Minor Dissertation on

The role of the retailer in proactive adaptation to climate change at the farm level in South Africa

by Katherine Smit

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Supervisor: Nadine Methner

Co-Supervisor Laura Pereira

Declaration

I know the meaning of plagiarism and declare that all of the work in the mini-dissertation, save for that which is properly acknowledged, is my own.

Signed: Katherine Smit

University of Cape Town Masters Candidate

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Abstract

Abstract

Globally, agriculture is one of the most vulnerable sectors to climate change. Despite the high coping capacity of large-scale commercial agri-firms in South Africa, they are vulnerable to the impacts of climate change, particularly due to the semi-arid nature of the country and the frequency of droughts. Vulnerability at the farm-level has major implications for overall agri-supply chain resilience as the impact at the farm level is transmitted up and down the chain. Whilst large-scale commercial agri-firms are adapting autonomously some authors suggest that it won't be enough for them to manage the risks and impacts brought about by the expected rate of climate change. Enhancing the agri-firms' adaptive capacity to adapt proactively –in anticipation of climate change – could be essential to increase supply chain resilience and thus maintain economic development and safeguard employment in the agriculture sector in South Africa. The sustainable supply chain literature indicates that more powerful stakeholders, such as the retailers, have a bigger role to play up and down the chain. The retailer is in a strategic position to influence both supply and demand and thus have a powerful effect on the capacity of the agri-supply chain to proactively adapt to climate change. This study therefore aimed to look at the role of the retailer as an enabler to proactive adaptation at the farm-level for large-scale commercial agri-firms' in South Africa. The study used a qualitative research approach and looked at six agri-firms to gain a deeper understanding of the agri-firms perceptions of the retailer as an enabler and answered three objectives, i) to identify how the agri-firms were responding to climate risks, ii) to identify what barriers constrain proactive adaptation and iii) to explore what role the retailer could play in overcoming those specific barriers to proactive adaptation. The results of the study showed that the agri-firms' relatively high capacity to cope with climate variability, translated into incremental and system adaptation measures and included technological, land use management and financial insurance measures. These responses were, however, often reactive with few agri-firms regarding climate change as a high risk. Their key barriers to more proactive adaptation were: financial (e.g. cost-benefit), information (e.g. uncertainty around climate change impacts and projections), technological (e.g. inadequate research and development), organisational

(shareholders only interested in short-term return on investments) and included constraints within the agri-supply chain (e.g. consumer demands for the perfect fruit). To overcome these barriers the respondents suggested a variety of measures that the retailer could do to enhance the adaptive capacity of agri-firms both directly (e.g. research at farm level, funding sustainability programs) and indirectly (e.g. influencing consumers, supporting technological development, supporting large scale research and influencing government policy). Further research on how the retailer perceives itself as an enabler (and whether its perceptions align with the agri-firms) would be necessary to ensure that shared value is created in response to shared risk.

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List of Acronyms

BHC	British High Commission
CSR	Corporate Social Responsibility
DEA	Department of Environmental Affairs
DRDLR	Department of Rural Development and Land Reform
FfF	Farming for the Future
IPCC	Intergovernmental Panel on Climate Change
MRL	Maximum Residue Limits
M&S	Marks and Spencers
SADC	Southern African Development Community
WWF-SA	Worldwide Wildlife Fund for Nature South Africa

Chapter 1: Introduction

1 Introduction

1.1 Introduction and Problem Statement

Globally, agriculture is one of the most vulnerable sectors to climate change (Adger et al., 2007) with more and more evidence indicating that the impact of climate change on key agricultural species and agricultural livelihoods will be significant (IPCC 2014; Mukheibir and Sparks 2003). The Intergovernmental Panel on Climate Change (IPCC; 2014:1775) defines vulnerability as "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt".

South Africa is particularly vulnerable to climate change because of its high dependence on agriculture (IPPC 2007). South Africa has a dual agricultural economy – divided into small holder or subsistence [1] based producers and large-scale commercial agri-firms (hereafter referred to as agri-firms) (DEA 2011). Whilst subsistence producers farm to help sustain their families (McConnell and Dillon 1997), large-scale commercial agriculture[2] is driven by profit maximization and is ''production primarily for market'' (Poulton et al., 2008:9). Numerous studies have focused on the vulnerability of small holder farmers to climate change (Tibesigwa et al., 2015; Nhemachena et al., 2010) and on agri-firms (Oosthuizen 2014; Blignaut et al., 2009). A recent study has shown that agri-firms in South Africa are particularly vulnerable to the impacts of climate change (Tibesigwa et al., 2016). Using the Ricardian cross-sectional framework Tibesigwa et al. (2016) find that simultaneous decrease in precipitation and an increase in temperature will reduce productivity, and that an increase in temperature alone negatively affects agri-firm output more than a decrease in precipitation. Their results also suggested that the strongest impact would be on commercial crop farming, with mixed farming systems the least vulnerable.

[1] Subsistence producers provide enough food to sustain their family whilst smallholder farmers sell some of their produce.

[2] In South Africa, agri-firms are typically those with an annual turnover of more than R7, 5 million, whilst medium and small scale are those with annual turnovers of R4, 5 million < turnover ≤ R7, 5 million and R750 000 < turnover ≤ R4, 5 million, respectively (Stats SA 2014).

This is of concern as South Africa's commercial agriculture contributes 12% to Gross Domestic Product (GDP) (with multipliers) and 30% to national employment (DEA 2011), providing as many as 869 000 jobs in 2015 (StatsSA 2014:iv). Total income earned by the commercial farming sector (net farm income) in South Africa was R212 998 million in 2014 with field crops and horticulture crops bringing in R45 190 million and R45 114 million, respectively (Abstract of Agricultural Statistics 2015). Of this, agri-firms brought in a total of R66 809 102, with medium scale (R4 734 811) and small scale (R10 142 521) bringing in less (Abstract of Agricultural Statistics 2015). In addition, South Africa is the main food exporter in the Southern African Development Community (SADC) (DEA 2011), thereby contributing to regional food security.

Climate risks (e.g. hail, seasonal shifts) are not isolated at the farm level but are transmitted up and down the agri-supply chain (Jaffee et al., 2010). Agri-supply chains (Fig.1) bring "basic agricultural products from production in the field to final consumption" (FAO 2010:20). They consist of many interconnected stakeholders that can be divided into public (government and international organisations such as the Food and Agricultural Organisation) and private authorities (co-operatives, research institutes, individual producers, processors, food traders, retailers, consumers and financial institutions) (Jaffee et al., 2010). In fact, climate impacts at the farm-level have become so prominent for global agri-supply chains, that retailers (in particular) have become concerned. For example, Marks & Spencer (M&S; large United Kingdom (UK) retailer) recorded losses in the millions (GBP) when extreme weather events in source countries interrupted their fresh produce supply (Nicholls 2015). ASDA (large UK retailer) initiated research on the vulnerability of their supply chain to climate change and found that 95% of their suppliers were vulnerable (ASDA 2014). For example, the vulnerability of their source countries to climate change is valued at £101.9 million (2014). In South Africa, Woolworths (a local retailer) recorded a loss of R20 million due to supply chain disruption from flooding and hail in 2012 (Smith 2015).

Agri-supply chains need to be, and can be made more resilient (Macfadyen et al., 2016). Resilience is defined as "the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or

reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation" (IPCC 2014:1772). The high likelihood of the impact of climate change means adaptation at the farm-level is essential (Howden et al., 2007). Adaptation is defined by the IPCC (2014:1758) as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects". Agri-firms often adapt autonomously, defined as the "ongoing implementation of existing knowledge and technology by farmers themselves, in response to experienced changes in climate[3]" (Leclere et al., 2013:325). However, the rate of climate change is likely to push agri-firms' financial coping and knowledge limits to the edge (WESSA 2010; Stokes and Howden 2010).

Proactive adaptation, which is done in advance or in anticipation of climate change impacts, might be necessary (IPCC 2014a; Ash et al., 2012; Kates et al., 2012). Vital to agri-firms is that the proactive adaptation measures need to optimize practices according to changing climatic conditions so as to maximize output (DEA 2013; Oosthuizen 2014). However, the constraints (i.e. barriers) to proactive adaptation are numerous (Kolikow et al., 2012; Moser and Ekstrom 2010; Howden et al., 2007). Barriers to adaptation are "factors that make it harder to plan and implement adaptation actions or that restrict options" (IPCC 2014:1762). Overcoming them will likely require interventions to enhance agri-firms' adaptive capacity (Eisenack 2014; Burke et al., 2009; Pelling 2011). Adaptive capacity is defined as "the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC 2014:1758). For example, enhancing climate change awareness can lead to less uncertainty in decision-making on proactive adaptation measures (Marshall et al., 2013).

Enhancing agri-firms' adaptive capacity and agri-supply chain resilience can be done

[3] The IPCC (2014a:1759) also defines it as "adaptation in response to experienced climate and its effects, without planning explicitly or consciously focused on addressing climate change. Also referred to as spontaneous adaptation"

"through the implementation of appropriate interventions at the appropriate scale, but this should not be left up to producers or government policy alone" (Macfadyen et al., 2016:7)". Embedded in the concept of sustainable supply chain management (SSCM)[4] is the idea that agri-supply chain stakeholders work together to create shared value (as termed by Porter and Kramer (2011)) in response to shared risk. Supply chain interventions are often pursued by governments (e.g. taxes, regulations), although "many of them can be implemented by retailers – potentially to greater effect for globalized supply chains" (Styles et al., 2012:60). The retailer is in a strategic position of power to influence both supply and demand (Burch et al., 2014; Styles et al., 2012; Hingley 2005) "that can lead to wide-scale change of practice" (Macfadyen et al., 2016:7). They influence supply at the farm level through certification and audit requirements to promote sustainable agriculture practices (Macfadyen et al., 2016; Styles et al., 2012). They influence consumers significantly through choice editing[5] (Dawson 2012), an influence "that is likely to become more powerful over the next decade" (Dawson 2012:339).

There is an increasing need for retailers to play a more proactive role in proactive adaptation to climate change at the farm level (Macfadyen et al., 2016) as the risk is projected to be problematic. In addition, they have become largely dependent on large-scale agri-firms and are "continually looking for fewer and larger suppliers who can work with them in partnership" (Hingley 2005:69). The existing climate change adaptation literature, however, shows few empirical studies on the role of the retailer as an enabler[6] to proactive adaptation at the farm level. This study aims to inform this gap in the literature within a South African context and questions how the retailer can assist in strengthening the adaptive capacity at the farm level. It is important to

[4] SSCM is defined as "as the management of material, information and capital flows as well as cooperation among stakeholders along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements" (Seuring and Muller 2008:1699).

[5] Choice editing for sustainability is "eliminating the option of buying products with a poor environmental or social record – is one progressive strategy taken by retailers that does not rely on consumer behaviour change, but instead mainstreams sustainable products as default options" (Gunn and Mont 2014:464)

[6] Enablers will often be "processes, particularly action and reflective learning processes at times of change, that provide a supportive environment in which action for adaptation is normalised, where (for example) peer pressures to follow the industry's or organisation's status quo are downplayed and where learning is encouraged and made available to others" (Ballard et al., 2013:24).

address this research gap, as South Africa's agri-supply chain resilience is important to maintain national GDP, increase employment and could be critical for national and regional food security.

1.2 Aims and Objectives

It has been argued in the introductory chapter that proactive adaptation by South African agri-firms is necessary. As numerous barriers hinder proactive adaptation, the role that a more powerful stakeholder could play in enabling agri-firms is questioned. Within the agri supply chain, the retailer experiences the risk of the agri-firm with evidence of supply chain disruptions impacting their market share and ability to meet consumer demands (due to increasing climate variability and extremes). The literature on the retailers' role as an enabler to proactive adaptation to climate change for agri-firms is, however, sparse. Therefore to address this gap in the literature, this study aims to:

Identify the role that the retailer could have in enabling proactive adaptation for fresh horticultural produce agri-firms in South Africa. The focus is therefore primarily at the retailer-agri-firm interface depicted in the figure below.

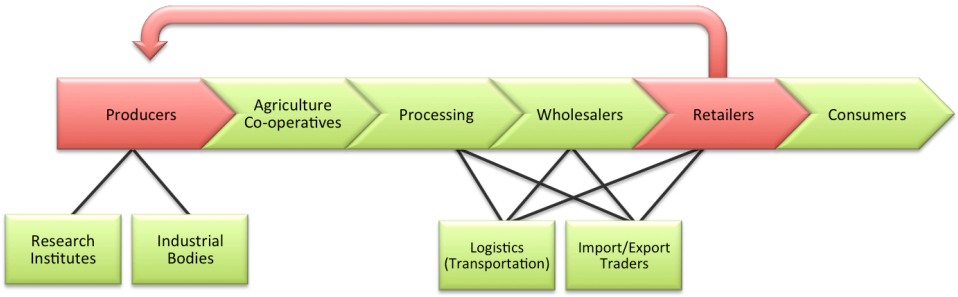

Figure 1: Illustration of a typical agricultural supply chain showing that this thesis will be looking at barriers and enablers to proactive adaptation primarily at the retailer-agri-firm interface (Source: Tsolakis et al., 2014)

To explore this aim, the objectives of the study are as follows:

i) **To identify how agri-firms are responding to climate risks;**
ii) **To identify perceived barriers to the agri-firms' proactive adaptation;**

And;

iii) **To explore what interventions agri-firms think retailers could take in order to help them overcome some of these barriers (from objective ii).**

1.3 Contribution to Broader Research Topic

This study forms part of a broader research initiative established by the World Wide Fund for Nature South African (WWF-SA), Woolworths, M&S and the British High Commission (BHC) to address the issues of agri-supply chain vulnerability in South Africa. Extreme climate events in South Africa "prompted Woolworths and M&S to set aside finances to explore proactive action – supporting new technology investments and piloting solutions – to reducing risks in agri-supply chains" (WWF Project Outline 2015). The Agriculture Value Chain Climate Resilience Programme intended to identify the climate risks to the South African agriculture value chain and secondly, to identify what actions the stakeholders can take to mitigate and adapt to climate risks using a scenario based approach. A scenario based approach takes uncertainties (the further into the future we plan, the more uncertain our decisions become) into account and aims to create stories on how the future will play out. Ultimately these stories of the future can be used as decision-making tools to prioritise actions. This thesis was conducted in parallel with the development of the scenarios and therefore the final scenarios are not included in the thesis.

1.4 Thesis outline

Chapter 2 provides a review of the relevant literature focusing primarily on climate change adaptation literature and fresh horticultural produce agri-supply chain literature. Following this, Chapter 3 outlines the methods used in the study. It also describes the inherent strengths and weaknesses of the exploratory research and case study methodology applied in this thesis. Chapter 4 presents the findings of the study which are discussed according to the adaptation measures adopted (in line with objective i) barriers (in line with objective ii) and the role of the retailer as an enabler (in line with objective iii) in Chapter 5. Lastly, Chapter 6 concludes by highlighting the practical implications and provides recommendations for further research.

Chapter 2: Literature Review

2 Literature Review

2.1 Introduction

The literature review is separated into three sections and spans literature on climate change adaptation and agri-supply chains in an attempt to provide insight into the three objectives. Section 2.1 takes a closer look at the structure of an agri-firm and why proactive adaptation is so necessary in the context of double exposure that refers to the risk of both climate change and globalization (O'Brien and Leichenko 2000). It also explores whether more transformational adaptation is necessary, defined here as "major, purposeful action undertaken at the farm or supra-farm level in response to potential or actual climate change impacts and opportunities in the context of other drivers" (Rickards and Howden 2012:24). Section 2.2 looks specifically at the determinants of an agri-firms adaptive capacity and assesses what typical barriers or enablers the agri-firm could face in proactively adapting. Section 2.3 begins by showing the importance of fresh produce supply chains to retailers and how the retailer drives environmental improvement at the farm-level. It then explores the potential of the retailer as an enabler to proactive adaptation and provides insight into what retailers are doing in a South African context.

2.2 Climate Change and South African agriculture

Climate change projections up to 2050, under a controlled emission scenario, show warming (3-3.5°C) over the interior, a risk of drier conditions to the west and south of the country and a risk of wetter conditions along the eastern portion of the country (although projections are not uniform[7]) (DEA 2013). Projected climatic extremes also pose a problem (DEA 2013). For example, extreme heat waves are projected to more than double into the intermediate future in areas such as the Northern Cape (DEA 2013).

[7] Although precipitation is still poorly simulated in climate models in comparison to surface temperature (IPCC 2013), the IPCC (2014b) has a high confidence that climate change will amplify existing water stress.

The key physical impacts projected for South Africa include increases in irrigation demand due to changing increased evaporation rates and higher temperatures; changes in plant diseases and insect distribution; reduction in yields and quality of certain produce (e.g. maize); and spatial shifts in the country's optimum growing regions (DEA 2013). These are dependent on geographical locations (i.e. spatial heterogeneity) and commodity inherent characteristics (e.g. certain produce is more vulnerable to higher temperatures) (Gbeitibouo and Ringler 2009; IPCC 2014).

Literature on the impacts of climate change to South African agri-firms focuses on the physical impacts on crop yield and production (Du Toit et al., 2002; Walker and Schulze 2008), economic impacts derived from yield losses (Blignaut et al., 2009; Gbetibouo and Hassan 2005; Benhin et al., 2008), financial vulnerability of agri-firms (Oosthuizen 2014) and application of integrated climate change models for water management (Louw et al., 2012). For the majority of the studies the impacts to both yield and finances are largely negative. For example, Benhin et al. (2008) shows that South African crop-farming net revenues are expected to fall by as much as 90% by 2100, with small scale producers most affected. For horticultural crop yields, Blignaut et al. (2009) similarly found that output will be negatively impacted by a decrease in precipitation (particularly on rain-fed fields). DAFF (2013) found that marginal non-irrigated vineyards could become uneconomical by 2050 (with production area decreasing by up to 30%). Increased temperatures are also likely to impact on water quality (CSIR 2015). For example, a recent study calculated that algae concentration levels in the Berg River (Western Cape Province) would increase with warming temperatures (CSIR 2015). The results showed that it would impact financially on commercial agri-firms along the Berg River due to the high operational costs required to maintain and unclog irrigation systems.

Despite the projected negative impacts, climate change will also result in opportunities for agri-firms in different areas (i.e. there will always be both winners and losers) (Oosthuizen 2014; Gbetibouo and Ringler 2009; IPCC 2014). For example, warming temperatures will result in more favourable agriculture areas in the Free State, Eastern Cape and Kwazulu Natal where frost in winter is prevalent (Coetzee 2014). Evidence for this includes the fact that tropical fruit such as avocadoes and mangos are now able to grow in areas facing warming such as the

Eastern Cape and Western Cape, respectively (Kobus Pienaar; personal conversation 2015). Oosthuizen (2014) also showed that intermediate climate change scenarios would positively impact on the financial position of farming systems in Carolina, South Africa (albeit climate extremes such as hail are not included in the models).

2.3 Risk of climate change for fresh-horticultural produce included in this thesis

2.3.1 Vegetables

There is limited work on the consequences that climate change will have on vegetables in South Africa. Potatoes in South Africa will face a positive effect of increased CO2 levels, with strongest yield increase in the Sandveld winter crop (SmartAgri 2016). In general, Shivashankara et al. (2013) show that elevated CO2 can improve vitamin C, sugars, acids and carotenoids in tomatoes and strawberries. However, they found that elevated CO2 might decrease the protein and mineral content of certain vegetables. Higher temperatures coupled with decreased irrigation potential is likely to have a negative impact on vegetable quality in terms of vitamins, antioxidants and minerals.

2.3.2 Citrus

In the Western Cape, warmer spring temperatures are projected to show an increase in yield and fruit quality due to warmer spring temperatures (in the fruit set and cell division phase) (SmartAgri 2016:292). However, higher maximum temperatures, an increase in hot days and an increase in heat waves will reduce yield and quality due to heat stress and shortened growth period (SmartAgri 2016:292). In the United States, production is projected to shift slightly northward in the southern states, with yield decline in Florida and Texas due to excessive heat during winter. In most cases, CO_2 effects are likely to counteract the decline in yields (Rosenzweig et al., 1996).

2.3.3 Avocadoes

There is little work done on the potential consequences of climate change on avocadoes in South Africa. Howden (2005) provides a succinct summary on climate change impacts on avocado growth and development in New Zealand. The author

shows that warmer nights provide could provide less chance for fruit set failure in areas experiencing cold nights during flowering period. Hotter temperatures could however lead to smaller Hass fruit with a shift in growing regions away from the hotter producing areas. Warmer temperatures could also mean earlier maturation for the fruit, shifting the harvest times for different areas. Increased moisture extremes (e.g. flooding) could result in increased risk and spread of *Phytophthora cinnamomi.* Higher levels of atmospheric carbon dioxide could also provide greater potential for fruit set and retention.

2.3.4 Apples and Pears

The biggest risks to apples in South Africa are reductions in winter chilling, warm weather during key developmental stages, increased heat stress, more frequent shortages of water in the storage dams leading to irrigation water curtailments, increased postharvest disorders, and shifts in the risk of hailstorms and pest outbreaks (SmartAgri 2016). Future temperature increases are projected to cause a 28% reduction of the area suitable for apple production in South Africa by as early as 2020 (Cartwright, 2002). According to DAFF (2014:17), pears have similar climate requirements to apples, but with less stringent chilling requirements and lower sensitivity to heat stress". They argue that most commercial pear producers "should be able to make the necessary adjustments to climate change needed to remain profitable" (DAFF 2014:17).

2.3.5 Cherries

In the Western Cape, stone fruit are projected to face decreases in yield and fruit quality due to poor bud-break (delayed foliation) as a result of insufficient chilling (cultivar dependent) (SmartAgri 2016:291). Higher temperatures in late winter will likely decrease yield due to early bud break followed by cold weather or frost. Projections also show that cooler weather in spring could result in lower fruit quality (reduced sugar levels).

2.4 Proactive adaptation and Large Scale Commercial Agri-Firms

2.4.1 Large-Scale Commercial Agri-firms

There are significant differences between smallholder farmers and agri-firms (McConnell and Dillon 1997). Of particular importance is that agri-firms mobilise economies of scale, a factor that is becoming critical to compete in today's economy (DEA 2013). According to Tebisigwa et al. (2016) advantages of this include easier access to markets and contracts with buyers (Byerlee et al., 2009; Eastwood et al., 2010; Hazell et al., 2010; FAO 2014), and access to credit and insurance markets (Chavas 2001; FAO 2014; Collier and Dercon 2014). Agri-firms are also typically structured in a similar way to corporate organisations. This means that the responsibility for producing, marketing and selling is divided within the company in contrast to smallholder farms that are operated typically by one farmer (McConnell and Dillon 1997). For example, agri-firms make use of in-house specialists to deal with different issues (e.g. legal, agri-chemical). This increases their ability to re-organise and communicate issues as the workload is dispersed. The structure of an agri-firm may also result in negative effects. For example, a negative effect on employment (e.g. mechanisation resulting in fewer jobs) and the environment (e.g. intensification of spray regimes).

All these factors contribute to the high coping capacity of agri-firms to climate variability (Thomas et al., 2005; Adger et al., 2007; Smith and Malik 2012). Coping capacity refers to "the ability of people, institutions, organizations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term"(IPCC 2014:1762). This high coping capacity means that agri-firms are unlikely to require interventions for climate change adaptation that smallholders might require. For example, smallholders who have a poor knowledge of appropriate adaptation measures (Gbetibouo 2009) might require workshops and skills training. In contrast because agri-firms have access to capital and a high organisational capacity, they will likely require support mechanisms and policy changes that enhance technology development and adoption, crop diversification, innovative insurance strategies, favorable trade agreements and markets and improved long-term financial and risk management (Challinor et al., 2007).

2.4.2 Agri-firms and Risk

Agri-firms also function within a multi-stressor environment (Ziervogel and Taylor 2008; Belliveau et al., 2006), of which climate change is only one risk. According to Belliveau et al. (2006:364) "these multiple exposures interact to influence farmers' decisions, or more precisely their management practices, and hence agricultural adaptations to climatic variability and change cannot be conceived via simple stress–response models" (e.g. Risbey et al., 1999). This multi-stressor environment is challenging for proactive adaptation particularly as climate change is often not prioritised when there are far more pressing issues to deal with on the short-term (e.g. market risks).

As part of the multi-stressor environment O'Brien and Leichenko (2000) refer to the concept of "double exposure". Double exposure refers to "cases where a particular region, sector, ecosystem or social group is confronted by the impacts of both climate change and economic globalization. It recognizes that climate impacts are influenced not only by current socioeconomic trends, but also by structural economic changes that are reorganising economic activities at the global scale" (O'Brien and Leichenko 2000:227). In terms of globalization risks, South African agri-firms face uncertainty surrounding volatile exchange rate leading to increased input costs such as fertilizer (FertSA 2015), changing markets (ABSA 2015) and trade barriers as recently witnessed by the citrus industry due to Citrus Black Spot (CBS; a fungal disease that causes black spots on the leaves and skin of fruit) (ABSA 2015).

2.4.3 Proactive adaptation

In most situations, the agri-firms' coping capacity is typically enough to manage climate variability. In many cases agri-firms respond to immediate threats and not necessarily future trends (Howden 2007). This is because the risk of climate change is often so far into the future (e.g. projections up to 2050 as described in Section 2.1) that they are difficult to incorporate. But these impacts are exceptionally important to consider for agri-firms, particularly on a global level. For example a shift in production areas internationally could affect local packhouse programmes and export relationships.

Therefore to minimise impacts and maximise on these opportunities that climate change brings, agri-firms might have to look beyond traditional short-term coping mechanisms (Ash et al., 2012). Coping tends to be "reactive and temporary strategies employed in order to ensure immediate survival in a crisis situation" (Vincent et al., 2005:202). In addition, coping strategies are often not sufficient enough to manage the severity and rate of climate change (Fussel 2007). Instead, proactive adaptation is regarded as essential to "reduce the risks and capitalize on the opportunities associated with climate change" (Fussel 2007; Fankhauser et al., 1999; FAO 2007; Howden et al., 2007). A succinct summary describes proactive adaptation as:

> "Unlike reactive adaptation, it is forward-looking and takes into account the inherent uncertainties associated with anticipating change. Successful proactive adaptation strategies are therefore flexible; that is, they are designed to be effective under a wide variety of potential climate conditions and to be economically justifiable (i.e., benefits exceed costs)" (Easterling et al., 2004:24).

As a result, Fussel (2007) argues that it shares many common features with risk management strategies.

Adaptation measures at the farm level can be broadly separated into four different types, albeit not mutually exclusive[8]: i) technological ii) change in land-use management techniques, iii) farm financial management and iv) change in government policy (although the last point is more a driver of proactive adaptation then a measure implemented) (Smit and Skinner 2002).

Technological developments include developing new crop varieties, early warning systems, water management innovations and resource management innovations (Smit and Skinner 2002). A technology that is becoming common is the use of shade-netting, widely adopted in countries such as Spain, with increasing examples found in South Africa. Oosthuizen (2014) argues that due to the impact of increasing temperatures on citrus in South Africa, shade netting is required to reduce the impacts of reduction in fruit set as a result of sunburn. Land-use management includes

[8] In addition comparing climate change adaptation strategies between different commodities (e.g. apple vs. pears) is challenging (Dupuis and Biesbrook 2013).

changes to crop choices, diversification, irrigation and the timing of operations (Smit and Skinner 2002). For example, converting to drip irrigation to use water more efficiently (DEA 2013). Farm financial management includes crop insurance or investing into future shares (e.g. maize) to reduce risks related to climate (Smit and Skinner 2002). However, as certain geographic areas become riskier, insurance companies increase premiums making financial insurance largely unaffordable for agri-firms (UNEPFI 2011). Development of government policies to mainstream proactive adaptation can encourage proactive adaptation at the farm level (IPCC 2014). These policies often include land use regulations (Chiotti and Johnston 1995) and water use permits (Easterling 1996).

Many of the measures described above are effective response measures against both climate variability and climate change. These measures can be seen as proactive when they are undertaken with a much longer time frame in mind. Questions one might ask when proactively adapting include "How will future climatic and non-climatic conditions differ from those of the past? Do the expected changes matter to current decisions?" (Fussel 2007: 268). Questions that take climate change into account, and not just climate variability are important as they can reduce the risk of maladaptation[9] (Magnan 2014).

2.4.4 Spectrum of adaptation

There is also a spectrum of different adaptation responses, with incremental changes on the one end of the spectrum (typically shorter term strategies) and transformative changes on the other (typically longer term strategies). All three adaptation types are, however, not always clear cut (Kates et al., 2012) and often overlap (Rickards and Howden 2012). Incremental adaptations to climate change are described as "extensions of actions and behaviours that already reduce the losses or enhance the benefits of natural variations in climate and extreme events" (Kates et al., 2012:7156). For example, measures such as changes in land management practices within an existing agricultural system (e.g. switching to drip irrigation, or changing planting times) (Rickards and Howden 2012). Systems adaptation includes changes to an

[9] Maladaptation is a process that results in increased vulnerability to climate variability and change, directly or indirectly, and/or significantly undermines capacities or opportunities for present and future adaptation (Magnan 2014).

existing system such as the adoption of precision agriculture, geographical diversification or switching from livestock to crop types (Rickards and Howden 2012). Some studies do, however, indicate that incremental or systematic changes will not be enough to manage the severity and rate of climate change impacts (IPCC 2014; Ash et al., 2012; Rodriguez et al., 2011). Instead, a more "transformational" (Kates et al., 2012; Howden et al., 2007; O' Brien 2011; Pelling 2011) or "transformative" (Park et al., 2012) change is necessary. Transformational adaptation is seen as necessary as it is argued to provide greater benefits the larger the degree or impact of climate change, illustrated in Figure 1 below. Transformational adaptation has many definitions including "those activities adopted a larger scale or intensity" (Kates et al., 2012) or "a discrete process that fundamentally (but not necessarily irreversibly) results in change in the biophysical social or economic components of a system from one form function or location (state) to another thereby enhancing the capacity for desired values to be achieved given perceived or real changes in the present or future environment" (Park et al., 2012; see Lonsdale et al., 2015 for more). However, in keeping with Rickards and Howden's (2012) definition in an agricultural context, transformational adaptation is defined here as a "major, purposeful action undertaken at the farm or supra-farm level in response to potential or actual climate change impacts and opportunities in the context of other drivers" (Rickards and Howden 2012:24). They argue that there are multiple dimensions of transformative change. For example, spatially the change can occur across a whole system (e.g. conversion of a farm from a conventional to an organic system, or the depth of change might completely create a new system (e.g. change from being a dryland region to an irrigated region).

Importantly transformational adaptation is seen as a response to "multiple drivers and a source of multiple benefits" (Pelling 2011; Park et al., 2012) and also "reinforces the realisation that agricultural research can no longer remain insulated from off-farm, non-science or non-agricultural knowledge or processes" (Rickards and Howden 2012). This is critical for agri-firms who operate in a multi-stressor environment and who require multi-disciplinary solutions (Howden et al., 2007).

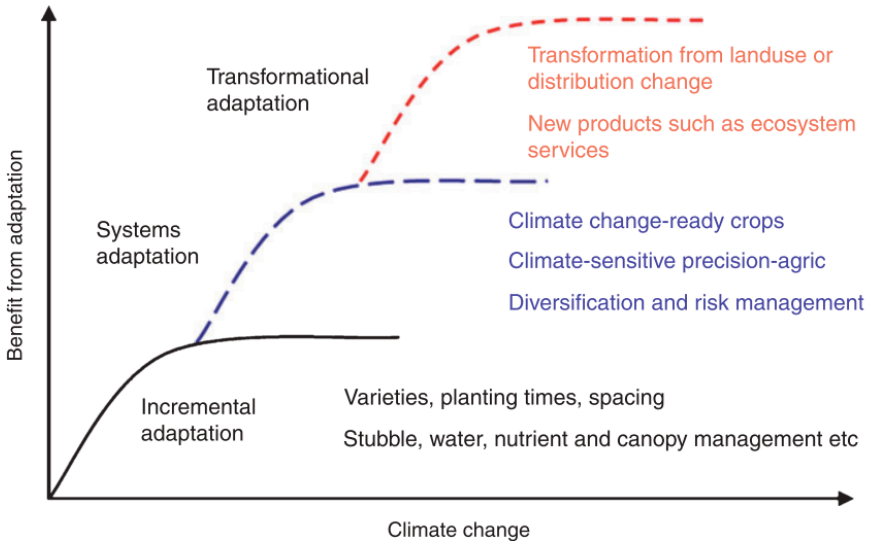

Figure 2: Levels of adaptation in relation to benefits from adaptation action and degree of climate change, using examples from Howden et al. (2010). Source: Rickards and Howden (2012).

2.5 Barriers and Enablers to Adaptive Capacity

Despite the potential benefits of more transformational adaptation (Fig.1), there is also greater risk and complexity associated with the change (Rickards and Howden 2012) and in turn more complex barriers. In slight contrast to the definition of the IPCC introduced in Chapter 1, barriers can be defined on a more positive note as "obstacles that can be overcome with concerted effort, creative management, change in thinking, prioritization, and related shifts in resources, land uses, institutions, etc." (Moser and Ekstrom 2010:2). This definition is pertinent to this thesis because it highlights that barriers are surmountable, albeit largely dependent on the agri-firms adaptive capacity (including their intention to proactively adapt[10]). Essentially adaptive capacity is a dynamic concept that can be built on over time (Engle 2011), which makes enhancing adaptive capacity an important step to overcoming barriers (Marshall et al., 2014; Marshall et al., 2013). To better understand what would constrain (i.e. barriers) or enable agri-firms' to proactively adapt, the following

[10] Having a high adaptive capacity does not always translate into adaptation (Grothmann and Patt 2005). For example, producers in Zimbabwe, provided with climate change information did not have the 'adaptation intention' to switch from maize to millet (despite the fact that millet seed is more readily available, less expensive and will be less vulnerable to climate change projections) (Grothmann and Patt 2005).

section looks at determinants of their adaptive capacity and focuses on financial, technological, information, institutional (Smit and Pilifosova 2001), and organisational (Baudoin et al., 2016). These are often not mutually exclusive as one may constrain the other.

Organisational

Organisational capacity refers to the resources available to a company (e.g. financial, experience, pool of knowledge etc.) to manage/cope with problems (Porter 2011). Organisational capacity is an important determinant to understand how an agri-firm might be structured or managed to deal with change. Organisational barriers are often financial, but for agri-firms barriers are more often related to the risk of uncertainty in decision-making (Tsolakis et al., 2014). Due to the multi-stressor environment in which agri-firms operate in, agri-firms are inundated with uncertainty. Climate change is a particularly challenging uncertainty for an organisation, as it requires a much longer planning horizon. And agri-firms are essentially motivated by short-term profit margins, therefore investing in an expensive proactive adaptation strategy that might or might not yield significant benefits at a later stage will be costly (Kolikow et al., 2012), specifically to their shareholders (Investec 2011).

A large aspect of proactive adaptation is about building capacity to cope with uncertainty (e.g. surrounding cost-benefits of adaptation measures) (IPCC 2014). Many organisations lack the skills to handle uncertainty in business planning processes (Boyd and Osahr 2010). However, there are tools to manage for the uncertainty around climate change and these including using the precautionary principle (Wilby and Vaughn 2011), scenario planning (Vermeulen et al., 2013), dynamic adaptive pathways (Haasnoot et al., 2013) and no-regret strategies[11] (Hallegate 2009). These tools can be implemented during strategic planning sessions. Wilby and Vaughn (2011) suggest that climate change 'champions' are necessary to set visible goals and influence these decision-making processes. Climate change champions might be particularly important to influence agri-firm shareholders who are the ultimate decision-makers (Vermeulen et al., 2013; Hallegate 2009).

Institutional

[11] No regret strategies are defined as adaptation measures that yield benefits even in absence of climate change (Hallegate 2009).

Institutional capacity refers to the wider institutional context that an agri-firm would be operating within (Porter 2011). Institutional capacity can be constrained by rules and regulations (Moser and Ekstrom 2010; Westerhoff et al., 2011; Eakin 2005) that do not take climate change adaptation into account. For example, high import costs for imported irrigation technology (e.g. import duties), 'red tape' around the use of new chemicals to combat pests and diseases and uncertainty regarding policy outcomes. Policies such as land reform can contribute to the agri-firm's uncertainty, albeit indirectly linked to proactive adaptation. For example, proposed land caps could dis-incentivise foreign investment into the agriculture sector[12]. In addition this uncertainty contributes to an agri-firm's "worry-load" in the context of their multi-stressor environment. As a result, climate change is not seen as a priority, which inhibits proactive adaptation as very little attention is afforded to it.

A supportive institutional and policy environment can enable local proactive adaptation (Nelson et al., 2007; Schipper and Pelling 2006; Burch 2010). Kates et al., (2012) also suggests that more transformational adaptation requires longer-term changes to policy and support from government. Ziervogel and Eriksen (2010) look at the type of institutional interventions that could be strengthened to enable adaptation in the food system to buffer it against climate change. Their list ranges from helping to ensure that agri-firms have access to climate change information and securing land rights and tenure to encourage agricultural investment (Bryan et al., 2009). At an international level, they point to increased investment in agricultural research and technology developments (World Bank 2009).

Information and Knowledge

Lack of climate change awareness is listed as a key barrier to proactive adaptation (Berkhout et al., 2006, Marshall et al., 2013; 2014). Climate change awareness is the "extent that primary producers (i.e. agri-firms) understand, relate to, and prioritise climate change as a driver of change within bio-agronomic systems" (Tonn 2007 in

[12] In early 2015, the Department of Rural Development and Land Reform (DRDLR) proposed an additional land reform policy (DRDLR 2015). The additional policy aims to introduce a cap on the amount of land an individual can own and prohibits land ownership by foreign nationals. In terms of agricultural area it included caps of: 1000ha for small-scale farmers, 2500ha for a medium scale commercial farm and 5000ha for a large-scale commercial farm.

Marshall et al., 2013). Marshall et al. (2013) empirically show that peanut agri-firms in Australia with low climate change awareness had lower adaptive capacities. Furthermore, the inconsistencies in climate change projections and projected impacts makes it difficult for agri-firms to make informed decisions (Vermeulen et al., 2013). On the other hand, the "most informed about science and climate change are not necessarily the most concerned about its potential consequences" (Kahan et al., 2012). Here information is only beneficial to the agri-firms if it is useful to them (i.e. related to the usability gap between climate change information production and application) (Kalafatis et al., 2015). Adaptation knowledge and information gaps are also barriers to successful adaptation (DEA 2013). Reliable information on adaptation measures available needs to be generated so that agri-firms invest in the appropriate adaptation measure.

To overcome the usability gap, Kalafatis et al. (2015:31) argues that "trust building (Kirchhoff 2013; Pagano et al., 2002), improving awareness of needs and limitations (Kirchhoff 2013; Roncoli et al., 2009), and improving understanding around issues of accuracy and reliability of climate information (Kirchhoff 2013; Pagano et al., 2002; Power et al., 2005) is important. In addition, Klopper et al. (2006) argues that increased interactions between agri-firms and producers of climate information are critical to ensure that the righ information is modelled and the end user disseminates the information correctly.

The IPCC (2014) also argues that government needs to support production of climate change and adaptation information and effective dissemination of it (e.g. through research funding) (Mendelsohn 2000). However in South Africa, the government is focused on small-scale resource poor farmers and therefore public funding for research is typically allocated elsewhere (DAFF 2015). To overcome financial constraints on gathering information, sharing and pooling of resources is particularly important (Wilby and Vaughn 2011). Collective solutions can lessen the cost and time taken to find solutions and promote learning. Here the role of commodity organisations (e.g. South African Avocadoes Growers Association) is important. They have well organised strategic research programmes that can facilitate research on a national level. They are often important players in researching the effectiveness of

specific adaptation measures (e.g. netting structures) that can later help other agri-firms decide on the effectiveness of the measure.

The previous paragraph also picks up on adaptation information and knowledge – i.e. what type of information is available on adaptation measures that the agri-firms can use (even if they are uncertain of climate change)? Developing adaptation options and taking future socio-economic scenarios into account is incredibly challenging with so many present pressures to face (Iglesias et al., 2007). Again, the role of commodity organisations or training facilities is important for information dissemanation and knowledge production on different adapation options (Iglesias et al., 2007).

Financial

Financial constraints can often be related to gathering information of the adaptation measure or be related to the cost-benefit of the adaptation measure (Smit and Pilosova 2011; Kolikow et al., 2012). Agri-firms already have access to capital and therefore constraints for many technological and land use management changes are often more to do with the latter.

Modelling programmes are increasingly being used to take uncertainty into account and provide a better projection of the cost-benefit of an adaptation measure. For example, Louw (2012) uses an integrated modelling framework to investigate the costs and benefits of various adaptation strategies towards climate change in the Western Cape (South Africa). His results showed that the modelling outcomes could contribute significantly towards decision-making.

Technological

Technological factors can be a barrier as "technological factors can delineate the range of adaptation strategies available to agri-firms, since agri-firms can only adapt to climate change using tools that have already been developed" and "the state of current technology will place indirect limits on adaptive activity" (Kolikow et al., 2012:596). For example, there is a limit on a technological development that can respond to drought. Countries like Israel are proof that technology is an important factor in adapting to harsh climate conditions. According to Fleischer et al. (2011)

they have turned many unproductive regions into highly profitable vegetable and fruit farming systems (Fleischer et al., 2008).

According to Smit and Skinner (2002:99) "the lead responsibility for developing technological adaptations tends to be governments and agri-business" (e.g. industry research bodies). Therefore increased funding is needed to remain competitive to countries that invest significantly in technological development (e.g. Israel). A big challenge, however, is getting the agri-firms and their consultants to adopt the technologies (Smit and Skinner 2002).

Embeddedness in the agri-supply chain

Being embedded in the agri-supply chain, stakeholders up and down the chain can influence an agri-firm's adaptive capacity (Kolikow et al., 2012). For example, the power imbalance between retailers and agri-firms (Hingley et al., 2005) can result in squeezed profit margins decreasing long-term-financial security of agri-firms (i.e. financial barrier) (Evans 2012). In contrast, other stakeholders within the agri-supply chain can enhance an agri-firms information and organisational capacity. For example, growers associations and industry bodies are voluntary institutions whose aim is to protect and promote the interests of their suppliers. They often provide their industry with access to global markets, optimise effective production of quality fruit, are committed to research and development and can even influence policy (e.g. www.cga.co.za and www.avocado.co.za), all actions that have the potential to enhance adaptive capacity.

2.6 Agri-supply chains and the role of the retailer

2.6.1 Fresh produce agri-supply chains

Fresh produce agri-supply chains (FPASC) are unique in comparison to other supply chains for reasons including seasonality of harvesting, specific requirements regarding transportation and storage conditions and the short-life cycle of certain produce (Van der Vorst 2000; see Tsolakis et al., 2014 for more). As a result they are often described as complex (Dolan and Humphrey 2001). For example, Figure's 3 and 4 illustrate the complexity of a typical fruit and vegetable supply chain, respectively. The both illustrate how many stakeholders and resources are required in moving a

horticultural product from the supplier to consumer.

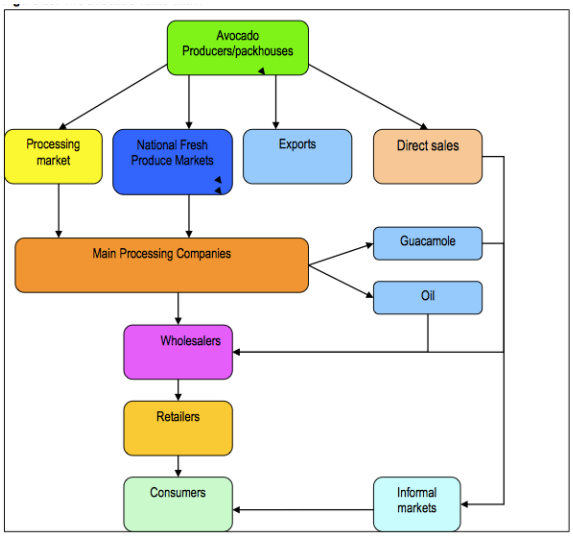

Figure 3: Depiction of typical avocado (fruit) supply chain in South Africa. (DAFF 2015)

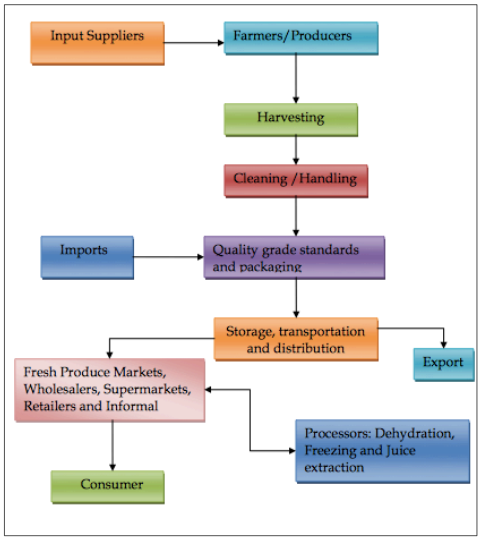

Figure 4: Depiction of typical carrot (vegetable) supply chain in South Africa. (DAFF 2015)

To retailers FPASC's are important, as fruit and vegetables draw consumers into their shop. Retailers therefore put emphasis on quality (i.e. instant appealing produce) and consistency (i.e. preferably available year round) to consumers to ensure consumer loyalty (Dolan and Humphrey 2001).

Although the retailer often establishes standards and carries out some monitoring, in practice there are often more dominant role players within an agri-supply chain. Exporters are have secured a valuable position in the horticultural supply chain (Dolan and Humphrey 2001). They provide year round produce to retailers and

diversify marketing outlets by accessing regions across the world. As a result agri-firms in South Africa are laregy dependent on them. Other stakeholders can also be key players. For example, in South Africa, the dominant player in the mango agri-supply chain is the category manager who bridges the gap between agri-firms and retailers and controls the sourcing of fruit globally (Repo and Rade 2010). His influential reach and interest is, however, likely to be limited to a specific industry (e.g. mangos).

2.6.2 The retailer

Asides from the other key players, retailers are still in a key strategic position of power as market share is owned by fewer and larger organisations (e.g. Walmart, Tesco, Checkers). For example, Tesco has 28.3% of the Great Britain grocery market share (statistica.com). They are also recognized as food authorities and gatekeepers of standards, playing a critical role in the agri-supply chain due to their major influence on the way food is produced, processed and consumed (Burch et al., 2014). With this influence over decision-making at both ends of the supply chain, retailers are increasingly expected to take responsibility for operations beyond their own internal operations (Baldock et al., 1996; Macfadyen et al., 2016; Styles et al., 2012). Similarly, Smith (2007:850) argues, "although the prime responsibility for retailers clearly lie within their own operations, they are increasingly expected to use their influence with consumers 'up the chain' and agri-firms 'down the chain' ".

There is evidence to show that locally and internationally retailers are increasingly taking a more proactive stance in sustainability measures, particularly at the farm-level to support their suppliers (Peck 2006). Sustainability is described as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). It often includes measures that ensure responsible use of natural resources and reduction of poverty. On the other hand, adaptation to climate change focuses, in particular, on responding to climate risks (Howden et al. 2007). However, Smit and Wall (2005) argue that the two concepts (sustainability and adaptation) are mutually supportive. Smit and Pilifosova (2001:899) argue, "Because actions taken without reference to climate have the potential to affect vulnerability to it, enhancement of adaptive capacity to climate change can be regarded as one component of broader sustainable development

initiatives".

What is evident is that retailers' actions in the sustainability arena show how they have been able to influence agri-firms to adopt sustainable practices - interventions that could similarly be used in proactive climate change adaptation. Retailers primarily drive environmental improvement of suppliers using third party environmental certification, environmental requirements for agri-firms (e.g. GlobalG.A.P. (Good Agricultural Practice), Nurture) and agri-firm improvement programmes (Styles et al., 2012). These interventions are often voluntary (in legal terms), although failure to comply can result in loss of market access for the agri-firm. For example, Sainsbury's works with independent consultants and 334 dairy agri-firms to improve efficiency of dairy production (Sainsbury 2010). Mylan et al., (2014:24) show how UK retailers are able to stimulate eco-innovation in milk supply chains through i) paying premium prices to agri-firms who meet certain environmental criteria, "enabling them to further invest in eco-innovations " and ii) building networks and information flows to provide best practice information amongst agri-firms and providing feedback and suggestions for improvement. M&S developed a website that provides water efficiency guidelines for agri-firms and developed a green factory programme aiming to develop more efficient production methods (i.e. investing into research) (M&S 2010). Despite international standards such as GlobalGAP, many high-end retailers also develop private regulations to ensure that their produce is of a certain quality to meet customer demands. For example, Tesco (a large UK retailer) implemented Nurture an additional audit over and above GlobalGAP. The major disadvantage with private regulations is that the agri-firm often bears the cost and is often forced to comply with numerous audits to satisfy a globalised market.

The role of retailers in facilitating change at the farm-level is, however, limited to a certain extent, based on their incentive to initiate change (Mylan et al., 2016). For example, retailers do very little to promote sustainability in the UK bread chain as bread sales "generate little profit" (Mylan et al., 2016:25). Mylan et al. (2016:25) show that retailers' influential role in stimulating environmental sustainability in UK milk chains was largely pushed by external pressures from policymakers and NGOs.

2.6.3 The role of the retailer as an enabler to proactive adaptation

Thorpe and Fennel (2012:5) suggest that retailers should raise awareness and understanding of adaptation at the farm-level to increase information capacity. To do this, retailers "should raise awareness internally and train employees across key business functions. They should also ensure that board members are informed and tasked with integrating adaptation strategies into core business processes. And they should develop 'champions' who are to secure and sustain executive level commitment" (Thorpe and Fennel 2012:5). In doing this the retailer should also ask producers about current climate trend and impacts so as to gain a better understanding of the actual needs of the producer and the commodity inherent characteristics and risks. Thorpe and Fennel (2012) suggest that building longer-term and more stable relationships with suppliers is necessary to enhance financial capacity. Lastly the suggest that working through existing institutions is important as this "helps ensure that efforts respond to local needs and bring scale and sustainability, while avoiding uncoordinated parallel efforts that could create confusion and paralysis" (Thorpe and Fennel 2012:18).

For global supply chain resilience, Macfadyen et al. (2016) argue that retailers need to focus particularly on restoration and expansion of ecosystem services at the farm-level. For example, retailers need to ensure that agri-firms use agro-chemicals sparingly, protect water resources and mandate practices that maintain and restore soil resources (Macfadyen et al., 2016). In addition they argue that retailers need to help prepare agri-firms by identifying future crops and products and "develop them into marketable commodities". As climate change makes some produce non-viable in certain regions, production may need to shift to new produce. Whilst this often happens autonomously by agri-firms, support from retailers is necessary to influence demand (Macfadyen et al., 2016). Landscape-scale diversification should also be encouraged at the farm-level to minimise risk as mixed farming systems are recognized to be more resilient to climate change and market volatility (Howden et al., 2007; Tibesigwa et al., 2016).

2.6.4 Retailers and South Africa

In South Africa key developments in corporate governance around sustainability by retailers stem from the establishment of King Code of Corporate Governance III (King III). It is a non-legislative code that outlines sustainability as:

> "The primary moral and economic imperative of the 21st century. It is one of the most important sources of both opportunities and risks for businesses. Nature, society, and business are interconnected in complex ways that should be understood by decision-makers" (IoD 2009:9)

Here, greater focus on corporate accountability and responsibility by retailers is considered important to maintain a good reputation (Kapstein and Ethan 2008).

South Africa's top retailers (according to % market share) include Pick 'n Pay, Shoprite Checkers, Woolworths and Spar with Massmart and Metcash being the two main wholesalers (Louw et al., 2006). Van Bormann and Scholtz (2016) found that South African retailers recognised climate change as a major risk to security of fresh produce supply in South Africa. Whilst the degree of concern between companies varied, the retailers argued that climate change is not getting the attention from agri-supply chain stakeholders (e.g. government) that it deserves (Van Bormann and Scholtz 2016). Another concern is that "as supply becomes more constrained, retailers will only be able to absorb a certain level of product cost increase before passing it on to the consumer" (Van Bormann and Scholtz 2016:14). This would have significant influence on consumers in South Africa.

Pereira (2013) looks explicitly at four strategic areas where food retailers in South Africa have the potential to build adaptive capacity to climate change in the food system. These areas are innovation, customer awareness, retail as a buffer under shocks and procurement policies. The first three however do not focus on enhancing agri-firms adaptive capacity. For example, enhancing innovation dealt with food processors (e.g. Tiger Brands) and customer awareness dealt with increasing retailer employees and consumer awareness on climate change. Procurement policies are one area in which the retailer has a direct effect on agri-firms adaptive capacity and this is primarily through implementation of sustainability requirements as described in the

previous section.

There is evidence to show that Woolworths and Pick 'n Pay (local retailer; in particular) have instituted projects that build the overall agri-supply chain resilience in South Africa through various environmental and social upliftment projects. Pick 'n Pay have a programme to help small-scale suppliers consider climate risks (Van Hille and Louw 2012). Woolworths, however, seems to be truly leading the way at the agri-firm level with their Farming for the Future (FfF) programme (Pereirra et al., 2013; van Hille and Louw 2012; Methner 2013). The FfF program is part of Woolworths Good Business Journey strategy – with 98% of Woolworths fresh produce FfF accredited (Woolworths Sustainability Report 2015). The FfF program promotes sustainable agriculture by regulating soil quality, water use efficiency and pesticide and herbicide use[13]. These FfF standards are implemented and monitored (using audits) with on-farm training by Woolworths that includes an open platform for communication of problems with the retailer (King and Thobela 2014). Although the program is designed to increase the sustainability and "health" of the farms, King and Thobela (2014) go further to mention that it "helps the agri-firms adapt to climate change and extreme weather events" (albeit not empirically tested). Methner (2013) also argues that FfF allows for better knowledge transfer and skills development (i.e. information capacity). This is beneficial as "the regular communication and information exchange between the three parties fosters learning processes and experimentation which in turn helps to improve the FfF programme". The FfF example is, however, unique in South Africa, and for the majority of large retailers in South Africa, Day (2009:2) argues that despite having sufficient capability to manage climate change issues "a great deal more can and should be done to help in combating global climate change issues".

Aside from corporate social responsibility (CSR) requirements, Methner (2013) discusses two key drivers for Woolworths adopting the FfF standard; institutional and organisational. State regulations can be "compelling incentives for companies to

[13] According to Methner (2013), "FfF is a science based agricultural model deployed at farm level that measures eight key sustainability components. These eight main components are soil management, irrigation water management, environmental legal requirements, biodiversity management, waste and waste water management, cooling and energy use and carbon footprint, pest and plant management (all have measurable sub-categories) as well as a self audit by the farmer" (interview, L. van Schoor, 7 March 2012).

contribute to environmental governance" (Methner 2013). However, in South Africa the state capacity to enforce regulations is limited (Methner 2013). For example, the government has a limited capacity to manage certain areas essential to the agriculture sector (e.g. water infrastructure). Woolworths realised that they could not have a 'wait and see' attitude (Methner 2013) and instead teamed up with an external consultant and an NGO (Environscientific and WWF) to implement sustainable practices at the farm-level through the FfF programme. Organisational drivers can include a company's branding strategy and organisational culture. Woolworths promotes its' brand as high quality at an affordable prices (Methner 2013). Therefore the retailer benefited from branding and marketing schemes around environmental issues that appealed to its consumers (Methner 2013). Methner (2013) also points out how both of these drivers were essential in pushing the FfF programme forward. For example, Pick 'N Pay operates within the same institutional drivers, but lacks some of the organisational capacity that Woolworths has to incorporate a programme like FfF into its agri-supply chain.

2.7 Summary

Agri-firms are structured in such a way that their coping capacity to climate variability is high. However in order to proactively adapt certain constraints will need to be overcome and often have to do with technological limitations (i.e. lack of suitable technology) or organisational constraints relating to uncertainty on the cost-benefits of expensive technology. The role of the retailer as an enabler therefore needs to be quite specific in ensuring that they support proactive adaptation strategies at the farm-level that increase resilience to climate change but also maximise profits. Whilst the climate change adaptation literature was sparse on the role the retailer could play, some papers pointed to their role in restoration and expansion of ecosystem services and identifying future crops and products and developing them into marketable commodities.

Chapter 3: Methodology

3 Methodology

3.1 Introduction

Increasingly, sustainability challenges are requiring new ways of knowledge production and decision-making (Lang et al., 2012). Many studies have begun to involve actors from outside of academia as a means to address real world-problems (Lang et al., 2012). As part of the larger project of which this study forms part, WWF, M&S and Woolworths were involved in the case selection. This type of collaboration can be seen as a form of trans-disciplinary research which is defined as a "reflective, integrative, method drive scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Lang et al., 2012:26). The approach typically focuses on societally relevant problems and aims to create knowledge that is solution orientated (Lang et al., 2012). Ideally a trans-disciplinary research process is "conceptualized as a sequence of three phases, including: collaboratively framing the problem and building a collaborative research team (Phase A); co-producing solution-oriented and transferable knowledge through collaborative research (Phase B); and (re-) integrating and applying the produced knowledge in both scientific and societal practice (Phase C)" (Lang et al., 2012:27). This thesis only reached Phase A, and therefore further research is recommended to compliment the study, detailed in the concluding chapter. With the previous chapters having given an outline of the role of the retailer in the agri-supply chain and the vulnerability of agri-firms to globalisation and climate change, this chapter aims to describe the research methodology adopted to achieve the research aims and three objectives.

3.2 Research Design

As the study is exploratory in nature, a qualitative research design was adopted to gain an in-depth and holistic understanding. Exploratory research aims to i) gain a better understanding, ii) test the feasibility of undertaking a more extensive study and

iii) to determine priorities for further research (Babbie and Mouton 2010). An inherent limitation of an exploratory type research study is that "they seldom provide satisfactory answers to research questions" (Babbie and Mouton 2010:80) because the evidence collected is not sufficiently representative. However, they can "hint at the answers and give insights in to the research methods that could provide definite answers" (Babbie and Mouton 2010:80).

Using a case study approach to explore the aim was considered necessary to gain a deeper insight into the topic (Eisenhardt 1989). Yin (1984:23) defines case study research methodology "as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used." Case studies "arise from the desire to understand complex social phenomenon' and "allow investigators to retain the holistic and meaningful characteristics of real life events" (Yin, 2003:2). The case study research design has, however, been criticised (Babbie and Mouton 2010). Firstly, some argue that whilst it provides deep and insightful information on specific areas of interest it cannot be used to build general theory. However, Eisenhardt (1989), Flyberg (2001) and Yin (1994) argue that building theories from case study research is possible. For example, Eisenhardt (1989:533) argues that comparing results with similar or conflicting literature "sharpens generalizability, improves construct definition, and raises theoretical level".

3.3 Selection of agri-firms

According to Eisenhardt (1989:536) selection of cases is an important aspect of building theory from case studies. As part of the larger project, six samples of agri-firms were selected by WWF (with guidance from Woolworths and M&S). This highlights one of the challenges of trans-disciplinary research (Lang et al., 2012); agri-firms that are associated with the retailers and somewhat more sustainable than others were likely to be chosen (i.e. selection bias). Here, "power is exerted through the control of funding" (Harris and Lyon 2014:11). On the other hand, non-random sampling ensures that each case study will yield as much information on the topic as possible (Leedy & Ormrod 2005:145). Similarly Eisenhardt (1989:537) argues that "random selection (of case studies) is neither necessary, nor even preferable".

However, to prevent any sense of bias in the interviews, the anonymity of the agri-firms was reinforced and Woolworths and M&S were not mentioned in the interviews to prompt the interviewees.

The selection of agri-firms (described below) led to a single case study approach with embedded sub-units. Here the researcher needs to be interested in looking at the overall issue, but is intrigued by the different perceptions that each agri-firm might present (Baxter and Jack 2008). The sub-units then allow for within case analysis and across all subunits (Baxter and Jack 2008), which can provide a deeper understanding of the issue at hand.

To ensure that a comparative analysis was possible, certain variables were controlled for. Firstly, the pre-selected cases were all large-scale commercial fresh fruit and/or vegetable agri-firms from South Africa. As defined in the literature review, this includes agri-firms whose turnover is more than R7, 5 million per annum. The agri-firms are therefore all financially secure and have the potential adaptive capacity to plan ahead for climate change. Secondly, all the respondents included senior managers or directors in the company of between 12-30 years experience at any one company. Although the perception of climate change might differ between individuals within the organisation, it was assumed that senior personnel would have a better understanding of climate risks and how these may have changed over the years and also understand the direction that their organisation wanted to take in terms of climate change adaptation. In addition, these individuals are likely to have a better understanding of the relationship between the retailer and the agri-firm due to the years they have worked in the firm. Lastly, all the agri-firms supplied to numerous retailers overseas (e.g. Tesco, Waitrose) and South Africa (Woolworths, Pick N Pay, Checkers).

The agri-firms were located in different geographical locations. Firstly, of the six agri-firms that were selected to do the interview, four fell within a winter rainfall area and two fell within a summer rainfall area. Looking at different geographic areas and climatic zones is important as the risk and opportunities posed by climate change are locality and context specific (Gbetibouo and Ringler 2009). The paragraphs below describe the context in which the agri-firms operate and Table 1 (below) provides an

overview of the agri-firms (e.g. farm size, what is produced, area farmed and experience of respondent).

Summer Rainfall Areas

Agri-firm 1 is located near Letsitele in the Limpopo Province. Letsitele has an average annual temperature of 21.7 °C with an average annual rainfall of 646 mm. Agri-Firm 1 has expanded into the Western Cape characterised by its Mediterannean climate. The agri-firm has a number of operational businesses that focus on mass production and distribution of primarily citrus, easy peeling mandarin, banana and sugar-cane tissue culture plants. The agri-firm has a accredited nursery that produces certified citrus, mango, pomegranate and guava trees. In addition, their laboratory specialises in production of disease free banana plants.

Agri-firm 2 head offices are located in Tzaneen in the Limpopo Province. Tzaneen is classified as a sub-tropical area experiencing high levels of humidity. The average annual temperature is 20.4 °C in Tzaneen with an average annual rainfall of 965 mm. Agri-Firm 2 also operates in various estates located on different continents. In South Africa, they operate in Limpopo, KwaZulu-Natal and Eastern Cape Province. Internationally, they are establishing orchards in Mozambique and have farms in Colombia (South America). They focus primarily on avocadoes although they also produce mangos and processed products such as avocado oil, dried mango and guacamole. The agri-firm has a number of operations which includes packing and processing facilities, avocado ripening facilities in Netherlands, France, and the UK, an exporting company and an accredited nursery which supplies over 100 000 trees a year.

Agri-firm 3 is located in Babsfontein in Gauteng Province with 500ha of vegetables under production. Babsfontein climate is classified as warm and temperate with annual average temperature of 15.5 °C and average annual rainfall of 713mm (climate data.org). Recent intensification of production has occurred through the construction of two large hydroponic systems.

Agri-firm 6 is located in Rustenberg in the North West Province. The climate in Rustenberg is warm and temperate with an average annual temperature of 18.6 °C (climate data.org). Previously a protea farm, the farm has switched to cherries, blueberries, with a few remaining hectres of nectarines. In addition, figs are produced in a state of the art climate controlled building.

Winter Rainfall Areas

Agri-firm 4 is located in Ceres in the Western Cape Province. Ceres experiences a typical Mediterranean climate with cool and wet winters. Average annual temperatures range from 29,9 °C to a July minimum of 2,4 °C with average rainfall at 1088mm. The agri-firm has six farms located in a 220 km radius which equates to approximately 3000ha of vegetables (broccoli, carrots, cauliflower, onions, swiss chard spinach etc.) and apples, nectarines, peaches and pears are under production. In addition, they have a sheep stud farm.

Agri-firm 5 is located in Grabouw in the Western Cape. Grabouw is warm and temperate with an average temperature of 14.8°C and average annual rainfall of 1007mm. They are specialist producers, packers and marketers of fresh apples and pears and control 1200ha of produce whilst influencing 1700ha. In addition their operation has an established research facility that facilitates the rollout of best practice methodology on their farms as well as their alliance growers.

Table 1: Overview of agri-firms and respondents interviewed in the study

Case study	Farm Size	Produce	Area	Experience of respondent	Role on Farm
1	1200ha	Citrus & easy peeling mandarins	Letsitele. Hot and Dry Climate	15yrs	Technical & Compliance Manager
2	2000ha	Avocados	Tzaneen. Sub-Tropical Climate	14 yrs	General Manager
3	500ha	Vegetables	Babsfontein. Warm and	25 yrs	Manager

			Temperate Climate.		
4	3000ha	Vegetables, apples and pears	Ceres. Mediterranean Climate.	28 yrs	Managing Director
5	Control 1200ha & influence 1700ha	Apples and Pears	Grabouw. Warm and Temperate Climate.	27yrs	Director
6	15ha cherries, blueberries & figs	Figs, Cherries and Blueberries	Rustenberg. Warm and Temperate.	25 yrs	Co-Owner

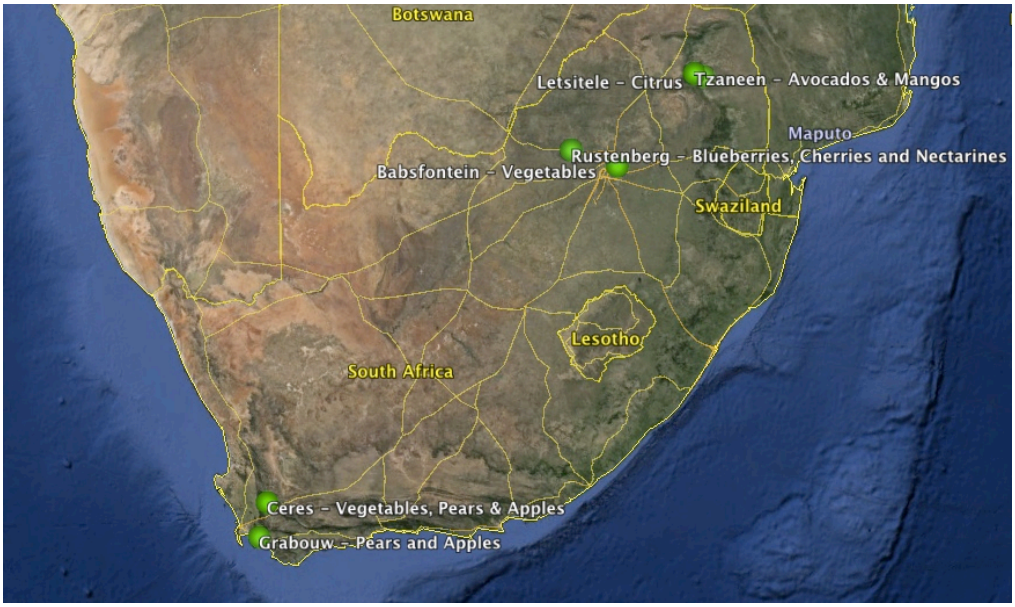

Figure 5: Geographical locations of agri-firms selected for the study

3.4 Data Collection and Analysis

A case study approach typically combines data collection methods such as interviews, questionnaires and observations (Eisenhardt 1989). For this thesis, two research methods were employed. Firstly, a semi-structured interview was developed. According to Given et al. (2008: 810), "a semi-structured interview is a qualitative data collection strategy in which the researcher asks informants a series of predetermined but open-ended questions". It is often described as an interview style

that is somewhat conversational. In addition, a significant advantage of a semi-structured interview is that it allows the research to probe deeper into certain questions (Given et al., 2008).

To develop the semi-structured interview a pilot questionnaire was conducted on one agri-firm, outside the sample group. A pilot study is essentially a small-scale implementation of the study prior to larger study (Given et al., 2008: 624). A pilot study provides the researcher with the opportunity to "examine adjustments or alternatives" and can help determine the "types of wording or questioning techniques that will provide rich responses and those that do not" (Given et al., 2008: 624). After the pilot study was used to adjust the semi-structured interview, the draft was sent through to WWF and two experts[14] involved in the agriculture and climate change field for further comment. Questions were refined accordingly.

For objective *i) to identify climate risks and response measures by the agri-firms,* consideration was given to the following:

i) The respondents were asked what their climate risks were. Bryant et al. (2000) suggest that it is important to first ask which climate variables farming systems are most sensitive to (Ziervogel and Wiid 2015), to understand their context specific vulnerability;
ii) The respondents were then asked what response measures they had implemented to minimise their climate risk. Where possible, observations were made in the field alongside the respondent.

For objective *ii) to identify barriers to proactive adaptation at the farm level as perceived by the agri-firm,* consideration was given to the following:

i) To find out whether the agri-firms considered climate change as a risk, they were asked what their five biggest risks to their operation was. This was to give insight into their multi-stressor environment (Ziervogel and Taylor 2008), which would reveal a more comprehensive understanding of the barriers to climate change adaptation;

[14] Stephanie Midgley and Nadine Methner from SmartAgri project.

ii) Looking at their adaptation responses to climate risks, the agri-firms' were then asked to describe what barriers they faced in implementing more proactive adaptation measures and what support they would like to receive. When the respondents were hesitant in answering the question (perhaps due to the lack of knowledge and uncertainty surrounding climate change), barriers as highlighted in the literature review (e.g. institutional, financial, organisational) were used to prompt them.

To investigate objective *iii) explore what interventions agri-firms perceive a retailer could take in order to help them overcome some of their barriers to proactive adaptation*, the questions asked engaged with the following topics:

i) To gain insight into agri-firms' perceptions of the retailer, they were asked whether they thought the retailer should play a role in proactive adaptation (e.g. Styles et al., 2012);
ii) To explore practical interventions that retailers might adopt, the respondents were asked how they thought the retailer could play a role (e.g. fund research).

Observations of the respondents and farms were carried out which included taking notes and photographs of the adaptation strategies. Observational research "involves collecting impressions of the world using all of one's senses, especially looking and listening, in a systematic and purposeful way to learn about a phenomenon of interest" (Given et al., 2008:573). Field notes were taken after the interview was finished and included descriptions of the setting, overall impression of how the respondents reacted to certain questions and other variables such as the attention span of the respondent and the researcher. To prevent researcher bias (a general weakness of observations) observations were discussed and cross-validated with the research assistant (a PhD candidate) who accompanied the farm visits.

3.5 Data Analysis

Recorded interviews were transcribed and the information was collected and redacted. As the information collected from the interviews was extensive, Nvivo was used to

neatly categorise the data. Nvivo is a coding program for qualitative research that helps cluster or categorise the results into broad categories to find similarities or differences between cases. For example, to identify the barriers to adaptation being experienced at the farm level the interviews were coded into institutional, financial and technological constraints (Smit and Pilifosova 2011).

Despite the benefits of coding, it is inherently influenced by the researcher's personal involvement (Saldana 2009) – thus constituting an element of subjectivity. Subjectivity guides "everything from the choice of topic that one studies, to formulating hypotheses, to selecting methodologies, and interpreting data. In qualitative methodology, the researcher is encouraged to reflect on the values and objectives he brings to his research and how these affect the research project" (Ratner 2002:1). To deal with the element of subjectivity, the literature review and observational notes were referred to continuously (and iteratively) to assist in distinguishing between certain themes. Positively, Ratner (2002:2) also argues "the researcher's subjectivity can enable her to accurately comprehend the world as it exists in itself".

3.6 Limitations of the research design

There are certain limitations applicable to this study. Firstly, this study investigates the topic purely from the agri-firms' perspective. It is beyond the scope of this study to analyse what the retailer thinks it should do and why. This thesis instead contributes to a systematic understanding of agri-firms adaptive behavior as it aims to explore where the retailer should not intervene (Feola et al., 2015). Feola et al. (2015) argues that this is important to avoid wasting resources on proactive adaptation policies where bottom-up adaptation (i.e. autonomous) is already effective. A further study focusing on the retailers perception would therefore be of interest to complement this study. Secondly, due to the transdisciplinary nature of the study, a personal bias of the respondents towards Woolworths and M&S must be acknowledged. Lastly, the research was conducted during a particularly bad El Nino event (July 2016) and therefore participants perceptions of climate change could have been influenced by the event. In some instances the El Nino was seen an example of drought related risks in the future.

3.7 Ethical consideration

In compliance with the University of Cape Town's research ethics, ethical clearance was applied for, and the approval is provided in Appendix A. The following steps were taken to ensure the anonymity of the agri-firms: Prior to the interview, the full scope of the research project was explained to the respondent. This included making them aware that at any point they could withdraw or decide not to answer. Furthermore, interview transcripts were redacted so as to reinforce the anonymity of the agri-firms (included the removal of any mention of specific commodities, geographical locations and names).

3.8 Conclusion

The aim of this thesis led to an exploratory qualitative research design that involved the use of semi-structured interviews and observations to research the case study. Whilst case study methodology has inherent weaknesses, multiple agri-firms were used to find patterns that could generate theories. Ultimately the research design highlights that this thesis can "hint" at an answer and use the findings to recommend areas of priority for further research.

Chapter 4: Results

4 Results

4.1 Introduction

In reporting results for case study research it is important to "enable the reader to feel as if they had been an active participant in the research and can determine whether or not the study findings could be applied to their own situation" (Baxter and Jack 2008:555). The results therefore deal with each agri-firm separately and present the evidence for all the objectives beginning with objective i) how the agri-firms responding to climate risks, proceeding to objective ii) what barriers the agri-firms facing to proactive adaptation, and ending with objective iii) how the agri-firms perceive the retailer can play a role in enabling proactive adaptation at the farm-level. The concluding section in conjunction with Tables 2 and 3 (below) provide a succinct summary of the results. Many of the adaptation measures were common across the agri-firms. These were often sustainability measures that ensured sustainable management of soil and water. For example, all of the agri-firms used technology to manage water sustainably, including drip irrigation and probes. These types of strategies will not be repeated for each agri-firm, unless something unique was found. Furthermore, the results are limited to an extent as they are based on what the respondent said in the interview and from personal observation during farm-visits (i.e. some adaptation measures may have been missed). For example, whilst some of them had extensive research facilities, few mentioned the work they were doing in this area.

4.2 Agri-Firm 1 (primarily citrus)

Climate risks and response measures

The respondent argued that water availability (e.g. drought) and excessive heat (resulting in sunburn) and any of the climate extremes (e.g. hail) were a risk to their operation. In response to sunburn, Agri Firm 1 had established a total of approximately 100ha netted citrus with the netting inducing a more favourable microclimate with less sunburn. An additional motivating factor to invest in this technology was also to reduce wind and hail damage on the fruit, resulting in "95%

packouts on some of our fruits under the nets". But the nets themselves pose other challenges as the agri-firm had ended up with pest repercussions because of the new microclimate (e.g. increased life cycles due to higher temperatures).

For water availability, the agri-firm consistently assesses soil moisture to manipulate tree physiology to encourage fruit set and improve quality. In drought periods, the agri-firm drills for underground water reserves and forgoes a certain amount of hectares on old orchards (i.e. to look after young orchards that use water more efficiently).

Barriers to proactive adaptation

The multi-stressor environment was the forefront of the respondent's mind, with labour, water competition, market stability and land reform listed as top risks. The challenges with water were largely to do with a lack of integrated water catchment management and competition for water rights between domestic, agriculture and mining sectors. For example, the respondent said that the river the farm extracts water from was completely overallocated. Challenges around land reform had to do with the potential introduction of policies such as the 50/50 framework and land caps[15], making the long-term investment environment unstable[16]. As a result, climate change was not a priority **(i.e. institutional barrier).** In addition, the respondent was uncertain as to what risk climate change posed to his operation and argued; "I'm not a climate fundi, I believe it does exist" and "I think that with climate change we are going to see more and more extremes". According to the respondent, any increase in rainfall would negatively affect the citrus's internal quality and pose more of a risk to fungal diseases and pests. Whilst the respondent said he was interested in planning

[15] Land caps propose a maximum of 1000ha for small scale farmers, 2500ha for a medium scale commercial farm and 5000ha for a large scale commercial farm. The 50/50 policy framework is concerned with the rights of the people who work and live on the farms. Essentially, it is a policy that intends to redistribute 50% of the ownership of the land and farming operations into the hands of the workers who have lived and worked on the farm.

[16] These issues were common for some of the agri-firms and will not be detailed for each agri-firm.

ahead for climate change, when asked how far into the future their operation would like to plan for, he was uncertain (**i.e. organisational barrier**).

Further expansion of nets was difficult based on the cost of the nets (R R150 000-R180 000/ha) **(i.e. financial barrier)**. Coupled to this is the fact that decision-making in the agri-firm is done by shareholders who are largely interested in short-term return on investments instead of longer-term investments leading to proactive adaptation benefits **(i.e. organisational barrier).** The respondent argued that the nets pose challenges as the microclimate creates pest repercussions. To combat this the respondent said that the agri-firm had to spray more to justify the cost of the netting to the shareholders. This shows that adaptation measures are costly and often lead to unintended consequences or additional cost.

Whilst difficult to define as a barrier, the respondent felt that the demand/ pressure to produce the "perfect fruit" was challenging. This is because the agri-firms needed to simultaneously deal with the projected increase in pest and disease distribution/frequency due to microclimate and the reduction in maximum residue limits by many retailers (e.g. Lidl requires a limit of five active ingredients present in small quantities on citrus). The barrier here is related to the lack of funding for research in less harsh pesticide regimes **(i.e. supply chain barrier)** and the uncertainty of moving to a spray regime that might not deliver the same yield as before, a problem for shareholders **(i.e. organisational barrier)**; "Our directors and shareholders want us to have that clean fruit. It's opening up that whole debate - how can we get there without having all of those sprays or by using softer chemicals. At the moment, we can't do without the spray otherwise we will get damage. But I know that we can – it might need more tractors and spray machines, but there are means and ways" and "the directors might come fire me. The safest route is just to put on the standard chemical programme, which is not the answer. The bottom line is we have to maximize our income for our shareholders". He also noted that the consumers **(i.e. supply chain barrier)** had a large role to play "we keep on pointing fingers at the retailer, but the demands actually comes from the consumer". Although he felt that the retailer might use the "perfect fruit" as a marketing tool, he felt that the retailer needed to educate the consumer better and to be less demanding on the agri-firms.

Role of the retailer as an enabler

The respondent felt that a collective solution was needed for adaptation to climate change at the farm-level: "I think with this whole climate change debate, it has to be a community global effort. Everybody has to play a role. Where we are trying so hard to do the right thing, it doesn't help if our neighbouring farmers – that's another threat – if we don't have co-operation amongst everybody". When asked whether the retailer should play a bigger role in risk sharing/ supporting their agri-firm, he replied, "I think certainly FfF does. It's a very positive thing. They forcing us to monitor our water etc. and every time they do an audit we have to show that we are improving and that our environmental strategies are being revised all the time". The programme therefore seemed to be increasing adaptive capacity at farm level through enhancing information capacity. To support proactive adaptation, the respondent felt that the retailer should promote sustainable agricultural programmes such as FfF (or the equivalent) to consumers to create a demand for more sustainable produce. In addition the respondent argued "obviously any advice that comes from them on how to improve environmental issues would be great **(i.e. information enabler).** But I don't know if we can do anything more at the moment. But they could keep us, not motivated, but spur us on".

Figure 6: Agri-firm 1: Netting covering citrus in Letsitele

4.3 Agri-Firm 2 (primarily avocadoes)

Climate risks and response measures

Hail and drought were of concern to the farming operation. The agri-firms response to drought conditions stem as far back as 1944 to a man who implemented a catchment management plan. He selected one spring to begin with in which alien trees were eradicated and no agricultural development was allowed. Where severe erosion was taking place, contour furrows were made and indigenous trees and grasses were planted. The conservation methods he implemented now ensure that streams flow even during drought periods.

To protect against hail, the agri-firm had adopted three measures: diversification, hail nets and financial insurance. Diversification both geographically and commodity wise, was deemed an effective method of self-insurance. Although they are geographically spread, they had a hail event that affected all farms significantly; “If it hadn’t been for our timber side of the business we would have been in a very difficult situation”.

Agri-firm 2 were the only firm that was collaborating with a retailer on shade-netting programme. Woolworths assisted the agri-firm through investment in 1ha-3ha of netting on avocadoes. Ideally, every fruit sold to them grown under the netting would receive an additional premium to aid the funding of the nets. However, the collaboration was not successful as it was not financially feasible. To make nets viable the avocadoes trees need to be low enough which means that they also need to planted close together. Traditionally trees are not planted so close together so the agri-firm had to plant from scratch to suit the netting requirements. In addition, an avocado crop only starts producing after its fourth year of growth, which essentially means that the agri-firm would not see a return on investment prior to that period.

Barriers to proactive adaptation

There were many proximal issues to deal with that climate change was not seen as a priority for agri-firm 2. For example, "there are a lot of short term variations that you are trying to manage that you don't even want to – I'm not saying we want to put our heads in the sand about climate change, but there is enough going on to keep us busy". The respondent instead felt that the exchange rate and market competition posed the highest risk to their operation **(i.e. institutional barrier).** Another barrier was the respondents uncertainty around climate change projections **(i.e. organisational and information barrier)**: "they probably could be useful if we knew that we could rely it and trust it and make decisions on them. We probably haven't even got to the point in trying". This uncertainty constrained their ability to make decisions. For the shade-netting programme with Woolworths inadequate research on netting certain avocado varieties (e.g. what crop density is required to maximise yields) resulted in an **(i.e. information barrier)** underestimation on the profitability of such a project (R350 000 – R400 000/ha).

Role of the retailer as an enabler

The respondent initially felt that the role of the retailer had more to do with mitigation against climate change, (e.g. installing solar powered lights in their stores). For adaptation, the respondent felt that the retailer could play a larger role in highlighting the importance of South African supply to international markets and government.

"The fact that its good quality fruit, it's a reliable source, it's a nice country to work in and live in and all that". This was a vague response but it seemed that the respondent was pointing to support in enhancing institutional capacity to support the agri-firms in their multi-stressor environment (**i.e. institutional enabler**).

4.4 Agri-Firm 3 (vegetables)

Climate risks and response measures

Agri-firm 3 pointed to hail as being the largest threat to their operation. He argued that the climate was getting more unpredictable: "had a bit of hail here and there for 25 years, but it wasn't a risk. Two years ago we had hail five times and it was heavy and bigger. I don't know if this is the kind of thing we are going to get in the future. The open field was totally gone and some of the structures collapsed because of the associated wind". He was also the only one to include weather as one of his top five risks as a significant hailstorm in 2014 wiped out a large percentage of their crop. This event motivated them to adopt a covered hydroponic system[17]. The hydroponic system had also intensified vegetable production significantly whilst using significantly less resources. For example, it took eighty percent less water to grow one head of lettuce than if it was growing in the open field. When asked what the return on investment on the system was, the respondent argued that "We didn't even try to calculate when we faced the disaster of two years ago – it wasn't a question, it was a question if you wanted to survive or not".

Barriers to proactive adaptation

There were minimal barriers faced by Agri-firm 3. The respondent argued that they had a poor relationship with their industry body (**i.e. supply chain barrier**). This poor relationship, however, in reality did not constrain them; instead they had invested significantly into a hydroponic system (R27 million) and were building an additional hydroponic structure next door. However, he was uncertain whether the structure was even effective against climate: "you don't know exactly how it will affect you personally. We are trying to do as much as we can to protect against

[17] The plant roots are not immersed in the soil but in a nutrient solution.

climate change – and that's it. And any technology that is relevant to make us safer we will definitely go for it". Finances were therefore not a constraining factor.

Role of the retailer as an enabler

The respondent was very hesitant to accepting that the retailer would have incentive to help in supporting adaptation at the farm level, echoed by "help in return for what"? He argued that the agri-firm preferred to stay independent; "no, you do what you do, and I do what I do". The respondent also argued in many instances that the retailer created difficulties for him. For example, he felt that the retailer was making sure their suppliers were not in good relationships with each other, which was creating chaos between suppliers to ensure that they are always competing against one another. This can create a barrier to proactive adaptation as learning and knowledge sharing between actors is an important aspect of behaviour change (**i.e.. agri-supply chain and information barrier**) (Smit and Pilifosova 2011).

Figure 7: Agri-firm 3: Hydroponic system for vegetables in Babsfontein

4.5 Agri-Firm 4 (vegetables)

Climate risks and response measures

Agri-firm 4 pointed to hail and frost as being a significant threat to the farming operation: "in between 1998-2003 (5 years) we had total crop loss of 4 years (hail and frost)". To respond to hail and frost, agri-firm 4 had implemented trial netting on 10ha to protect against hail and frost, but was still uncertain as to the benefits. For example, "we are looking at putting nets over 1 hectare of vegetables. We are looking at whether there are any other benefits except hail and frost. It might be important for sunburn and wind damage, not sure".

Agri-firm 4 had diversified both geographically and commodity wise: "Up in our area we can get a lot of late frost. That's why we have such a broad variety of cultivars and areas of farming to spread our risk (late frost is out of our control and over one night we can get total crop loss)". They had also implemented incremental adaptation changes by choosing hills to plant their deciduous fruit on hills which were 2 to 3 degrees Celsius warmer than the lower areas used for vegetables (significantly removing the risk of frost).

Agri-firm 4 had also adopted financial insurance, which had saved them in the four years of total crop loss.

Barriers to proactive adaptation

The respondents top risks included labour issues, production costs increasing and land reform **(i.e. institutional barrier)**. The respondent felt that climate change posed a low risk to his operation: "I don't have the statistics to say it is so, or not so". Instead he saw the opportunities that it posed "But in a friendly way, if temperatures on average go up by 1-2 degrees C it will benefit our farm". The respondent also felt that the cost-benefit of adaptation measures such as netting was difficult to justify as the decisions to implement them were based on insufficient information **(i.e. information barrier)**. This was also in line with his feeling that there was a lack of funding for research on technology by government **(i.e. technological barrier).**

Role of retailer as an enabler

The respondent was adamant that sustainablity measures were key to adapting to environmental change issues and kept referring to ZZ2's Natuurboerdery[18] as the way forward. He was not part of the programme but recognized the benefits that it delivered (e.g. increase yield per ha). As a result, the respondent felt that the retailer could opt to fund research or implementation of programmes such as Natuurboerdery (or its equivalent) (**i.e. information enabler)**. He felt that he could not afford the technical teams and labs that ZZ2 has developed and argued that this is where the retailer could help. In addition, the respondent felt that the retailer could play a role in research and co-funding of nets which, according to the respondent could control for pesticides, hail and frost at once.

4.6 Agri-firm 5 (apples and pears)

Climate risks and response measures

Agri-firm 5 argued that seasonal shifts were a risk to their productivity echoed in the following statement: "autumn is coming later for us. It's not only us. Springtime is when our trees wake up and it's when they are most vulnerable to disease and we are finding wetter springs. That is definitely something that we have picked up. Whether it's a long term or short term thing we don't know".

Agri-firm 5 responded to climate risk through geographical diversification, research and spraying more appropriately. Diversification was an extremely effective self-insurance mechanism to the agri-firm as there would be no climate risks that would be able to wipe them out. Their research component was also significant with investment in breeding (including looking for new varieties with more resistant genes); "we invest into a research organization. So our long-term research is focused on these

[18] According to ZZ2 (2016:online), "agricultural practices and processes founded in Natuurboerdery are aimed at using the best technology in harmony with the laws of living nature, of which the most important are probably efficiency and adaptable sustainability. It can also be described as moving away from "hard" industrialised farming concepts by including more sensible concepts of organic farming".

challenges – recognizing that we can't keep spraying and that we need to look at different techniques".

Barriers to proactive adaptation

National political uncertainty arose as a significant stressor **(i.e. institutional barrier)**, resting largely around water availability and land reform: "political risk is a big challenge for us because its unknown and chops and changes. If you had to ask any grower it would be one of the bigger risks. We are concerned about the uncertainty". Climate change also posed a low to medium risk to the respondent, largely based on the uncertainty of the climate change projections **(i.e. information barrier):** "the biggest challenge that we have is working out from the specialists is how we are going to get impacted. We are part of the Smart Agri project, so I work with Peter Johnston and I know all their forecasting predictive models (I think there are 8-9) and there is no consistency in those models". Financial insurance was deemed far too expensive and was echoed in the following statement: "the premium just goes higher the more risky you are. It has become unaffordable. And I see you taping that – you can tell them that it's become unaffordable" **(i.e. financial barrier)**.

Retailer as an enabler

Although dependent on industry bodies for research, the respondent felt that the support and funding from government for climate change adaptation research was inadequate. As a result, the respondent felt that the retailer could invest more directly in industry research structures, because they are already well managed and controlled **(i.e. information enabler)**. However, he also argued that the retailer needed to be aware that the research would need to be open to everyone: "What we have had in the past is that the retailer wants user pay research. But that's a very specific research for a very specific reason. But industry wide we need more funding to assist research. And at the end of the day, its often things that impact on them all. It's a lot to do with sustainability of the soil and water that we all need to focus on".

The respondent also argued that the retailer needed to participate in climate change discussions to ensure that they understand the impacts. The respondent was worried

that if the retailer was not well informed on the impacts of climate change, then they would source from other countries: “in a number of these organized industry things, I do see one or two retailers sitting in which is very positive. We need more knowledgeable input. They need to understand what is going on”.

4.7 Agri-firm 6 (figs, blueberries and cherries)

Climate risks and response measures

The most significant climate risks to agri-firm 6’s operation were hail, frost and wind damage. As a result they had adopted shade netting and plastic sheeting to protect against frost and wind damage for one of their high value crops (blueberries). Agri-firm 6 was also producing figs in a climatically controlled building that removed the risk of pests, disease and extreme weather events. For Agri-firm 6, their motivation to invest in a climate controlled structure for figs and adoption of shade netting was triggered by weather extremes and the fact that blueberries, figs and cherries are a high value crop. As argued; “two to three years of a little bit of frost in the low lying areas, and then the one year we had a bit of ice rain which just made little marks which is just enough to make the crop not that easy to pack. So we just decided that there is no ways we can take a chance. It is such a high value crop that you have to do something. And being a high value crop it just makes paying off your investments on crops that much easier”. This shows that they were more willing to make financial investments on protective infrastructure because the high value crop contributed to a quick return on investment.

Barriers to proactive adaptation

Whilst the top five risks to agri-firm 6 included political uncertainty, market related pressures (e.g. exchange rate) and technological risks, agri-firm 6 was the only respondent to mention climate change as one of the five key risks to their operation. Technological risks had to do with the fact that government was not funding enough research on technology research and development, which the respondent felt, was necessary to remain competitive. This implied that he had prioritised climate change as a risk. He was however uncertain of climate change projections **(i.e. information**

barrier); “some of the projections that we’ve seen says that this area is going to be wetter than normal which suits us a little bit because its dry. He also recognized that climate change might result in opportunities for him; “more extreme winters causes less pests to survive through the winter. So there are ups and downs about everything”.

Role of the retailer as an enabler

When asked whether the retailer should play a role in creating an enabling environment at the farm level, he responded that it would be helpful. To do so he argued that they could provide financial back up in erratic weather conditions **(i.e. financial enabler)**. He argued that the retailer collaborating on shade-netting schemes was a good finance option (as one can organise a pay back scheme) as he’d heard success stories from his neighbours: “I think if it’s a win-win for both parties then why not. Best still is to have your government look after you and subsidise certain things. If climate change is a huge problem and creates drought in that area then there should be drought support”**.**

The respondent also argued that Woolworths had built really good relationships with their growers and even provided the agri-firm with a grant to develop and bring in peach and nectarine varieties from Florida into their operation. The respondent felt that the retailer could provide dispensation on fruit size or marks; “Woolworths used to say that if you could close the mark with your thumb on the peach they would still accept it. And I think that’s gone out of the window”. This is another example of the respondent indicating the producing the “perfect fruit” was challenging.

Figure 8: Agri-firm 6: Netting for blueberries in Rustenberg

4.8 Summary

How the agri-firms are responding to climate risks

There was a general perception that the weather has become more erratic and extreme over the past 5-10 years pointing to the increasing variability and unpredictability of the agri-firms' local climate, despite the fact that they all produce in different parts of the country (Table 2). The climate risks faced by the agri-firms show that the majority (five) saw climate extremes as problematic (and not seasonal shifts for example). However, few pointed to the specific risks of climate change associated to their produce as outlined in Section 2.3 in the Literature. Table 2 shows that the perception of climate change differed dramatically between agri-firms, with some perceiving it as a low risk and others perceiving it as a high risk. The risk also differed between the two vegetable farmers, an indication of the geographical heterogeneity of climate impacts (e.g. Gbetibouo and Ringler 2009). Some of these perceptions were based on recent experience of extreme events and others on climate change projections for their area.

Whilst some of the agri-firms were still uncertain of the risk that climate change

poses, they had all implemented measures to ensure protection against climate risks. As there is no single or optimal way of adapting to climate change or managing climate risks (O'Brien et al., 2012:449), a wide variety of responses were evident that included technological, land use management changes and financial mechanisms (Smit and Skinner 2002) (Table 2). This variety of the adaptation measures also reflects the heterogeneity of decision-making options (e.g. Belliveau et al., 2006). None of the agri-firms pointed to government programmes as driving proactive adaptation on their farms. What was evident as seen in Table 2, is that sustainabity measures were common across all agri-firms (e.g. soil and water protection), some driven by retailer and international audits (e.g. Global Gap, FfF). The next most common adaptation strategy had to do with technology and included adoption of shade-netting and drip-irrigation.

Table 2: Summary of stresses, climate risks, perception of climate change as a risk and proactive adaptation measures adopted by the agri-firms

Agri-Firm	Main Commodity	Top 5 Risks	Biggest perceived Climate risk	Climate change a risk?	Farm Finance	Technological	I
Agri-Firm 1	Citrus	Water availability, labour, market and land reform	Drought and Excessive heat	Uncertain	Self-Insurance through investments in portfolios	Shade netting (100ha), research and lab facilities, seasonal forecasts, drip irrigation	C d s n
Agri-Firm 2	Avocadoes	Exchange rate, market oversupply, electricity	Hail	Uncertain	Financial Insurance	Trial shade netting (10ha), research facilities, drip irrigation,	d d v r s n
Agri-Firm 3	Vegetables	Weather	Hail	High	Self-insurance through investing in hydroponic system	Hydroponic system	S n s n
Agri-Firm 4	Vegetables	Labour, production costs increasing and land reform	Frost and Hail	Low	Financial Insurance	Trial shade netting (1ha), drip irrigation, seasonal climate forecasts and use of models to plan what time, amount and growing time of the season to irrigate.	D fi w w ri s n
Agri-Firm 5	Apples & Pears	Land reform and availability of water	Seasonal Shifts	Uncertain	Self-Insurance through geographical and commodity diversificaiton	Rely less on physical expression of adaptation measures, research and lab facilities, switch to low chill varieties (or more resistant genes), drip irrigation,	D c a s n
Agri-Firm 6	Blueberries, Cherries and Figs	Climate change, market, political, water availability	Hail and Frost	High	Self-insurance through investment in netting and diversification	Climate controlled infrastructure for figs, shade netting for blueberries, use of seasonal climate forecasts, drip irrigation	S n a a p r

Barriers to proactive adaptation

Table 3 provides a summary of the barriers to proactive adaptation according to the determinants as outlined in the literature review (e.g. Smit and Pilifosova 2001). Determinants of adaptive capacity often interact (e.g. financing research looks at both financial capacity and information capacity).

It was evident that the multi-stressor environment was particularly constraining to proactive adaptation, mainly due to the challenge of having so many stresses to manage for and not prioritizing climate change as a risk. The cost of protective infrastructure (e.g. netting) was a constraining factor to three of the agri-firms, with the cost of financial insurance deemed too high by two of the agri-firms. Inconsistencies in climate change models and uncertainty surrounding climate change impacts constrained information capacity and led to difficulties in decision-making. Organisational barriers had to do with shareholders and their short-term interest in the farming operation. Their focus on short-term profit maximization made long-term adaptation costs difficult to justify. As proactive adaptation is largely reliant on technologies (e.g. Fleischer et al., 2011), low technological development in South Africa was also seen as a constraint to technological capacity. The retailer demands for agri-firms to produce the perfect fruit was challenging for two of the agri-firms' as it required more chemical use and thus more investment into research for softer alternatives.

Table 3: Summary of the perceived barriers and perception of how the retailer can play an enabling role in proactive adaptation.

Adaptive Capacity Determinant	Barriers	Perception of enabler
Institutional	Policy uncertainty that makes it difficult to plan ahead (e.g. water competition) (3) Multi-stressor environment which is often prioritised thereby lowering climate change awareness (5)	Highlight importance of South African agriculture to government to address uncertainty related to water policy and land reform (1)

Financial	High cost of netting infrastructure (3)	Co-fund implementation of nets through collaborative partnerships to strengthen on-farm experimentation (2)
	High cost of financial insurance (2)	
Information and Knowledge	Uncertainty on climate change projections and impact (3)	Fund research on sustainability measures to promote ecosystem restoration (2)
	Lack of funding for research by government (3)	Invest in existing industry research bodies (1)
		Retailer needs to participate in climate change discussions to ensure that they make informed decisions on procurement policies (1)
Organisational	Shareholder short term interest constrains long-term thinking (2)	
Technological	Low technological development in South Africa (1)	Support technological development to remain competitive (1)
Embeddedness in agri-supply chain	Producing the perfect fruit with lower maximum residue limits (2)	Inform consumers on sustainability measures (2)

How the agri-firms perceive the retailer as an enabler

Agri-firms were hesitant in answering the question "how can the retailer play an enabling role?" This was because the agri-firms were wary of the retailers' motives (i.e. who truly benefits). There also seemed to be a misalignment between what the respondents perceived as barriers and how they perceived the retailer to help overcome those barriers (see Table 3). For example, where Agri-firm 1 felt that cost was a significant barrier, instead of suggesting that the retailer could help financially (e.g. co-funding research) they suggested that they should better promote sustainable agriculture programmes (e.g. FfF) in store to inform consumers. How they viewed the retailer could also suggest what barriers they thought the retailer could address. For example, agri-firm 3 seem to have a strained relationship with a retailer, and therefore did not perceive them to play a role as an enabler. There were, however, a variety of suggestions on how retailers can help that emerged from the results. Many

of these were in line with Macfadyen et al. (2016), but were far more specific and relevant to a South African context (Table 3). The respondents pointed to five determinants of adaptive capacity in which the retailer could have an influential role in proactive adaptation - institutional, financial, information, technological and within the agri-supply chain (e.g. consumer awareness).

Chapter 5: Discussion

5 Discussion

5.1 Climate risks and response measures

The response measures by the agri-firms were for the most part autonomous. Many of the adaptation responses can be described as having the ability to "reduce the risks and capitalize on the opportunities associated with climate change" (Fussel 2007). For example, Agri-firms 3 and 6 adaptation responses were particularly resilient as the infrastructure removed the risk of impact of most climate extremes typically found in South Africa. However, many of the adaptation responses by the agri-firms cannot be classified as proactive, as they were not done in anticipation of climate change (IPCC 2014; Mendelsohn and Dinar 2009:67). For example, Agri-firms 3 and 6's past experience with climate variability played an important part in long-term decision-making, a similar finding to Ziervogel and Wiid (2015). The challenge of classifying actions as proactive is, however, difficult if one only uses climate change as a point of reference as adaptation responses can be see as risk reducing to many other stresses such as climate variability or water policy uncertainty. However, not planning for the risk of climate change (even with all the uncertainty it poses) could lead to maladaptation (Magnan 2014).

A significant gap identified by the agri-firms' was the lack of government policy, which are important drivers of proactive adaptation as highlighted by Smit and Skinner (2002). Government extension services in South Africa focus primarily on smallholder farmers, with the perception that agri-firms can manage climate change themselves (Van Bormann and Scholtz 2016). Larger transformations in agriculture are very high risk and therefore, in many cases, government is needed to share this risk.

5.2 Barriers and role of retailer as an enabler to proactive adaptation

5.2.1 Financial

Cost of netting infrastructure was constraining but was more related to the cost-benefit of the adaptation measure (Kolikow et al., 2012). Increased research on technologies that optimize farming practices according to changing climatic conditions (DEA 2013) is necessary to reduce uncertainty around cost-benefits of technologies. In addition increased use of integrated models might help with evaluating cost-benefits of adaptation (e.g. Louw 2012). This would have a significant effect on decision-making as the agri-firms (and particularly shareholders) are primarily concerned with profit maximisation.

The suggested mechanism to enhance financial capacity was for retailers to co-fund implementation of nets at the farm-level through collaborative partnerships to strengthen on-farm experimentation. This could be an effective mechanism to share risk and add value to both parties. It often requires long-term contract agreements in which the agri-firm is required to sell the produce under the nets to the retailer. This is an advantage as the retailer ensures security of supply and the agri-firm ensures sales. Furthermore it is in line with Thorpe and Fennel (2015) who suggest that building stronger relationships is important. This can be seen as a form of quasi-vertical integration which is defined as "a long-term contractual obligation in which both the buyer and seller have invested resources in the relationship. It differs from full vertical integration because the relationship ceases at the end of an agreed period of time and the firms remain independent entities" (Hobbs and Young 2001:11). However, the challenges as highlighted by agri-firm 2 concerning a partnership with Woolworths indicate that research on shade-netting specifics (e.g. dimensions, material, crop density) is required before such initiation of a project so as to minimise the risk of failure. It could also become problematic if retailers only fund shade-netting on high value crops (e.g. blueberries and cherries) because the return on investment is so much quicker and higher. Although farming these high value crops contributes to employment in the country, their influence on food security (these types of food are unaffordable to low-income households) is low. Here the concept of sustainability is important to incorporate into decision-making as well (Smit and

Pilifosova 2001; Howden 2007), rembering that it encompasses three pillars including social justice, environmental protection and economic development.

5.2.2 Organisational

Uncertainty around cost-benefits of adaptation measures seemed to be a major barrier to agri-firms. However, functioning in a multi-stressor environment (Ziervogel and Taylor 2008), agri-firms manage for uncertainty constantly (e.g. market, exchange rate etc.) and therefore one would assume they have a high capacity to manage for the uncertainty of climate change. In addition there are many tools to use to overcome uncertainty (Ramalingam et al., 2008; e.g. scenario planning). Interventions are therefore needed to enhance interest in proactive adaptation. As there seemed to be no climate change 'champions' in this study (Vermeulen et al., 2013), decreasing the information usability gap to ensure that information is useful for decision-making could prove essential (i.e. information capacity) (Kalafatis et al., 2015).

For organisational capacity constrained by short-term interest of shareholders, no direct enabler was mentioned by the agri-firms. The King Code of Corporate Governance Report states that "current incremental changes towards sustainability are not sufficient – we need a fundamental shift in the way companies and directors act and organise themselves" (King Code of Corporate Governance Report 2009:9). Climate change should definitely be an issue for shareholders as policy changes (e.g. National Climate Change Response Paper) are likely to be mainstreamed and civil society bodies are engaging governments and businesses on climate change actions (Investec 2011). Shareholders should also recognise that retailers are concerned, and will therefore aim to have the most climate resilient supply chain. If these shareholders are slow to act, it could result in lower returns further down the line.

5.2.3 Information and Knowledge

The results suggest that uncertainty around climate change impacts and projections seemed to be a significant barrier for the agri-firms as "embracing uncertainty often clashes with the traditional management idea that seeks to eliminate it" (Pereira et al., 2013:134). However, none of the agri-firms pointed to the retailer as funding research in this domain. Again, whilst the uncertainty of climate change projections is

challenging (similar to the cost-benefit uncertainty of adaptation measures), Fussel (2007) argues that "if low-regret or no-regret options exist, proactive adaptation does not necessarily depend on reliable climate impact projections".

The first mechanism suggested to enhance information capacity was for retailers to fund research on sustainability practices. The results suggest that some agri-firms conflated the concept of sustainability and climate change adaptation. This is not necessarily a negative thing as Smit and Wall (2005) illustrate that the two are mutually supportive. In addition, it is in line with Macfadyen et al. (2016) who argue that retailers need to ensure that agri-firms protect water resources and mandate practices that maintain and restore soil resources for global agri-supply chain resilience. Sustainability programs like FfF provide important knowledge on sustainable water and soil management practices, although they are not so focused on climate change. In addition, some programmes like FfF have created good relationships between the retailer and agri-firm, an advantage in knowledge sharing and co-learning (e.g. also evident in Methner 2013). Building on this existing relationship in the sustainability arena could be a practical platform for retailers to incorporate more proactive adaptation thinking into the agri-firms operation. If funding comes from the retailers end and focuses on the more proactive measures, agri-firm shareholders might be more willing to incorporate climate change adaptation into their risk management plan.

The second suggestion was that retailers could invest directly into industry research bodies. Industry bodies are effective in many ways, but primarily focused on a particular industry. Investing in industry research bodies could be feasible for the retailer if they find that a certain supply chain is particularly vulnerable. What is important is that the financing has specific mandates to address proactive adaptation in a holistic manner taking into account the multi-stressor environment that that particular industry might be facing (Howden et al., 2007). This is important as "conventional insular agricultural research is increasingly inadequate in the face of growing complexity and uncertainty" (Rickards and Howden et al., 2012:247). However, investment in research from agri-business is increasingly confidential and intended to increase competitive advantage. Government funding is therefore so important in order to generate knowledge for public use.

The agri-firms final suggestion on how to enhance information capacity had to do with the retailer keeping informed on climate change issues. It is necessary for retailers to participate in climate change discussions alongside the agri-firms so that knowledge sharing and a deeper understanding of the complexity of climatte change impacts is promoted between the two. This also ensures that a top-down approach does not prescribe the agri-firms what to do, but instead the retailers understanding is influenced by on the ground experience. On the other hand, it seems that some retailers are aware of the risks (e.g. Woolworths, M&S, ASDA) and participate quite proactively on climate change discussions to the extent that they are researching climate change's influence on their agri-supply chains. In the end, the "retailer" is comprised of many employees and agri-firms need to ensure that they understand the ethos of a particular retailer before assuming that the one employee sitting in on the discussion has the final say. This is an area where trust building between the two is important to ensure that information and knowledge are shared (Kalafatis et al., 2015), instead of assuming the worst.

5.2.4 Technological

Technology is highlighted as a key adaptive strategy and therefore should be seen as critical for agri-firms to remain resilient. Technologies adequate for South African climate risks are however not readily available due to low investment in research and development. This is typically a role that government should fulfil (World Bank 2009) and would be advantageous as it could provide employment opportunities and encourage agricultural investment (Bryan et al., 2009). The literature review, however, highlighted that even if the technology is available, it does not always mean that the agri-firm will adopt it. This then links back to organisational capacity and shareholders impact on long-term decision-making on more costly technologies.

The respondents felt that the retailer should play a role in supporting technological development. Many retailers do support technological research and development so long as it benefits their needs at the time. As the retailer becomes more concerned about climate change, it is likely that their research interests will naturally move in the climate change adaptation direction. Supporting (financially or technically)

technological development has short-term and long term benefits. On the short-term innovative technologies can increase quality and year round consistency (Dolan and Humphrey 2001). On the long-term innovative technologies have the potential to introduce more transformative change for agri-firms, often seen as necessary due to the rate of climate change (Rickards and Howden 2012).

5.2.5 Institutional

Two of the respondents perceived that the retailer should use their position of power to highlight the importance of the agricultural sector to government. The problem is that the respondents' perception was not necessarily linked to government increasing their adaptive capacity. For example, they did not explicitly say that they wanted the retailer to influence climate change adaptation policy or disaster risk policy. However, they did argue that a lack of proactive water catchment management and strong competition for water rights between agriculture, mining and domestic use was an issue for them. Because irrigation demand is projected to increase in many parts of the country, policies relevant to water management (e.g. catchment management agencies) are critical for successful proactive adaptation. Asking the retailer to influence government is no easy task, if not near impossible. In fact Woolworths' deciding factor to implement sustainable water programmes was because of the inefficiency from governments side (i.e. they could not simply wait and see). Therefore in many regards the agri-firms perception of the retailer as playing a role in institutional capacity is wishful thinking.

5.2.6 Embeddedness in agri-supply chain

Some of the respondents perceived that the retailer should use their position of power to influence consumers' awareness on sustainability practices (e.g. FfF) and consumers' perception of what constitutes the "perfect fruit". It seemed at first that the respondents were pushing for the retailer to be less demanding on production of the "perfect fruit" and then linking it tangentially to climate change to get more traction. However, if the retailer weren't so demanding (as a result of the consumer), agri-firms would not be so dependent on agri-chemicals, set to become a significant challenge due to climate change (DEA 2013). In the future society might need to decide whether less "beautiful" fruit but that is climate-smart (e.g. drought resilient) is

a better path. Macfadyen et al. (2016:6) also argue that for global agri-supply chain resilience, retailers should "educate consumers to recognise and accept cosmetic damage to fresh produce and to focus more on the health and environmental aspects of food". A conversation with Kobus Pienaar (FfF Technical Manager) after the interviews indicated that Woolworths had created in a section in one of their stores that sold 'imperfect' fruit (e.g. marks on skin but good quality) at almost half the cost as the 'perfect fruit' with mixed success. Consumer behaviour is unlikely to shift quickly and therefore long-term marketing strategies are required should this be identified as a potential avenue.

5.2.7 Implications

Autonomous adaptation by the agri-firms was effective, particularly incremental and systematic adaptation measures. To avoid wasting time and effort, the retailer would probably be more useful in facilitating more systematic and transformative adaptation, and not incremental responses. This explains why some of the agri-firms' responses look at the retailer as playing a role beyond any one particular agri-supply chain (e.g. government). One of the key benefits of playing a more supportive role at this level is that the retailer might be able to influence multiple barriers for the agri-firms (Rickards and Howden 2012). In addition, their influence at this level would enable a wider variety of agri-firms to adapt proactively instead of only those connected to specific retailers.

The agri-firms presented a number of climatic and non-climatic challenges to proactive adaptation. This suggests that an integrated, holistic and multi-disciplinary solution is necessary to be become more resilient as "achieving increased adaptation action will necessitate integration of climate change-related issues with other risk factors, such as climate variability and market risk, and with other policy domains, such as sustainable development" (Howden et al., 2007: 19691). Whilst the retailer has been identified as a potential enabler, the involvement of a number of diverse actors, including government, could lead to a more dynamic adaptation process (see Fujisawa et al., 2015). The South African government needs to play a more significant role at policy level as there is significant evidence that mainstreaming climate change adaptation is critical to proactive adaptation (Fussel 2007; Ziervogel et

al., 2014). However, it seems that, for now, where government capacity is low or government is unwilling to step in, retailers might have to come to the party similar to the way that Woolworths could not have a “wait and see” attitude and implemented their FfF standards.

Chapter 6: Conclusion

6 Conclusion

The literature review focused on South African agri-firms coping capacity and their risk of "double exposure". Whilst agri-firms are accustomed to managing climate variability and generally have high coping capacity, the study explored why more proactive adaptation might be necessary to manage the impacts of climate change. The sustainable supply chain literature indicated that the retailer is in a strategic position to influence both supply and demand and thus have a powerful effect on the capacity of the agri-supply chains to proactively adapt to climate change.

The aim of this thesis was therefore to explore the role of the retailer as an enabler in proactive adaptation to climate change at the farm level in South Africa. To do this the thesis was structured around three objectives, i) to identify how the agri-firms were responding to climate risks, ii) to identify the perceived barriers to proactive adaptation, and iii) to identify how the agri-firms perceived the retailer to play a role in overcoming those barriers (identified in objective ii).

The objectives were explored using a qualitative research approach and looked at six agri-firms in South Africa. The study looked only at the agri-firms' perception on the retailer as an enabler. This was deemed as an important first step so as to avoid wasting time and effort on the retailer facilitating proactive adaptation at the farm-level where bottom-up adaptation (i.e. autonomous) might already be effective.

For objective i), there are only a few examples in the respondent's answers which indicate an understanding that climate change may alter their risk profile. The findings showed that the agri-firms were adapting autonomously to climate variability for the most part, with the majority having implemented incremental adaptation measures. For example, Table 2 highlights incremental changes such as adoption of drip irrigation, and systematic changes such as diversification (e.g. geographical) which were both common.

For objective ii), the multi-stressor environment seemed to constrain proactive adaptation as the agri-firms had prioritized non-climatic risks (e.g. market related). In

addition, key barriers to proactive adaptation included:

- Policy uncertainty that made it difficult to plan ahead (e.g. water competition);
- Low climate change awareness;
- High cost of netting infrastructure;
- High cost of financial insurance;
- Uncertainty on climate change projections and impact;
- Lack of funding for research by government;
- Shareholder short term interest constraints on long-term thinking;
- Low technological development in South Africa; and
- The pressure to produce the perfect fruit.

For objective iii), to help overcome these barriers, the respondents suggested that the retailer could play a role in enhancing adaptive capacity of agri-firms. There were more suggestions of indirect support including:

- Highlighting the importance of South African agriculture to government to address uncertainty related to water policy and land reform;
- Fund research on sustainability measures to promote ecosystem restoration;
- Invest in existing industry research bodies;
- Getting the retailer to participate in climate change discussions to ensure that they make informed decisions on procurement policies;
- Supporting technological development to remain competitive; and
- Informing consumers on sustainability measures.

The suggestions for direct support from the retailer included:

- Co-funding implementation of nets through collaborative partnerships to strengthen on-farm experimentation.

Overall the findings showed that agri-firms are either not aware or not concerned about the potential impact of climate change on their risk profile. In addition, they will only really adapt to climate change proactively if the cost-benefit is worth it. However, the findings did indicate that the agri-firms are interested in the retailer playing a more pivotal role in proactive climate change adaptation. Here they are

more interested in the retailers' indirect role in creating an enabling environment by talking to government. This will create certainty about policies that were worrying to the agri-firms', which included land reform, labour laws and water rights. If successful a more stable political environment could then contribute to continued market access, employment opportunities and safeguard food security.

The recommendations for further research include the following:

1. Validation using a quantitative research method should be employed in a further study. Here the qualitative findings can guide the quantitative (Babbie and Mouton 2010) in an attempt to understand the perceptions of a larger sample group of agri-firms in South Africa;
2. Complimentary research should also be done on how the retailer views themselves as enablers and whether their perceptions align with that of the agri-firms in this study. This is important to gain a better understanding of where they can play a role feasibly to avoid wasting time and money for both stakeholders;
3. The role of government as a third partner in increasing the resilience of fresh horticultural agri-chains in South Africa should be researched. This thesis highlighted the importance of the retailer playing an indirect role in proactive adaptation to climate change at the level of government. This should be pursued to understand what specific support is required.

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Appendix

Appendix

Date:	Place:
General	
1. Please describe your role (including areas of responsibility)	
2. How long have you been farming at this company for?	
3. What commodities do you produce/process?	
4. Is there any on-farm processing?	
5. What is your main crop?	
6. Have you expanded or reduced your operations in the last 5 years? Why?	
7. List the top 5 risks that are affecting your farming operation 1. 2. 3. 4. 5.	
Climate variability: the way climate fluctuates yearly above or below a long term average value *Climate Change: Long term continuous change (incr. or decr.) to average weather conditions or the range of weather.* **8.** How much risk do you believe that current climate variability poses to your farming operation? (Rate 1-5: 1 being no risk, 5 being huge risk). (ie. short-medium term) **9.** How much risk do you believe climate change poses to your farming operation? (Rate 1-5: 1 being no risk, 5 being huge risk). (ie. long term)	
Climate Risks and Responses	
1. What 3 climate risks pose the greatest challenge to your farming operation? (ie. what climate risks is your farming operation prone to?)	

1. 2. 3.
2. For each climate risk that you identified, where in the value chain is the impact biggest (e.g. all at the harvesting phase?)
3. Looking at each climate risk, how have you responded? xx. (What percentage of your profits is absorbed by insurance? Is it cheaper to put up nets than pay insurance?)
4. Do you think these responses are working?
5. Do you believe that they will work in the future?
6. Are you interested in planning ahead for the future? How far into the future?
7. Lets look at your responses (or lack thereof), what prevents you from taking more proactive measures to reduce the impact of these climatic risks? ie. What are the key barriers that you face when you try to respond?
8. What support are you receiving currently to face these barriers?
9. What additional support would be helpful for you to manage these risks? (Are they existing, need to be expanded? etc.) What are the enablers? For example: **a.** Disaster risk management? (government, insurance, retailer) (risk sharing) **b.** Financial (banks) **c.** Technical advice? **d.** Reliable climate information sources? **e.** Social networks? **f.** A change in market drivers? **g.** Policy changes?

h. Partnerships? **i.** Any others?
Role of the retailer
1. Who do you supply to? And for each, how long have you been supplying to them? (Describe areas of collaboration, % of products supplied)
2. What are your reasons for supplying to each retailer? (benefits?)
3. What type of contract do you have with the retailers and how much flexibility is there on both sides?
4. How long have you been with the FfF program? Do you think you are benefiting from the FfF program?
5. How dependent do you consider your farm from the contract with the retailers? **6.** Has the problem of "who is in power" come into play? **7.** Do you trust the retailers? Has the level of trust altered during the collaboration? What were the main reasons?
8. (If supplying to more than one retailer, how would you compare your relationships with the retailers?
9. What is the level of information exchange/knowledge sharing? How do you communicate risks/problems with the retailers?
10. Previously you identified certain enablers. Do the retailers play a role in managing these climatic risks? Yes_____ No_____

11. Do you think the retailer should play a bigger role in risk sharing/ supporting you in managing risks and taking advantage of opportunities in the coming years? (How? Determine specific activities on which to act together) (ie. width of collaboration) Yes _____ No _____ How -In General? -In terms of Climate Risks?
12. Out of the 3 climatic risks that you listed, what risk do you think that the retailer can practically help manage in the near future, and which ones should they disregard for now?
Future
1. Where do you feel most uncertain with regards to climate change?
2. Imagine that the future is a good one, unfolding exactly as you'd like to see it. What's happening in this picture? What role is the retailer playing?
3. Imagine that the future is undesirable, unfolding in a way that represents your worst fears. What's happening in this picture? What role is the retailer playing?
General
1. Is there anything more you want to say, any more uncertainties, anything you've not yet touched upon that could be important?

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Enablers and barriers to adaptation at the farm level in the Limpopo and Western Cape Provinces – can the retailer help?

Dear Katherine Smit

I am pleased to inform you that the Faculty of Science Research Ethics Committee has approved the above-named application for research ethics clearance, subject to the conditions listed below. You are required to:

. · Implement the measures described in your application to ensure that the process of your research is ethically sound; and

. · Uphold ethical principles throughout all stages of the research, responding appropriately to unanticipated issues: please contact me if you need advice on ethical issues that arise. Your approval code is: FSREC 33 – 2015 I wish you success in your research. Yours sincerely Dr Richard Hill Chair: Faculty of Science Research Ethics Committee

Cc: Prof Mark New, Nadine Menther, Supervisor and Principal Investigator

Faculty of Science

University of Cape Town RONDEBOSCH 7701 South Africa E-mail: richard.hill@uct.ac.za Telephone: + 27 21 650 2786 Fax: + 27 21 650 3456

23 July 2015

Katherine Smit Department of Environmental and Geographical Sciences

Signed