherited and family-owned businesses. To support ongoing learning of these
Green Skills for CSA in Agriculture in the Western Cape

practitioners, extension officers are critical. Extension officers should have specialist knowledge on climate-smart agriculture and sustainability practices to impart on farmers and farm workers.

Extension services have great potential to act as a link between farmers, industry, government, researchers and training providers for example, through monitoring and reporting back on skill shortages amongst farmers such as when a farmer’s failure to comply with environmental policy arises from lack of understanding or capacity, presenting a training opportunity.

Opportunities through collaboration and new partnerships

The potential and value of mentorship of new farmers by experienced farmers was mentioned by a number of interviewees across different commodity value chains. For new farmers, mentoring can be a valuable form of training that provides tailored expert advice and support as they transition towards more sustainable and resilient practices. Whether this could be feasible for transferring green skills – which are in short supply amongst established or large-scale commercial farms – is unclear.

The potential for other forms of partnerships to unlock opportunities also emerged, such as the benefits of public/private partnerships – i.e. government, commercial farmers, and agribusiness. Another example of such collaboration can be seen in the cases of large wine estates (Spier, Boschendal) opening opportunities for artisanal and small-scale producers (farmers Angus and Rico with pasture-raised hens).

Opportunities through collaboration and partnerships can also be seen in linking hotspots across different industries or value chains, for example:

- Indigenous cover crops for CA that are also viable alternative local feed production for poultry industry;
- Fruit pulp waste converted to compost or livestock feed;
- Compost from poultry production used as fertiliser for CA or fruit production;
- Apply the principles of energy and water efficiency audits used in packhouses and cold storage units to abattoir facilities; and
- Diversification of on-farm activities in general for diversified farm and farm worker income, including social services such as schooling for children living on farms, health and well-being programs.

The feasibility of the opportunities requires further exploration, but could be to the economic and environmental benefit of each value chain concerned.

From land reform to value-chain reform

The pitfalls in existing land reform processes, such as too many beneficiaries on one piece of land, or insufficient support or capital to enter into advanced industries, have been repeatedly described. However, at the same time, there are opportunities for potentially lucrative black-owned enterprises at other stages in the value chain, aside from on-farm production.

Focusing on developing enterprises at other points in the value chain, outside of on-farm production, could also stimulate interest in agriculture amongst South African youth and change the perception amongst youth that a career in agriculture equates to toil, manual labour and oppression.

Building livelihood resilience as a key response to climate change

Building resilience in the agricultural sector in the context of climate change is primarily understood to mean

- Adaptation in terms of improved water and electricity efficiency;
- Building resilience to water shortages and extreme weather and heat;
- Changed agricultural practices (planting regimes, cultivars) based on climate projections; and
- The protection of ecosystems and fertile soil and land for helping to build resilience in the landscape to damage caused by flooding and erosion; and
- Mitigation concerns in this context refer to reducing emissions through energy efficiency and renewable energy options, protecting the soil, and carbon capture.

However, building livelihood resilience by diversifying income streams is another form of resilience against risks and stressors (of which climate change is one of many).

Green by design

The design of buildings, and the use of particular materials or technologies is often what makes the difference to the ‘greenness’ of an enterprise. Some examples of this include energy efficiency in packhouses; the design of irrigation systems; the type of packaging used in freight containers for fruit; and the design of abattoir with appropriate drainage systems. This points to the need to integrate green skills into the engineering curriculum, to equip engineers to have a systems-perspective and to identify potential social, environmental and economic co-benefits of one design over another.

Weaknesses in the OFO

The Organising Framework of Occupations (OFO) tends to oversimplify the role descriptions and skill needs in occupations studied within agriculture. This can be seen clearly in the case of extension services (that of Agriculture Consultant and Agricultural Scientist):

<table>
<thead>
<tr>
<th>OFO Title &amp; Code</th>
<th>Occupation description and alternative titles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture Consultant: 213201</td>
<td>Advises farmers, agricultural businesses, rural industries and government on the production, processing and distribution of farm products. <em>Alternative titles and specialisations:</em> Animal Husbandry Consultant / Advisor; Advisor; Agriculture Field Officer; Farm Economic Techniques Advisor; Agriculture Mentor; Vegetable Consultant; Field Husbandry Consultant / Advisor; Horticulture Consultant / Advisor; Landcare Officer; Orchard Consultant; Agriculture Advisor; Farm Consultant / Advisor; <em>Agriculture Extension Officer</em>; Pasture Consultant; Agriculture Economic Advisor; Floriculture Consultant / Advisor</td>
</tr>
<tr>
<td>Agricultural Scientist: 213202</td>
<td>Studies commercial plants, animals and cultivation techniques to enhance the productivity of farms and agricultural industries. <em>Alternative titles and specialisations:</em> Plant Production Scientist; Animal Nutritionist; Seed Production Agronomist; Soil and Plant Scientists; Plant Pathology Manager; Plant Physiologist; Companion Animal Nutritionist; Plant Pathologist; Quarantine Scientist; Agronomist; Seed Analyst; Seed Product Developer; Pomologist; Farming Scientist; Plant Biologist / Ecologist / Toxicologist; Animal Husbandry Scientist; Seed Production Horticulturist; Plant / Seed Breeder; Agrostologist; Agricultural Immunologist</td>
</tr>
</tbody>
</table>

This oversimplification means that scarce agricultural specialisms are often clustered together or conflated with other industries. For example, in the case of veterinarian, there is no poultry vet specialisation. The scarcity of poultry vets is a recognised problem for the industry, and it is not clear how the OFO system might help the DHET to ‘identify, report and monitor skills demand and supply in the South African labour market’ if such scarce specialisms are not captured. Similarly, the OFO system does not capture a differentiation between the role and
tasks of, say, a green abattoir manager, to a standard abattoir manager, raising concerns over its efficacy as a tool for green skills development planning.

8.2 Limitations of Methodology

Hotspots in the three distinct value chains were explored using slightly different methods in each case. This is useful to see whether and how results differed. The exploration of the poultry value chain was far more in-depth than that of pome fruit and winter grain. Site visits for the poultry study were useful for developing a better understanding of the constraints that producers may face in adopting a greener practice (e.g. costs, access to training especially for alternative means of production) and in building a potential network of practitioners – in short, they helped to bring the study to life. The additional site visits and interviews were particularly valuable for the poultry sector, as this sector appears to be less developed in terms of the amount and availability of sector research and reports compared to the fruit industry. However, future studies with time constraints or funding constraints may still produce useful insights through desk-top research and key informant interviews.

While the methods helped to identify context-specific challenges and responses, the conceptual frameworks provided a lens or reference point for identifying green opportunities – in particular, the value chain approach and the concept of circular economies.

There were a few critical limitations in the methodologies adopted, which should be addressed in future studies. One such limitation is the bias in the choice of key informants, which resulted in i) an emphasis on manager level, high skill level, or on very specialist technical skills, and ii) the focus in the results on farm and primary production, and not at later stages in the value chain (such as sale and consumption). Another critical gap in the analysis and conceptual frameworks (particularly relating to transformation) is the omission to address gender, considering the under-representation of women from senior management positions in the agricultural sector.

8.3 Implication for the Western Cape Agricultural Sector Climate Change Framework and Implementation Plan

The Western Cape Climate Change Response Framework and Implementation Plan (SmartAgri Plan) includes six Priority Projects that have been chosen to catalyse the early adoption of important climate change response interventions that have a high impact (WC DoA, 2016). These six Priority Projects are:

1. Conservation Agriculture for all commodities and farming systems;
2. Restored ecological infrastructure for increased landscape productivity, socio-ecological resilience and soil carbon sequestration;
3. Collaborative integrated catchment management for improved water security (quality and quantity) and job creation;
4. Energy efficiency and renewable energy case studies to inspire the transition to low-carbon agriculture;
5. Climate-proofing the growth of agri-processing in the Western Cape; and
6. Integrated knowledge system for climate-smart agricultural extension.

The findings and lessons from this study into the green skill implications for climate-smart agriculture in the Western Cape can help to inform the roll-out of the SmartAgri Plan Priority Projects in several ways, as outlined in the table below:
<table>
<thead>
<tr>
<th>SmartAgri Plan Priority Projects</th>
<th>Related findings from green skills study</th>
<th>Related recommendations for WC DoA from green skills study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conservation Agriculture for all commodities and farming systems</td>
<td>Slow uptake of CA short course; need for tailored support and expert advice. Gaps in skills to adjust or develop locally made CA machinery / no-till planters. Gap in market for new bio-friendly inputs.</td>
<td>Promote CA short course, especially amongst extension and support services.</td>
</tr>
<tr>
<td>2. Restored ecological infrastructure for increased landscape productivity, socioecological resilience and soil carbon sequestration</td>
<td>As above. Outdoor hens (or ‘biodynamic farming’) as a type of farming practice that increases landscape productivity.</td>
<td>Support training institutions to work with bio-dynamic farmers to develop training course and mentoring service for new or small-scale farmers wishing to adopt biodynamic farming practices.</td>
</tr>
<tr>
<td>3. Collaborative integrated catchment management for improved water security (quality and quantity) and job creation</td>
<td>Need for farmer and farm worker training in correct removal of alien invasive species in riparian zone. Across poultry production, but particularly at the slaughterhouses, there is room to reduce water usage, or manage waste water better.</td>
<td>Train extension services to provide training in correct removal of alien invasive species in riparian zone. Provide support for upgrading water and waste management systems in abattoirs.</td>
</tr>
<tr>
<td>4. Energy efficiency and renewable energy case studies to inspire the transition to low-carbon agriculture</td>
<td>Conservation agriculture can reduce emissions through reducing tilling. Packhouses and cold storage in the fruit value chain are site where improved efficiency would be beneficial. Slaughterhouses are sites of high energy use and would benefit from improvements to efficiency, as promoted in the fruit industry.</td>
<td>Promote CA short course, especially amongst extension and support services. Support processors (abattoirs, packhouses), which are sites of high energy use, with energy audits and finance to adopt renewable energy systems.</td>
</tr>
<tr>
<td>5. Climate-proofing the growth of agri-processing in the Western Cape</td>
<td>Water is a critical concern across commodities. Malting barley (for beer) can use high volumes of water, as well as the juicing of fruit. Slaughterhouses are sites of high water use and there is room to reduce water usage, or manage waste water better.</td>
<td>Support processors (malters, fruit juicers), which are sites of high water use and waste water generation, to identify appropriate management of waste water and with finance to upgrade infrastructure.</td>
</tr>
<tr>
<td>6. Integrated knowledge system for climate-smart agricultural extension.</td>
<td>Cross-cutting: Need for climate-smart support, partnerships, networks and collaboration</td>
<td>Support the development of partnerships and networks around CSA</td>
</tr>
</tbody>
</table>

### 8.4 Recommendations

The study has emphasised the value and importance of close cooperation amongst different agents to develop a more integrated skill provisioning system for agriculture that includes opportunities to develop the skills needed to transition to a green economy. While the emphasis is on collaboration between organisations, different bodies have distinct roles to play in line with their mandate and available resources. A key recommendation for
refining these roles and responsibilities would be for the co-development of a joint strategic framework for green skills development by all organisations involved in training in the agricultural sector.

**SETAs**

SETAs are critical for driving training in a sector. Key to driving green skills in the agricultural sector is the AgriSETA, but they would need to work closely with the other SETAs and with training organisations in the province. However, it was very difficult to engage with the AgriSETA during this study raising concerns about the likelihood of future collaboration.

- **AgriSETA**: Communicate the need for CSA training options to training organisations and encourage the development of CSA courses focused towards specific commodities. Develop opportunities for practical learnerships for extension services to specialise in different industries. Identify a network of trainers / extension services for niche environmental services (fire, alien invasive, other land management issues), also for producing new crops, cover crops or for new on-farm enterprises.
- **FoodBevSETA**: Assist in the development of new training courses for climate-smart or sustainable abattoir management, and in waste water management for food processing sites (e.g. malters, fruit juicers, breweries).
- **W&R SETA**: Help to raise awareness amongst large food retailers such as Woolworths, Pick n Pay and Shoprite of the potential positive social, environmental and economic impacts of sourcing from climate-smart enterprises, and from small local producers and/or independent suppliers.
- **LGSETA**: Help to raise awareness in local government of other stages of production in the poultry value chain besides farming, and of other new local entrepreneur opportunities, as community development and empowerment initiatives.
- **EWSETA**: Support the development of training programs for water and energy-efficiency auditors and support research that helps to better understand options for bio-fuel and energy from waste.
- **ETDPSETA**: Adopt a train-the-trainers approach to include climate change into the curriculum of educators, including CSA into the curriculum of agricultural educators.
- **CHIETA**: Support research into the development of organic and/or biofriendly pesticides and fertilisers for CA.

**Sector bodies**

All bodies and associations representing the interests of member stakeholders in a sector could assist in the dissemination of information amongst their members and the development of new training courses. Such associations are also in an ideal position to explore opportunities for mentoring and experiential learning, by identifying and connecting interested parties on both sides (e.g. a mentor and a mentee farmer). In particular, large associations representing the interests of the three commodities explored in this study can address particular interests:

- **South African Poultry Association**: Support the training needs for small farmers. Support non-conventional practices and develop training and extension services that go beyond traditional caged farming methods.
- **South African Abattoir Association**: Identify interested members to pilot mobile or climate-smart abattoirs.
- **GrainSA**: Promote training in conservation agriculture at Villa Academy amongst members.
- **HortGro Science**: Identify opportunities to share research relevant to other sectors where there is no market pressure for this so it is not regulated, for example, energy and water efficiency systems for abattoirs or millers.
WC DoA and Elsenburg College

The scope of work performed by Western Cape Department of Agriculture (Wc DoA) covers a range of development, research and support services. The WC DoA is in a prime position to mobilise other role-players and bring different stakeholders together. The WC DoA is also responsible for overseeing the training and supply of extension services through Elsenburg College. The WC DoA is well situated to:

- Integrate CSA in agricultural college curriculum, notably for extension services.
- Make information on extension services, climate risks, business development options and financial support available to farmers.
- Implement improvements for support/ extension services. For example, the veterinary support provided to Hopefield has been very beneficial – can this be replicated and improvements made (e.g. include CSA into vet training).
- Develop a system or mechanism through which extension services can capture and report the skill needs in the communities and farmers that they serve, to help inform skill needs/training needs.
- Work with Casidra to explore the feasibility of new employment and enterprise opportunities associated with the hotpots identified in each commodity value chain, and support those opportunities in these areas to upgrade their infrastructure.

DHET

The Department for Higher Education and Training oversees universities and other post-secondary vocational education and training in South Africa. The DHET is mandated to support national skills planning at post-secondary level, in part through the maintenance of the OFO. However, the study has raised concerns over the efficacy of the OFO as a tool for green skills development planning, as there is an oversimplification and no distinction between green vs. traditional occupations and skills. It is recommended that the OFO as a skill planning tool be reviewed, or substantial changes made to differentiate green occupations and skills.

Specific changes needed to the OFO that this study identified include:
- Simplification of Agriculture Extension Officer, described as alternative title of Agriculture Consultant.
- Revise fruit farmer description to adequately capture the range of expertise that the occupation must draw from to compete effectively in this market.
- Packhouse and coldstorage manager conflated as warehouse manager, needs to include energy efficiency and reducing energy waste.
- ‘Energy systems’ engineer and energy auditors are currently not captured in the OFO.
- There is an over-simplification of winter grain farmers, which appears to fall under the broad occupation of Agronomy Farmer (2015-611101) under the unit group of Field Crop and Vegetable Growers. This confflation does not distinguish the practice of a farm producing conservation agriculture.
- In contrast, there appears to be a lot of overlap in OFO codes relating to agricultural/earth/soil advisors and consultants, which could result in confusion.
- The OFO provides a narrow or overly simplistic view of a poultry farmer, and does not even have a specific code for an abattoir manager (only an operations manager, which has very broadly defined responsibilities).

Future researchers:

**Green skills researchers**: The skill implications of a transition towards a green economy is a new knowledge field around which a community of interested researchers is developing. The study has identified several new questions and areas for future research, as well as lessons learnt from the research experience:
The conceptual frameworks employed in this study were useful for identifying green skill opportunities. In particular, the concept of a circular economy was particularly useful for identifying opportunities associated with waste reduction and alternative use. A broader range of interviews across the full value chain early on in the study could elicit a deeper understanding of the influence these stages have on primary (i.e. on-farm) production.

Applying the methodology used in this study to emerging micro-industries such as olives, honeybush, rooibos, and cut flowers in the Western Cape would make ideal research projects at the Masters-level, and would elicit substantial new knowledge and insights into the green skill opportunities in these industries.

It is important during site visits to see the activities underway as key informants are not always aware of their own skills (and green skills) and the risks and opportunities associated with the activities they perform on a day-to-day basis.

Agricultural researchers at the University of Stellenbosch, Elsenburg College or University of Pretoria:

- New research into resilience of indigenous poultry breeds to environmental stress, including climate change.
- Further investigation is needed into the potential of generating energy through waste or through growing crops for biofuel – for example, the potential to convert fruit waste, abattoir or manure waste to energy. This appears to be an area with great potential for green skills.
- Continuation and expansion of existing work and research relating to bio-friendly inputs, resilient strains, and suitable cover crops.
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