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Natural Disasters and Agricultural Insurance in the Western Cape: *Status Quo and International Trends*

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List of Acronyms

ARC	African Risk Capacity
CADENA	Componente de Atencion a Desatres Naturales/ Agricultural Fund for Natural Disasters
CRED	Centre for Research on Epidemiology of Disasters
DAFF	Department of Agriculture, Forestry and Fisheries
DRE	Disaster Relief Estimate
FISP	Farmer Input Support Programme
FONDEN	Fondo de Desastres Naturales/Natural Disaster Fund
GDP	Dross Domestic Product
GHS	General Household Survey
GVA	Gross Value Added
MPCI	Multi-Peril Crop Insurance
NGO	Non-Governmental Organization
NDVI	Normalized Difference Vegetation Index
PACC	Programme to Assist Climatologic Contingencies
PPP	Public Private Partnership
PROAGRO	Farming Activity Guarantee Programme
PSR	Programme of Support to Rural Insurance Premium
SA	South Africa
SAIA	South African Insurance Association (SAIA)

1. Introduction

Increasing population and changing climate conditions places added pressure and risk on food and other agricultural systems. To meet projected food needs, sustainable agricultural production calls for improvements agricultural productivity whilst addressing sustainable development goals linked to quality, access and diversity. In the South African context, the agricultural sector has a central role to play in building the economy and employment opportunities coupled with serving as stewards of the natural environment. The National Develop Plan (NDP) and Vision 2030 acts as a guide to policy and actions to meet such goals and responsibilities in terms of unemployment and economic growth, access to services and education, natural resource protection and the eradication of poverty.

Background

The South African agricultural sector has been challenged in recent years in terms of its contribution to gross domestic product and the ability to address unemployment, particularly with regards to integrating smallholder farmers into the economy (Aliber & Hart, 2009). Improved integration of smallholder farmers into the economy has emerged as a key policy focus due to the implications for poverty alleviation and restitution of unfairly marginalised groups (Cousins, 2010). One key reason for the struggle of smallholder farmers is the inability to effectively insure themselves against extreme weather events which threatens agricultural production. This has become increasingly relevant as climate change has led to the increased frequency and severity of extreme weather conditions (Stern, 2007). This means the risk is higher, leading to either inflated insurance premiums or very high loss ratios. The severity of the situation was evident in 2013 when international company Munich Re, then the leading crop reinsurer in South Africa (SA), withdrew from operations in the country (Barry, 2013).

The benefits of a well-functioning agricultural insurance system extend beyond assisting in ensuring stable farm production and income for the farming community over time, and the resulting optimal use of resources in the production process. Where risk cannot be adequately managed agricultural producers struggle to survive in the face of a negative event and they are more likely to take on less risky, and typically lower yielding, investments thus restricting the growth of the agricultural sector. In addition to incentivising taking on higher-yield investments, being insured also makes producers more creditworthy, making lenders more likely to grant a loan that could be used for a promising investment opportunity (Nnadi, et al., 2013).

Considering the levers identified for implementing the NDP, agricultural insurance can be viewed as a mechanism to support the national outcomes (and outcomes of the Paris Agreement) as it serves to protect against damage to or loss of livestock or crops as a result of unforeseen shocks faced by communities (Micro Insurance Network, 2018). Agricultural insurance is thus viewed as critical to farming success though providing farmers with risk transfer mechanisms when extreme weather events occur and, as importantly, provides security which allows emerging farmers to access credit products (Drewes, 2011).

The Western Cape agricultural sector has been particularly affected in recent times by floods, wildfires, storms and droughts. The substantial increases in the frequencies of these events over time has led to large increases in available insurance premiums, in the context of an already low take up rate of agricultural insurance (Mahlase, 2013). Unlike many developing countries, the South African Government does not subsidise crop insurance (Nieuwoudt, 2000; Mahul & Stutley, 2010) and the crop insurance industry has thus been struggling, with low penetration rates and insurers suffering high loss ratios. Where there has been take up, it has been by the commercial sector with no suitable insurance packages for smallholders (Mahul & Stutley, 2010; SAIA, 2013). Multi-peril crop insurance is available to clients and accounts for approximately three quarters of insurance premiums. The other three quarters relates to hail insurance (Mahul & Stutley, 2010).

In response to these known challenges, discussions surrounding the potential of a public private partnership for agricultural insurance has been ongoing in South Africa (SA) for a number of years. With the goal of supporting food security under changing climatic conditions, South African Insurance Association (SAIA), National Treasury and the Department of Agriculture, Forestry and Fisheries (DAFF) have spearheaded research in identifying priority insurance interventions in the agricultural sector (SAIA, 2019). At the time of writing of this report the details of the proposal were subject to approval by the Reserve Bank and the Financial Sector Conduct Authority and had not yet been made available to the public.

The point of departure for this research was the growing interest in smallholder farmers' capacity to cope with extreme weather conditions with limited risk management opportunities and the clear need for innovation in the industry. The work was initiated in 2015/16 season when the Western Cape Province was experiencing a severe drought in the main grain producing regions. The drought continued into more damaging impacts in the Western Cape through to 2018. The study continued to explore international cases to possibly inform local solutions for the sector, in the much-anticipated findings of the above-mentioned study.

Natural Disaster Typologies

Natural Disasters come in several different forms, differing in terms of regional concentration, frequency of occurrence and the reach and severity of the impacts. The Centre for Research on Epidemiology of Disasters (CRED, 2020) classifies six different types of natural disasters:

- Geophysical natural disasters originate from solid earth. One geophysical natural disaster is earthquakes resulting in ground movements or tsunamis. Another is mass movements such as landslides and rock falls. Finally ash fall, lava, mudflow or pyroclastic flow as a result of volcanic activity would also be included in this disaster type.

- Meteorological natural disasters are the result of short term extreme weather conditions. This would include storms which covers tropical and extra-tropical storms as well as the various types of convective storms: derecho, hail, lightening/thunderstorm, heavy rain, tornado, sand/dust storm, blizzards, storm surge and heavy winds. Extreme temperatures are also included under meteorological natural disasters which would cover cold waves, heat waves and occurrences of snow, ice and frost. The final meteorological natural disaster is that of heavy fog.

- Hydrological natural disasters are the result of the occurrence, movement and distribution of surface and subsurface water. Floods are covered under here whether it be a coastal flood, a riverine flood, flash flood or an ice jam flood. Avalanches are also covered as are wave actions which can be broken down into rogue waves and seiches.

- Climatological natural disasters are caused by long-lived atmospheric processes. There are three main tyes of climatological natural disasters: droughts, glacier lake outbursts and wildfires. The final disaster listed here, wildfires, can be broken down further into forest fires and land fires (brush/bush/pastures).

- Biological natural disasters are those caused by exposure to living organisms. This generally stems from either the exposure to a toxic substance or to a vector-borne disease. The most common biological natural disaster is an epidemic, referring to a disease outbreak. The disease can be viral, bacterial, parasitic, fungal or prion. Another type of biological natural disaster is an insect infestation which would either be attributable to grasshoppers or locusts. The final type of natural disaster in this group is that of animal accidents.

- Extraterrestrial natural disasters occur when either asteroids, meteoroids or comets which pass close to or make contact with earth or alternatively as a result of changes in interplanetary conditions. Impacts are included in the form of airbursts. Also included is space weather in the form of energetic particles, geomagnetic storms and shockwaves.

These different natural disaster types vary drastically in terms of how likely they are to occur in a particular region and in terms of how they impact on the communities they affect.

Agricultural Insurance Overview

Agricultural insurance can come in many different forms. A summary of the key agricultural insurance types is provided in Table 1. The list is not exhaustive or mutually exclusive, there are other insurance types and a country will generally have options for a number of these different insurance types.

Single risk or named peril insurance (damage based) provides indemnity against those adverse events where the location of the farm is frequently subjected to a particular peril.

Table 1: Different Types of Agricultural Insurance

Insurance Type	Risks Covered
Single Risk	One (even two) risks or perils of a non-systemic nature (e.g. hail, or hail and fire insurance)
Yield	Main risks that affect production (e.g. multi-peril crop insurance)
Price	Insured amount of production against decreases in prices in relation to a determined threshold.
Whole-farm	Combination of guarantees for various products on a farm which can be whole-farm yield or revenue insurance.
Revenue	Combination of yield and price insurance that can cover the whole-farm or a specific product.
Income	Price and yield process together with production costs for the whole-farm and is usually not product specific.
Index-based	Based on indices that are measured by government or third parties, for example, weather based indices, satellite imagery, average yields, livestock mortality

Source: (Bielza, et al., 2008)

Multi-peril (yield based) agricultural insurance protects against all perils that affect production. The sum insured is defined in terms of expected yield to the producer where the expected yield is determined based on the actual production history of the producer. The cost of this comprehensive cover is generally unattractive to small producers (Iturrioz, 2009).

Revenue insurance aims to protect the insured against low yield or low prices (or a combination thereof). In other words, it is multi-peril crop insurance with a price hedge. This type of insurance provides certainty that revenue estimates on which loans are based will be realised. Revenue insurance requires well developed commodities and markets.

Index based agricultural insurance products (also known as weather insurance) pay out based on the value of an "index", as opposed to actual in-field losses. The index would be a variable that is highly correlated with the losses and which cannot be influenced by the insured party (such as rainfall, temperature etc.). Advantages of index based insurance schemes are that issues of moral hazard and adverse selection can be avoided since physical phenomena cannot be affected by individuals. Payments are made based on a deviation from the index threshold therefore no loss assessments are required, making this type of insurance scheme less expensive and easier to administer (once the index has been created). However, sufficient data is required and it may be costly to construct the appropriate indexes and assembling the data may also be costly and time consuming (Iturrioz, 2009). Out of the BRICS countries, South Africa is the only country that does not provide this form of insurance to farmers. South Africa can also learn from other African countries such as Kenya, Rwanda and Ghana that have been progressive in this area with great success (den Hartigh, 2016).

Table 2 provides a comparative summary of different traditional and index-based insurance products available in Australia, highlighting the factors affecting the feasibility and practicality of implementing the two insurance types. Asymmetric information occurs due to the high cost in obtaining accurate information about losses and risks and also in monitoring farmer behaviour. Moral hazard refers to the changing of behaviour due to being insured which makes losses more probable. Adverse selection is the tendency for those of a high-risk profile to purchase insurance products. The table also provides information on the inherent risk associated with the agricultural schemes which will also influence the price and demand for these products.

Table 2: Costs Associated with Different Types of Agricultural Insurance

		Administration costs			Reinsurance costs
Insurance category	**Insurance type**	**Asymmetric information**	**Moral hazard**	**Adverse selection**	**Systemic risk**
Traditional	Named peril	Low	Low	Low	Low
	MPCI - voluntary	High	Moderate	High	High
	MPCI - compulsory	High	Moderate	Low	High
	Mutual - voluntary	High	Moderate	High	High
	Mutual - compulsory	High	Moderate	Low	High
Index-based	Yield index	None	None	None	Low
	Weather index	None	None	None	Low

Source: (NRAC, 2012)

It is evident from Table 2 that index-based insurance is not as affected by issues of asymmetric information, moral hazard and adverse selection when compared to traditional insurance packages.

Study Objective

The aim of this study is to provide an overview of the factors related to agricultural insurance, highlighting the need for appropriate agricultural insurance schemes and identifying the lack of such schemes in SA, especially for small-scale farmers. It is hoped that this will then stimulate further research and opportunities to develop workable solutions in terms of the risk management in the Western Cape agricultural sector, and particularly solutions which serve the needs of vulnerable small-scale farmers.

The study draws on lessons from international case studies to further inform conclusions and recommendations for the sector. The countries selected for further investigation are intended to enhance the understanding of agricultural insurance systems. The selected countries serve as examples of countries where agricultural insurance has been successful in the African context (Zambia and Kenya) and where it has not been as successful (Malawi). Leading players in the developing world, such as Mexico, are considered in addition to developed countries such as Australia and the USA.

2. International Context

There is widespread consensus on both the fact that global warming is happening and that this is causing extreme weather events to become both more frequent and more severe (Stern, 2007). Agriculture is particularly sensitive to climate change due to the reliance on climatic variables, such as temperature and rainfall. Crops (extending to cultivar choices and cropping calendars) and livestock selection are influenced by these variables in different geographic areas.

The Global Occurrences of Natural Disasters

For an event to be considered a disaster it needs to achieve a certain level of magnitude in terms of its impact. For example the recent wildfires in Australia would generally be considered to be a natural disaster. An accidental fire which burns a small patch of unused land would probably not be even though it is essentially the same event occurring.

The Centre for Research on Epidemiology of Disasters lists four qualifying criteria of which one needs to be met in order for an event to be classified as a disaster, whether it be natural as analysed in this paper or technological in nature. The four qualifying criteria are listed below:

- Deaths ≥ 10
- People affected ≥ 100
- A state of emergency declared
- The calling of international assistance (CRED, 2020).

Based on these criteria, Figure 2 shows the total number of the most frequent disaster types each decade globally from 1900 to 2019.

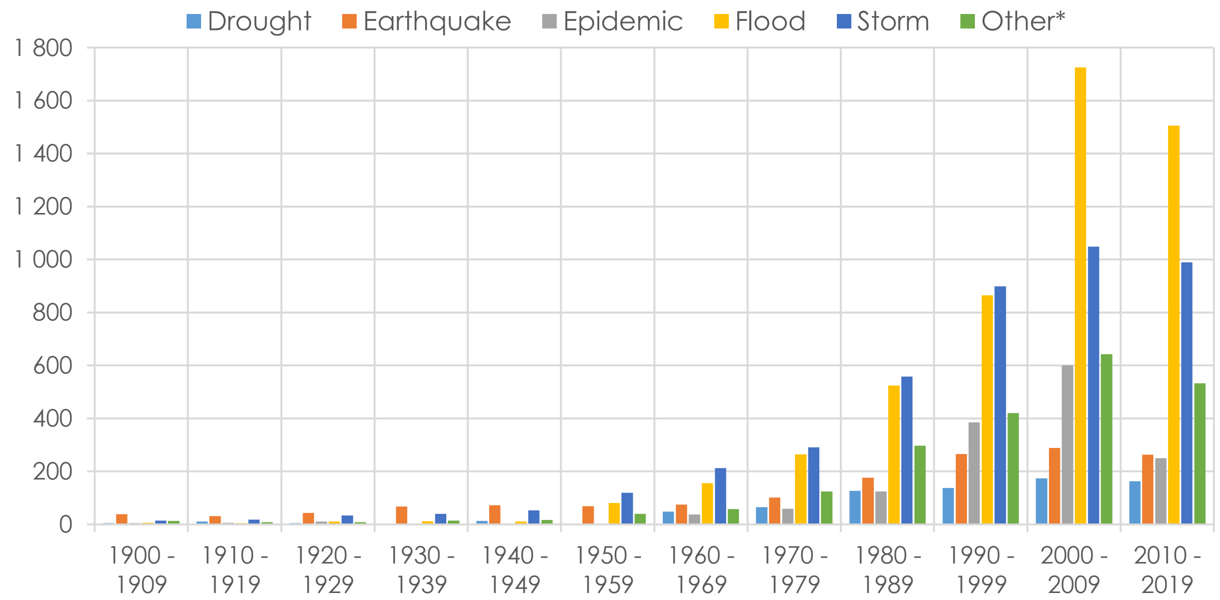

Figure 1: Occurrences of Global Natural Disasters by Decade, 1900-2019

Data source: (CRED, 2020)

What is very clear from Figure 1 is the rapid increase in the number of natural disasters occurring each decade, particularly over the past 50 years. With the exception of a seeming decline in the most recent decade compared to the one before there has been a very clear decade-on-decade rise in the frequency with which natural disasters are occurring around the world. Between 2010 and 2019 there were a recorded 3 703 natural disasters which occurred globally, less than the 4 478 recorded between 2000 and 2009. This is the first decade-on-decade decline since 1919. However, the amount recorded in the last decade is still significantly higher than any other decade prior to 2000.

The five specific natural disasters specified in Figure 1 were selected based on being the most frequently occurring natural disasters at the global level. Storms were the most frequent natural disaster occurring globally up until the end of the twentieth century. For both decades between 2000 and 2019 the most frequent natural disaster was floods with an average of 162 occurrences per annum over the twenty year period. The "other" category is made up of animal accidents, extreme temperatures, fog, impacts, insect infestations, landslides, mass movements, volcanic activity and wildfire. The specific breakdown of each natural disasters by decade is provided in Table 3 below. The first column shows the total number over the five decades from 1900 to 1949. The other columns represent the total number in each decade thereafter.

Table 3: Occurrences of Global Natural Disasters by Decade, 1900-2019

Disaster Type	1900 - 1949*	1950 - 1959	1960 - 1969	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2009	2010 - 2019
Geophysical	**279**	**78**	**88**	**125**	**223**	**330**	**357**	**310**
Earthquake	*251*	*68*	*74*	*101*	*176*	*266*	*289*	*263*
Mass movement	*4*	*1*	*2*	*1*	*15*	*12*	*8*	*5*
Volcanic activity	*24*	*9*	*12*	*23*	*32*	*52*	*60*	*42*
Meteorological	**160**	**128**	**221**	**306**	**596**	**991**	**1 271**	**1 196**
Storm	*158*	*119*	*212*	*291*	*558*	*899*	*1 048*	*989*
Extreme temperature	*2*	*8*	*9*	*15*	*38*	*92*	*223*	*207*
Fog		*1*						
Hydrological	**60**	**101**	**181**	**318**	**628**	**1 015**	**1 917**	**1 686**
Flood	*43*	*81*	*155*	*264*	*524*	*865*	*1 725*	*1 505*
Avalanche	*17*	*20*	*26*	*54*	*104*	*150*	*192*	*181*
Climatological	**42**	**1**	**57**	**91**	**186**	**240**	**315**	**258**
Drought	*33*		*48*	*65*	*126*	*137*	*173*	*163*
Wildfire	*9*	*1*	*9*	*26*	*60*	*103*	*142*	*95*
Biological	**29**	**2**	**37**	**64**	**172**	**396**	**618**	**252**
Epidemic	*26*	*2*	*37*	*59*	*124*	*385*	*600*	*250*
Insect infestation	*3*			*5*	*48*	*11*	*18*	*1*
Animal accident								*1*
Extraterestrial	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Impact								*1*
ALL	***570***	***310***	***584***	***904***	***1 805***	***2 972***	***4 478***	***3 703***

**note: The first column represents a period of 5 decades (1900-1949), all other columns represent 1 decade*

Data source: (CRED, 2020)

The Direct Cost of Natural Disasters

What is particularly concerning is the proposition that natural disasters are not just becoming more frequent but also more severe (Stern, 2007). Figure 2 shows the real total annual monetary damage to property, crops and livestock as a result of natural disasters. Values are inflated to 2019 prices using data from the World Bank (2019) to remove the effect of inflation. Even after the inflationary adjustment there is a strong upward trend observed. The increase in fluctuations around the linear time trend, indicated by the grey dotted line in the graph, show an increase in the annual variation in the occurrence of natural disasters.

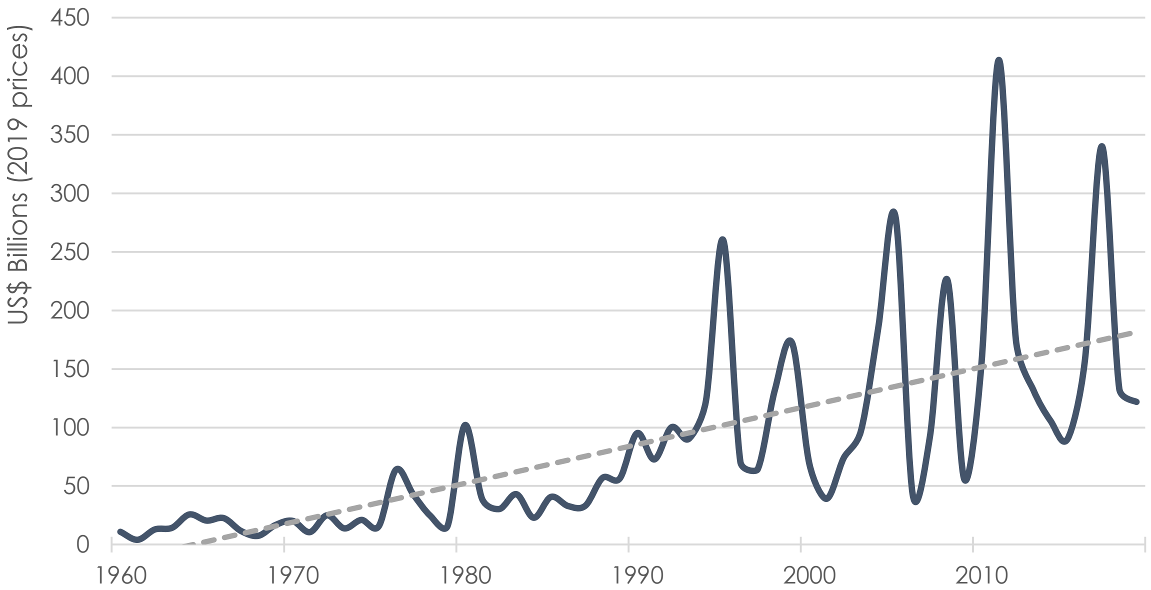

Figure 2: Real Annual Damage as a Result of Natural Disasters (2018 Prices), 1960-2019

Data source: (World Bank, 2019; CRED, 2020)

Despite the fact that the number of occurrences of natural disasters appeared to decline slightly in the most recent decade compared to the one previously, the amount of damage caused has continued to rise suggesting that there has been a big increase in the severity of the natural disasters which are occurring. The 4 478 natural disasters occurring between 2000 and 2009 caused total damage to the tune of US$ 1.16 trillion when converted to 2019 prices. Between 2010 and 2019, despite the number of disasters falling to 3 703, the total estimated damage recorded in 2019 prices was equivalent to US$ 1.82 trillion.

To further investigate the trend in the damage incurred as a result of natural disasters it is assumed that a linear relationship exists between the total damage incurred in a particular year t and a variable representing that year t:

$$Damage_t = \beta_0 + \beta_0 t + \varepsilon$$

The regression equation is estimated by Ordinary Least Squares (OLS). Damage is measured in US$ thousands, converted to 2019 prices. The year variable takes on a numeric value of the relevant year ranging from 1960 to 2019. Robust standard errors are used to account for the heteroscedasticity expected after observing the increasing fluctuations in Figure 2. This does not affect the point estimates which are used in this analysis but is done for correctness. The regression outputs are provided in Table 4 below.

Table 4: OLS Regression Outputs on the Annual Real Total Damage from Natural Disaster's

Observations	60		
R Square	0.407		
Prob > F	0.000		
Estimates:	**Coefficients**	**Std. Error**	**P > |t|**
Intercept	-5.97e+09	1.11e+09	0.000
Year	3 043 002	564 011	0.000

Data source: (World Bank, 2019; CRED, 2020)

The year coefficient is highly significant, indicating a strong relationship between the amount of damage and time. The coefficient is also very large, it estimates that on average the amount of annual damage caused by natural disasters increases each year by more than US$ 3 billion in addition to inflationary increases, ceteris paribus.

Natural Disasters and Economic Development

The implications of natural disasters do not stop with the direct cost of the damage caused. The disruptions to supply chains and economic services can have long term and far-reaching ramifications with potentially devastating impacts for economic development.

The literature on the overall impact of natural disasters on economic growth is inconclusive. This is largely due to the fact that different types of disasters have very different impacts and these impacts are felt very differently by different sectors. For this reason there is much contention in the empirical literature. Some studies, as would be expected under conventional thinking, reveal a significantly negative relationship between natural disaster occurrence and economic growth. However, other studies have shown no significant relationship, and even sometimes a positive one. Generally speaking a negative relationship is expected where the disaster affects the provision of essential intermediate inputs into production, such as the impact of a drought on a country's agricultural sector. Disasters like earthquakes which result in a decline in the ration of capital to labour have the potential to have a positive economic impact due to increasing returns and high reconstruction investments (Loayza, et al., 2009).

In response to the lack of coherence in the literature on the economic impacts of natural disasters a World Bank study (Loayza, et al., 2009) argues that such an assessment requires the differentiation between natural disaster types and between different sectors. The argument is substantiated through a Gross Method of Moments Estimator applied to a dynamic country-level panel model of economic growth, based on the Solow model, over a five-year period. The economic impacts of various natural disasters were found to be heterogeneous across different economic sectors across different disaster types, with growth in developing countries being more sensitive to the impacts.

The study found that the impact of all natural disaster occurrence on overall economic growth was not significant, evidence of the discussed potentially contrasting impacts of different disaster types and on different sectors. Even when broken down into different disaster types (droughts, floods, earthquakes and storms), only floods was shown to have a significant impact but the coefficient suggested a positive relationship meaning floods resulted in economic growth.

When looking at specific sectors more significant relationships emerge. Unsurprisingly given the reliance of agrarian production on natural elements, the relationships between natural disaster occurrences and agricultural sector growth were shown to be particularly strong. As would be expected given the reliance of agriculture on water, droughts are estimated to have a significantly negative impact on agricultural sector growth. The occurrence of a drought is estimated to on average cause a 1.1 percentage point decline in annual agricultural growth of developing countries, ceteris paribus. Storms were also expected to have a significantly negative impact on agriculture with occurrence here resulting in a 0.6 percentage point decline in annual growth of the sector, ceteris paribus. No significant effect was observed for earthquakes whilst floods were, interestingly, estimated to result in a significant 0.8 percentage point increase in annual agricultural growth, ceteris paribus. This is most likely due to the fact that floods tend to be localised events as a result of wider increases in rainfall, thus whilst for some the disaster will have devastating effects the wider agricultural sector benefits from the increased production as a result of increased rainfall (Loayza, et al., 2009).

The impact of natural disasters on industrial activity is not significant for the world as a whole but is significant for developing countries. This is largely due to the prominence of agri processing in the industrial sectors of developing countries and the strong relationship between agricultural production and natural disasters. Indeed, at least with regards to droughts and floods, the relationship with industry and natural disasters mimics the relationship with agriculture. Floods appear to be the only natural disaster with a notable relationship with growth in services sector. The relationship is again positive attributed to the dependence of services on agriculture and the potential increase in demand for services to implement relief schemes (Loayza, et al., 2009).

The different directions of impacts is also related to the severity of the disaster. As Loayza et al. (2009) show, a drought is generally quite a severe event and when the severity is increased the impact will become more negative. However floods are on average more moderate events allowing the positive relationship with economic development. Where floods become more severe the relationship will eventually become a negative one.

The assessment of the impact of the relationship between natural disasters and economic growth thus far identifies only the immediate effects and does not take into account the "aftermath" effects as the impact of a particular natural disaster lingers in the years after the event. In order to fill this knowledge gap, another World Bank study (Fomby, et al., 2009) was carried out to assess the lagged impacts of natural disasters on economic sectors. The study utilised a fixed-effects panel VARX model and found findings generally in agreement with the results of the study discussed previously. However, they find that once the cumulative impacts are considered a drought actually leads to a 1.6 percentage point decline in agricultural growth, floods lead to a 0.6 percentage point increase and storms lead to a 0.4 percentage point decline.

Agricultural Insurance around the World

In the face of the increasing threat posed to agricultural production by natural disasters, agricultural insurance premiums have increased significantly over the past decade, with emerging markets being a major driver (Society of Actuaries, 2015). In 2007, the World Bank assessed the global extent of agricultural insurance highlighting the fact that 88% of insurance premiums were collected from high-income countries in Europe and North America. Middle and low-income countries were shown to account for only 7.5% of collected premiums. Across the board, market penetration was shown to be low.

It was recently found that 82% of countries offer crop and livestock insurance, with crop insurance accounting for 90% of the premiums. Multi-peril crop insurance was reported as popular in middle-income countries and named peril is widely available. Area-yield and weather index insurance were found to be available to a lesser extent with penetration relatively greater in low-income countries (Hess & Hazell, 2016).

Hess and Hazel (2016) provide an updated list of all countries that offer agricultural insurance in developing countries, and the number of farmers insured. In 2014, an estimated 198 million smallholder farmers were insured globally, of which 650 000 were in Africa. In 2014, there were 18 schemes available in Africa with a weighted average subsidy of 37%. A summary of Hess and Hazel's findings is provided in Table 5 below.

Table 5: Regional Penetration of Agricultural Insurance, 2014

Region	Scale (million policyholders)	# of schemes	Weighted Average Subsidy
Africa	0.7	18	37%
India	33.2	4	64%
China	160.0	X	77%
Rest of Asia	1.0	7	64%
Latin America	3.3	8	91%

Source: (Hess & Hazell, 2016)

The challenges with insurability are widespread across the globe and often a public-private-partnership approach is required. For example, in Canada private companies, with premiums cost-shared, deliver crop insurance: 24% by provincial government, 36% by federal government and the remaining 40% by farmers. Delivery costs are 100% subsidised by government (Society of Actuaries, 2015). The subsidy considers the whole farm profit margin rather than revenues of commodities (Soil Association, 2017). Forage index insurance is another product on offer in Canada, however, the take up was found to be low (Society of Actuaries, 2015).

In the United Kingdom (UK) crop insurance is not government-subsidised and as such, uptake of private insurance is relatively low. However, the UK has suggested support for the Canadian crop insurance model and is considering new policies to support and protect farmers from adverse weather events and crop failures (Soil Association, 2017).

In the United States, private companies deliver crop insurance and 62% of premiums are subsidised by federal government. Farmers can take out coverage on a specific crop for particular revenue based on expected yield and pre-harvest prices, meaning that a revenue trigger is paid out even when farming operations are profitable and can be seen as another income stream. The programme has inefficiencies and it has been argued that it does not benefit smallholder farmers. It was up for review in 2018 (Soil Association, 2017).

In developing countries, most crop insurance contracts are indemnity based, where farmers are paid for actual losses incurred. For smallholder farmers in developing countries, indemnity based insurance can carry high administration costs, which makes insurance prohibitively expensive (Society of Actuaries, 2015).

In Kenya the uptake of agricultural insurance increased from 1.3 - 3.5% of farmers in 2009 to 34% in 2013. In 2014 the uptake had declined back down to 12% due to problems with pay-outs being smaller than losses incurred and certain seeds that could not be insured (Oxford Business Group, 2016). In 2016, a public-private-partnership was launched in Kenya whereby government subsidises 50% of the cost of crop insurance (for maize and wheat) and 100% of livestock premiums (for pastoral herders) depending on income. Affordable cover was to be offered to over 160 000 farmers by 2018 (Oxford Business Group, 2016).

Many government-initiated agricultural insurance programmes have moved away from Multi-Peril Crop Insurance (MPCI) to reduce costs and improve efficiency. In recent years, there has been an increasing trend in innovative options to mitigate risk for smallholders. Index insurance has received much interest, particularly in developing countries. The rise in prominence of index insurance is largely driven by advances in technology (access to remotely sensed data) and weather station infrastructure. The low administration costs associated with index insurance is attractive for developing countries, particularly countries that prioritise smallholder farmers (Society of Actuaries, 2015).

Mexico had a MPCI programme that became prohibitively expensive and in 2014 started making use of a weather index insurance scheme that is 100% subsidised by government. Another example is India where area-yield index and weather index insurance are supported. The Philippines still uses a national MPCI programme but is exploring index insurance. A few provinces in China are also exploring the use of index insurance (Hess & Hazell, 2016). Kenya's Kilimo Salama programme (now operating as the company ACRE Africa) offers weather index and area-yield index that covers a number of crops. In 2013, the programme covered over 67 000 farmers at an average cost of 5-25% on insured inputs or harvest. Kenya also has an initiative to protect livestock with the use of forage index insurance (Oxford Business Group, 2016).

3. Local Context

South Africa is a country full of diversity. The country's extreme poor live in overcrowded informal settlements in abject poverty often short distances from the country's wealthy elite who inhabit grand mansions with armies of domestic workers responsible for the upkeep. The landscape varies from pristine beaches to rolling mountains, lush valleys and barren rocky desert. The weather and in particular the time of the year when the rains come also varies across the country. As a result of these differences it is no surprise that the dominant agricultural activities also varies significantly across the different regions in the country.

The Western Cape Agricultural Sector

The importance of agriculture for South Africa can sometimes be obscured by the seemingly low 2.4% contribution to gross domestic product (GDP). This has also been decreasing over time. However, if food, beverages and tobacco, a subset of the agri processing industry, is included then the share rises to 5.3%. This share is also not uniform across the country with certain provinces relying more heavily on agricultural industries. For example, the Western Cape's share in GDP attributable to the agricultural sector, inclusive of food, beverages and tobacco, stood at 8.0%. These sectors tend to also be more labour intensive than others, hence the shares in national employment significantly exceed the shares in GDP (Pienaar & Partridge, 2015).

The importance of agriculture goes way beyond the contribution to the national economy and the high employment creation capacity, particularly in terms of much needed job opportunities for low skilled workers. One of the main inputs to agricultural production has historically been land. Land is a highly emotive issue in South Africa with the country's history of forced removals along racial lines during apartheid rule and a widely vocalised feeling that land reform and agricultural support in post-apartheid South Africa has not achieved its objective in terms of redressing the very evident inequalities in land ownership (Aliber & Counsins, 2013; Binswanger-Mkhize, 2014; Cousins, 2015). South Africa's constitution promises basic rights to all its citizens. One of these rights, as set out in the bill of rights (section 27.1.b), is the right to have access to sufficient food and water (RSA, 1996). This right is dependent on the country being food secure which is strengthened through being able to reliably produce food locally year round.

As is the case at the national level, the contribution of the agriculture, forestry and fisheries sector has a relatively small share in the Western Cape economy. In 2018 the sector contributed only 3.7% to gross value added (GVA) in the province, down from 4.8% in 2008. It should be noted that the end of the ten year period analysed was a time where agricultural production was severely affected by an intense drought across the province, country and continent (Pienaar & Boonzaaier, 2018). Despite this, the percentage share still makes up a very significant source of income in the province with the total GVA measuring R106 billion in 2018 (Quantec, 2020).

When looking at the complete sectoral breakdown of GVA as in Figure 3, it is important to also consider the share of the economy attributable to the food, beverages and tobacco sector. This sector is dependent on the domestic supply base of agricultural products as intermediate goods for production (Pienaar & Partridge, 2015). This share has increased since 2008, where it stood at 2.9%, to a total share of 3.6% in 2018. This increase has meant that the combined share of agriculture, forestry and fisheries, and food, beverages and tobacco, has only declined very marginally from 6.1% to 6.0%. The total combined GVA across the two sectors in 2018 stood at R260 billion.

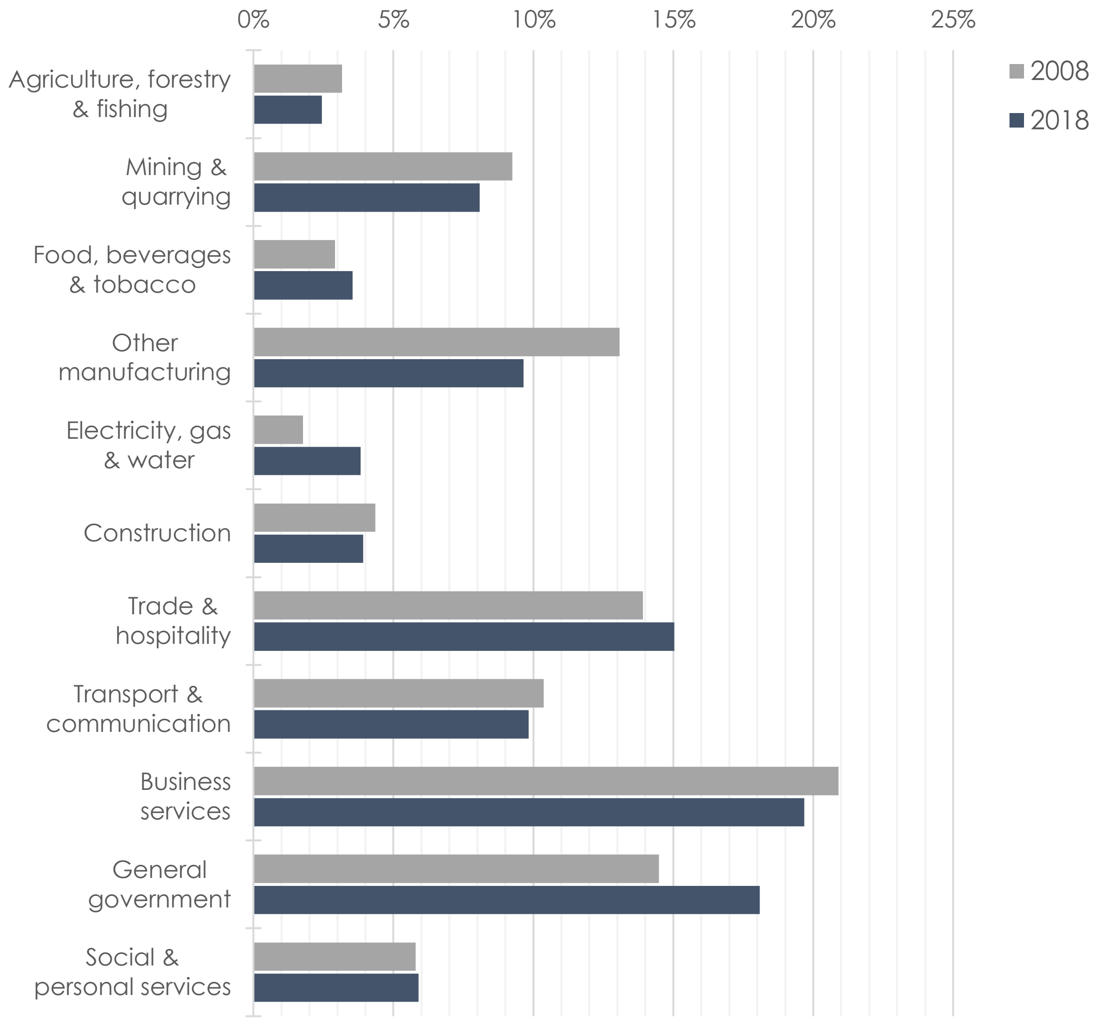

Figure 3: Sectoral Contributions to Western Cape GVA, 2008 vs 2018

Data Source: (Quantec, 2020)

It is not just the food, beverages and tobacco sector which has developed on the base of a strong domestic supply base of agricultural goods. The development of the trade and hospitality industry, with important links to tourism in the province, has also been through the utilisation of a reliable supply of quality fresh agricultural products from domestic producers. This sector made up 15.0% of the provincial economically in 2018, up from 13.9% in 2008.

Due to the sector's high labour intensity the agriculture, forestry and fisheries sector's contribution to provincial employment is significantly greater than the contribution to economic activity. As shown in the sectoral breakdown of Western Cape employment in Figure 4, in 2018 the agriculture, forestry and fisheries sector was estimated to employ 255 thousand people, 10.0% of provincial employment. The food, beverages and tobacco sector made up a more modest 2.3% of provincial employment in 2018. The share of both the agriculture, forestry and fisheries sector and the food, beverages and tobacco sector in provincial employment fell since 2008. In contrast, the trade and hospitality sector saw its share in provincial employment increase from an already high 21.6% in 2008 to 23.4% in 2018.

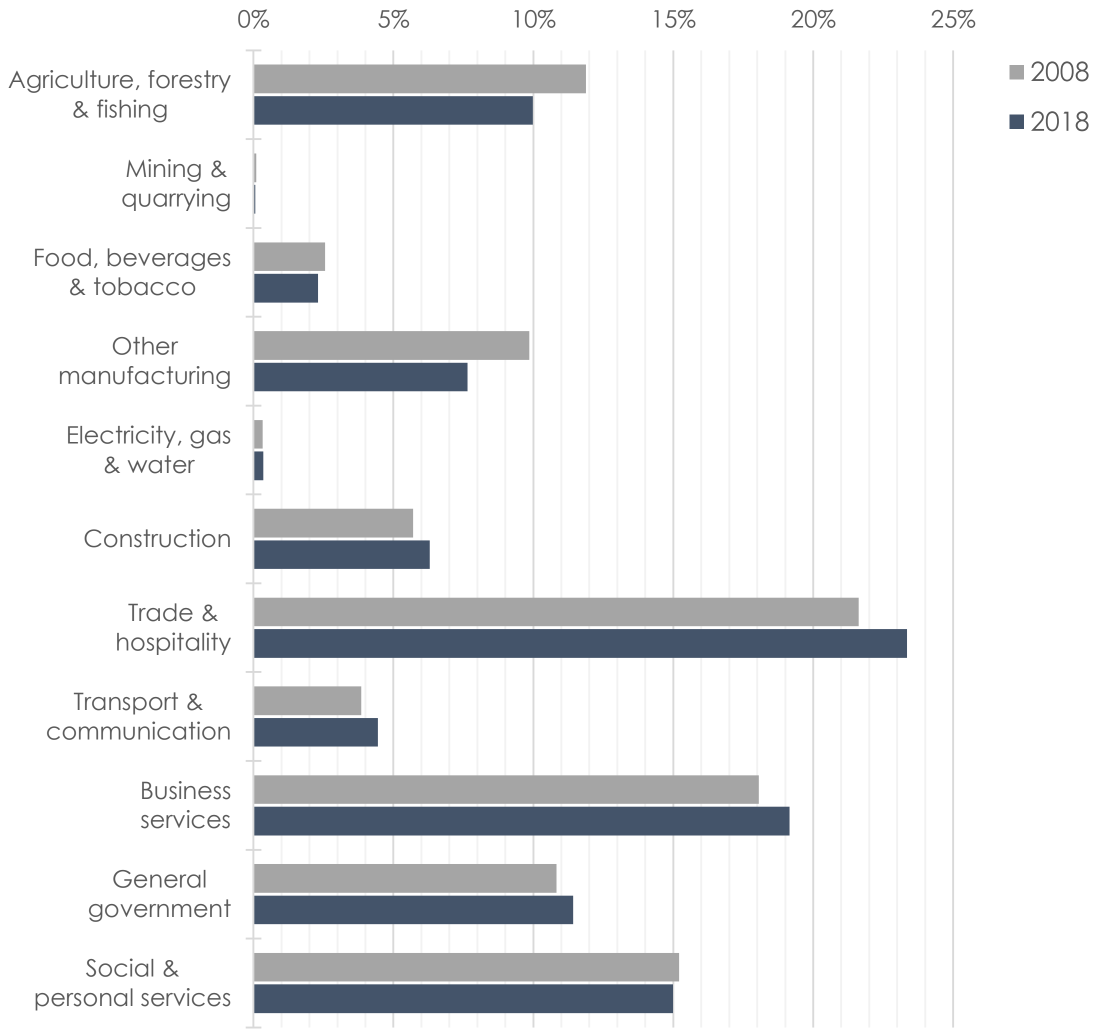

Figure 4: Sectoral Contributions to Western Cape Employment, 2008 vs 2018

Data Source: (Quantec, 2020)

Given the importance of agriculture at the national level already discussed, it is also useful to look at the Western Cape's share on commonly used performance indicators at the national level. Figure 5 shows the Western Cape's share in South Africa's national agricultural output, agricultural exports, agricultural employment and the population. It is clear the Western Cape, home to 11% of the country's population is very important for the national agricultural sector. This is particularly so with regards to agricultural exports, of which 48% are recorded as from the Western Cape. The province is also responsible for 19% of agricultural output and employs 20% of the national agricultural labour force.

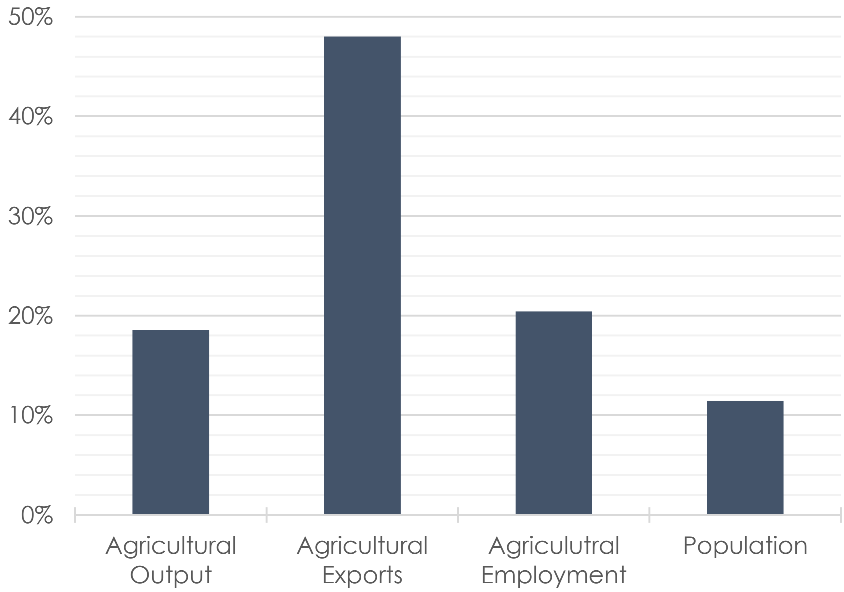

Figure 5: Western Cape Share in National Agricultural Indicators, 2018

Data Source: (Quantec, 2020)

The amount of land under crop cultivation in the Western Cape was recorded at approximately 789 thousand hectares as of 2017. Due to the extensive nature of production, wheat farming took up the largest share of this land area (42.9%), followed by wine grapes (11.6%), canola (11.5%), barley (11.0%), rooibos tea (7.5%), apples (2.7%), table grapes (1.7%), pears (1.4%), oranges (1.0%) and lupines (0.9%) (WCDoA, 2018).

The concentration of the production of different crop types varies based on the diverse agro climatic environment of the province's different regions.

Table 6 shows the regional breakdown in terms of hectares of the land under crop production for specific crop groups as at 2017. Approximately 35% of the land being used for grains, oilseeds and lupines in the Western Cape is in the West Coast District, particularly the Swartland and Bergrivier municipalities. The district also covers the largest share of land being used for vegetable production (36%) and for tobacco, tea and hops (99%). Most of the land being used for orchards in the province is in the Cape Winelands (57%).

Recent evidence shows that whilst the recent drought in the Western Cape has had a significant negative impact on agricultural activity in the province, there are signs or recovery showing giving promise for the sector for the coming years.

Table 6: Regional Hectare Breakdown of Western Cape Crop Land, 2017

	Grains, Oil Seeds, Lupines	Vegetables	Orchards	Tobacco, Teas & Hops	Total
Cape Town	***16 012***	***1 588***	***6 072***	***0***	***23 672***
City of Cape Town	16 012	1 588	6 072	0	23 672
Cape Winelands	***27 252***	***4 297***	***104 075***	***13***	***135 637***
Breede Valley	105	472	24 124	0	24 702
Drakenstein	16 300	435	18 354	8	35 098
Langeberg	2 754	386	23 470	0	26 610
Stellenbosch	150	155	15 001	0	15 306
Witzenberg	7 943	2 849	23 125	5	33 921
Central Karoo	**15**	**510**	**1 058**	**0**	**1 583**
Beaufort West	15	33	187	0	235
Laingsburg	0	329	328	0	657
Prince Albert	0	148	543	0	691
Garden Route	**78 284**	**2 594**	**7 540**	**633**	**89 052**
Bitou	1	4	110	5	121
George	1 140	1 122	2 952	467	5 681
Hessequa	70 810	100	783	4	71 697
Kannaland	2	353	2 759	20	3 134
Knysna	255	67	38	0	361
Mossel Bay	6 056	282	473	6	6 817
Oudtshoorn	21	666	424	130	1 242
Overberg	***199 002***	***401***	***20 814***	***97***	***220 315***
Cape Agulhas	66 878	4	377	58	67 317
Overstrand	2 022	59	1 296	37	3 414
Swellendam	60 283	92	3 001	1	63 377
Theewaterskloof	69 819	246	16 141	1	86 207
West Coast	***211 241***	***7 207***	***41 674***	***58 925***	***319 047***
Bergrivier	72 188	2 349	5 793	15 790	96 120
Cederberg	6 152	3 424	11 345	33 972	54 892
Matzikama	47	962	10 812	8 336	20 157
Saldanha Bay	23 660	57	42	806	24 564
Swartland	109 194	416	13 682	21	123 313
Total Western Cape	**531 792**	**16 087**	**180 175**	**59 668**	**787 722**

** Note: Table excludes extensive grazing areas*

Data Source: (WCDoA, 2018)

South Africa's Smallholder Farmers

Recent years have seen the support and development of smallholder farmers being pushed to the forefront of the policy directive in South Africa, forming a key part of the government's poverty alleviation strategy (Cousins, 2010). This is not a uniquely South African development, as after years of neglect, smallholder farmers have more recently become a key focus of the international development agenda.

The African Smallholder Farmers Group, a network of international Non-Governmental Organizations (NGOs) working to support marginalised farmers, claim the new emphasis on smallholder farmers can mainly be contributed to three factors:

> *"Three interlinked developments have contributed to push agriculture and smallholder farmers back on the international development agenda. The combination of persistent chronic hunger and poverty in most low-income countries, the realisation that poor farmers will be disproportionately vulnerable to climate change, and the spike in global food prices in 2008 have motivated donors to ratchet up their political and financial commitments to smallholder farming, especially in Africa."*
>
> (ASFG, 2010, p. 5)

Defining smallholder farmers in South Africa has been the source of debate and obscurities and there still exists a large degree of uncertainty as to what exactly classifies a farmer as a smallholder farmer (Cousins, 2010). According to South Africa's National Department of Agriculture, Forestry and Fisheries, smallholder farmers are defined as "those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour" (DAFF, 2012, p. 1) The World Bank has classified smallholders as farmers operating on less than two hectares of land (Wolrd Bank, 2003).

South Africa's General Household survey is an annual household survey which has been conducted by Statistics South Africa since 2002. The questionnaire consists of a number of questions around six broad thematic areas: education, health and social development, housing, access to services and facilities, food security, and agriculture (Stats SA, 2019a).

The questions needed to distinguish smallholders from their counterparts with "larger" operations are not completely consistent across the sixteen years of the survey in several ways of significance to this study. Firstly the question identifying households which farm changed in 2009 from previously asking whether the household had access to land which could be used for agricultural activities to asking if the household is involved in any such activities. Secondly the bracket responses relating to the size of the land changes in 2009 with previous surveys not allowing for the World Bank classification of less than two hectares. Then thirdly questions relating to the reasons for agricultural activities at the household level are not asked prior to 2009 and even in 2009 the question is asked very differently to in the subsequent years.

To overcome the first issue in the years from 2002 to 2008 agricultural households are defined as those households who have access to land and also responded "yes" to at least one of the activities[1] listed when asked if they take place on the land. From 2009 to 2018 agricultural households are able to be

[1] *Field crops, horticulture, livestock, poultry, orchards and other"*

just defined as those answering "yes" when asked if the household has been involved in the production of any kind of food or agricultural products during the past twelve months.

Between 2002 and 2009 it is only possible to identify farms smaller than 5ha or smaller than 1ha with no option to use the World Bank definition of 2ha. From 2010 onwards the 2ha classification is included in the survey and is thus observable. Most smallholder farms in South Africa are smaller than 1ha therefore the choice of classification, whether it be 1ha, 2ha or 5ha is not of great significance. When comparing households participating in agricultural activities on lands smaller than 1ha and lands smaller than 5ha, as in Figure 6, there is very little difference in the two trends. What is noticeable is the significant jump in numbers from 2008 to 2009, coinciding with the change in the questioning of the survey. In 2018 there were an estimated 1.83 million households involved in agricultural activities on land less than 5 ha in size and there were 1.80 million households involved in agricultural activities on land less than 1 ha in size.

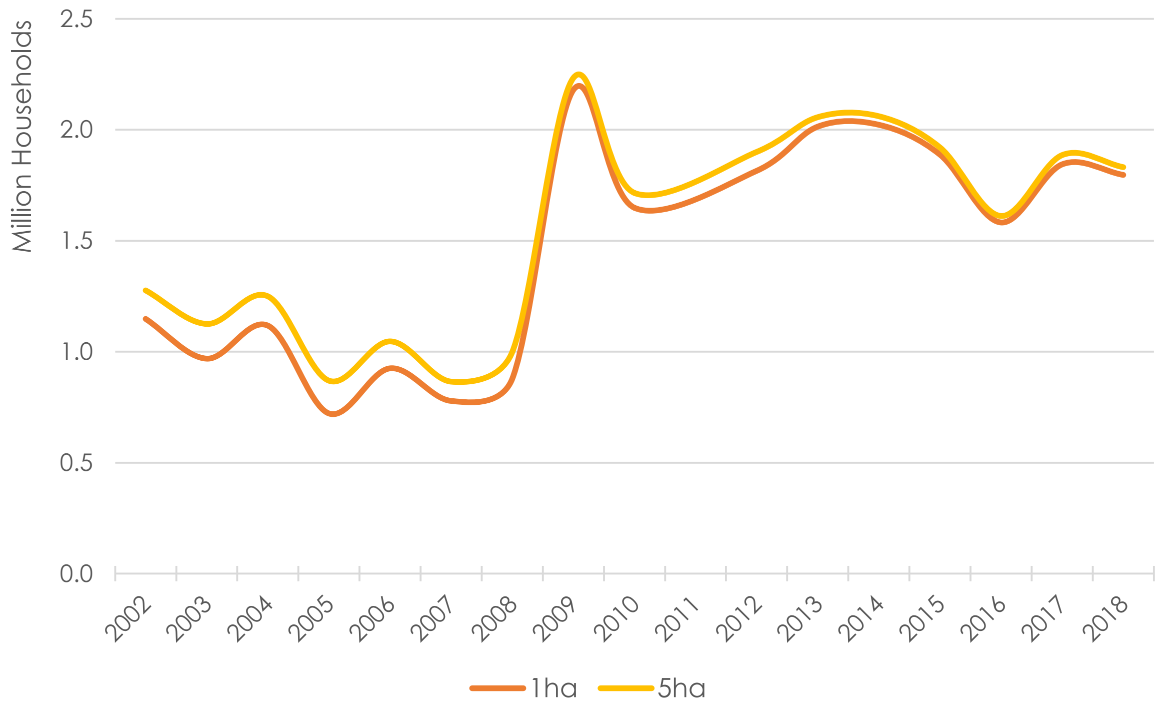

Figure 6: Number of Agricultural Households in South Africa by Maximum Hectares, 2002-2018

Data Source: (Stats SA, 2019b)

Most households in South Africa involved in agricultural activities are not able to earn significant incomes from these farming activities. This can be seen in Figure 7 which breaks down the households in South Africa involved in agricultural activities on pieces of land smaller than 2ah by the use of the resultant produce. The specific question use for this breakdown was not in the 2011 questionnaire but in all other years there is a very strong majority of households claiming their produce is used for an extra food source.

In 2018 a total of 1.48 million households used the produce from smallholder agricultural activities as an extra food source, 83% of the total. A further 152 thousand households (8.5%) claimed that these activities were the household's main source of food. Only 24 thousand households (1.4%) claimed that agricultural activities were the household's main income source and only 55 thousand (3.1%) used agricultural activities as an extra source of income.

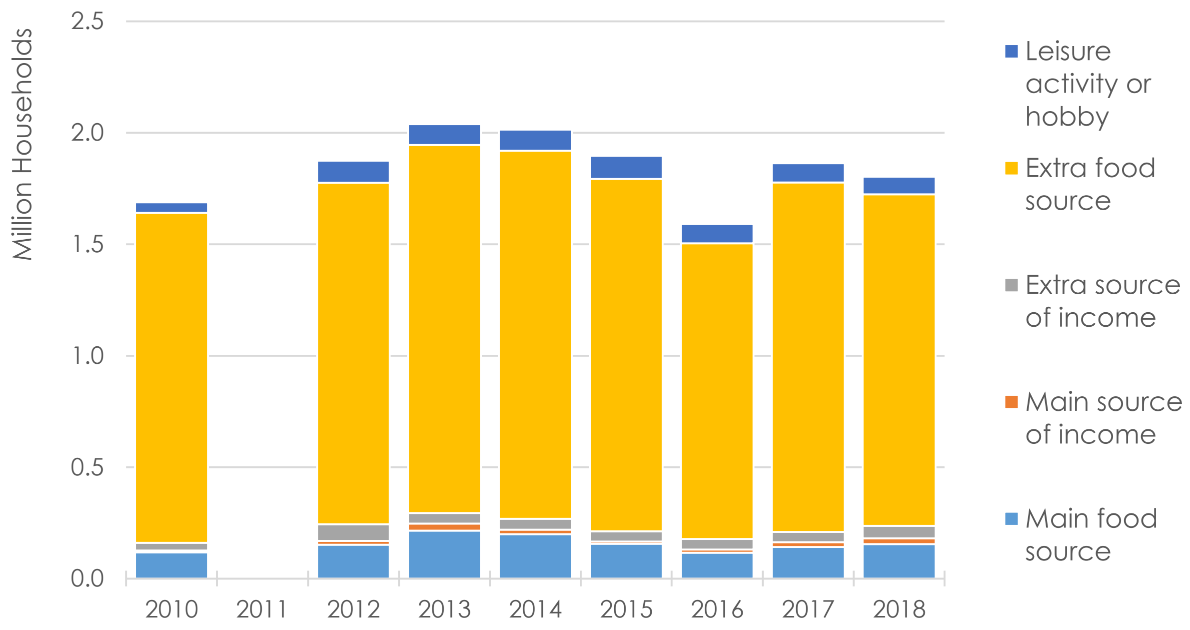

Figure 7: Smallholder (<2ha) Farming Household by Produce Use Classification, 2010-2018

Data Source: (Stats SA, 2019b)

Farming households in South Africa can be categorised into five main typologies, as laid out in Table 7. According to estimates at the time of categorisation there were approximately 1.8 million smallholder farming households in South Africa, of which 83-84% fall into category 1, producing for subsistence purposes (Accenture, 2018).

The National Department of Agriculture, Land Reform and Rural Development (previously the Department of Agriculture, Forestry and Fisheries) defines smallholders as those farmers falling in categories 2 and 3, requiring that producers look to market some of their produce but also retain some for household consumption. The general household survey only asks the main use of produce therefore it is not possible to construct a time series based on the categories in Table 7 which requires observing not just the main use but the breakdown of different uses. However the time series analysis provided does appear to suggest that a significant amount of households undertaking agricultural activities do so primarily for subsistence purposes in line with the findings of the categorisation of households above.

Table 7: Smallholder Farming Categories in South Africa, 2018

#	Description	Objective	Market goods	Income effect	Labour	Mecha-nisation	Capital intensity	Access: Finance	House-holds
1	Subsistence-oriented smallholders	Consump-tion	Negligible	Reduces food spending	Family	Very low	Very low	Absent	1.5m
2	Market-oriented smallholders in loose valuechains	Consump-tion + cash income	50% or more	Variable, from small to significant	Family + some hired	Low	Low	Some	240 000
3	Market-oriented smallholders in tight valuechains	Cash income + some consump-tion	75% or more	Significant	Family + many hired	Medium to High	Medium to High	Significa nt	5 – 10 000
4	Small-scale capitalist	Profit	100%	Very significant	Hired	High	High	Very significa nt	5 – 10 000
5	Commercial farmers	Profit	100%	Full contribut-ion	Hired	Very High	Very High	Good	35 – 40 000

Source: (Accenture, 2018)

The cross-sectional provincial breakdown of smallholder farmers is provided in Figure 8 below. More than half of smallholder famers are located in the three most concentrated provinces: Eastern Cape, Kwa-Zulu Natal and Limpopo.

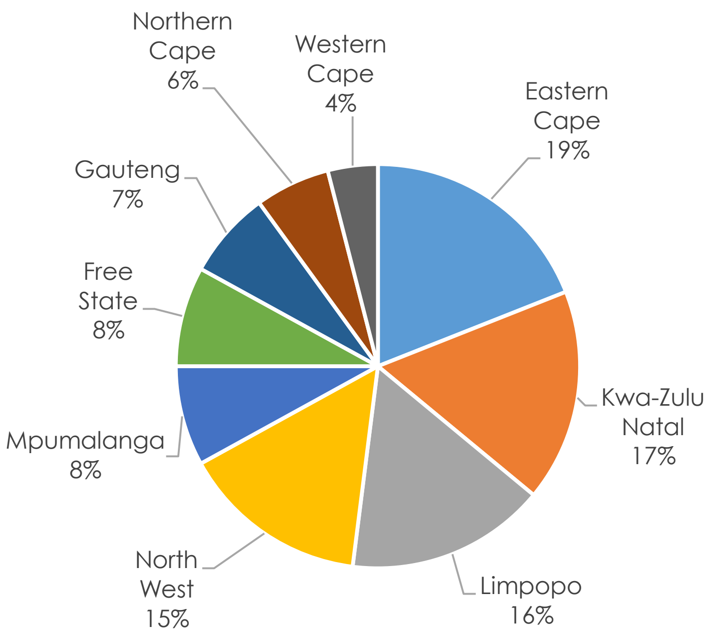

Figure 8: Provincial Breakdown of Smallholder Farmers in South Africa, 2018

Data Source: (Accenture, 2018)

The Western Cape has the lowest proportion of smallholder farmers at 4%. However this corresponds to a very significant approximately 10 thousand approximate households. Compared with provinces like the Eastern Cape and Kwa-Zulu Natal, the Western Cape has a significantly lower share of farmers farming only livestock, 27% compared to 45% and 47% respectively. The Western Cape also has a much higher proportion of farmers farming commodities not defined as livestock, grains and oilseeds (63%). The province's smallholder farmers have higher aggregated education levels than smallholder farmers from other provinces.

South African smallholder farmers are challenged by high yield variability due to weather-related perils, lack of collateral towards inputs, high dependence on rainfall and limited access to bank loans (Mapfumo, 2007). Agricultural insurance provides a solution to combat these problems in order to protect smallholder farmers against these critical risks and promote smallholder farming development in South Africa.

Natural Disasters in South Africa

Given agriculture's vulnerability to an increase in the frequency and severity of natural disasters, climate change threatens not only an important economic sector and provider of livelihood opportunities; it also threatens food security and the effectiveness of key development objectives in the country.

As was the case globally, the frequency and severity of natural disasters has been in the rise. This can be seen in Figure 9, and corresponding

Table 8 which shows the number of occurrences of each natural disaster type for every decade from 1960 to 2019. Again there is a slight drop off in frequency for the most recent decade, however this year was the highest recorded real damage over the decades analysed totalling US$ 3.64 billion once all values are converted into 2019 prices. The total damage for each decade is displayed as a line graph in Figure 9, measured on the secondary right-hand axis.

A major reason for the high level of damage in the past decade was the onset of a severe drought which had a devastating impact on agricultural production across the country and even wider across the continent. This drought initially affected dryland agricultural production before leading to a depletion of the dams which supply irrigated agricultural production which is concentrated in the Western Cape (Pienaar & Boonzaaier, 2018).

What makes a drought particularly damaging and costly is the fact that the impacts are felt over such a wide geographic area. Other disasters tend to be more localised in one particular area. To demonstrate this, average annual rainfall is estimated for each municipality in the Western Cape from 2009 to 2018.

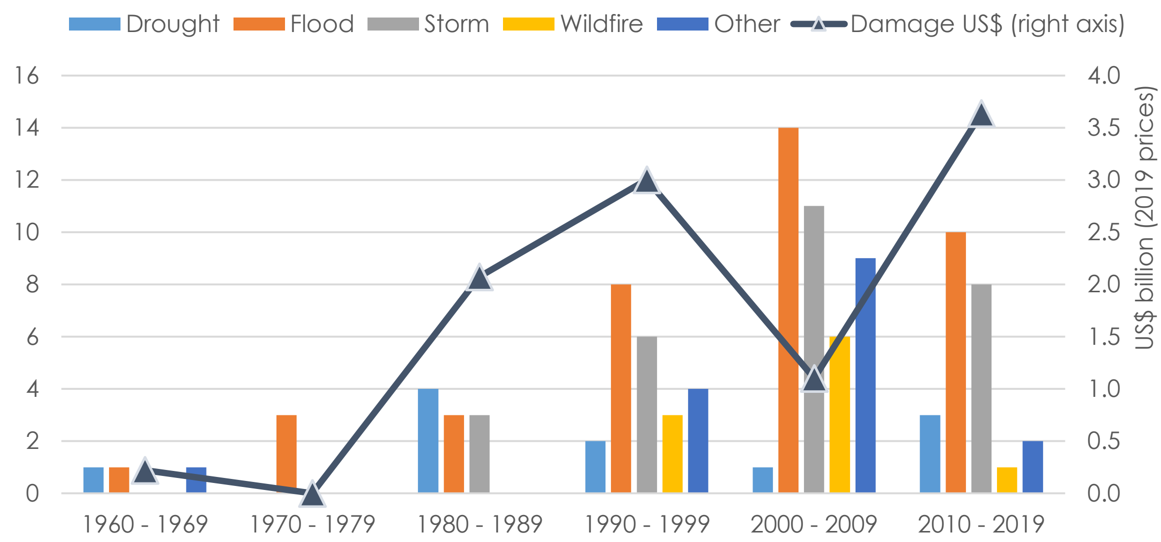

Figure 9: Occurrences of Natural Disasters and Real Total Cost by Decade, 1960-2019

Data source: (World Bank, 2019; CRED, 2020)

Table 8: Occurrences of Natural Disasters by Decade, 1960-2019

	1960 - 1969	**1970 - 1979**	**1980 - 1989**	**1990 - 1999**	**2000 - 2009**	**2010 - 2019**
Geophysical						
Earthquake	1			2	1	1
Meteorologica						
Storm			3	6	11	8
Extreme temperature				1	1	1
Hydrological						
Flood	1	3	3	8	14	10
Avalanche				1		
Climatological						
Drought	1		4	2	1	3
Wildfire				3	6	1
Biological						
Epidemic					7	
ALL	***3***	***3***	***10***	***23***	***41***	***24***

Data source: (World Bank, 2019; CRED, 2020)

Rainfall data was obtained from the Western Cape Department of Agriculture's Agri Outlook Database (WCDoA, 2019). The database consists of monthly reports on weather data for 44 stations across the Western Cape Province, as well as two stations in areas in the Eastern Cape close to the Western Cape border. Data on rainfall from each monthly report were collected before being merged together and areas were then manually allocated to the municipalities within which they are situated.

The database on rainfall was taken from 46 weather stations. Given that there are only 24 non-metro municipalities, there were obviously more than one weather station area within certain municipalities.

There were even some municipalities with no weather station data. For each municipality a reference area was selected based on three criteria, listed below in order of priority.

- Completeness of data
- Degree to which variation is in line with the average municipal and district variation
- Centrality in terms of geographic location within the municipality.

The four municipalities which had no weather station data (Overstrand, Bitou, Knysna, Laingsburg) were all relatively small in size and it was possible to obtain a reference from a weather station with good weather data very close to the municipal boundaries. Despite prioritising completeness of data, a small number of observations were missing for most of the weather stations. Missing values were imputed through matching stations with others that are both geographically very close and where a similar aggregate trend was observed over the study period. The full list of reference areas by municipality is provided in ***Appendix A: Municipal Reference Areas for Rainfall Data***.

For a particular area i a missing rainfall value at month $\bar{a}$ and year $\bar{t}$ is imputed using the value of its matched municipality, j, weighted according to the average ratio of rainfall in the two areas in other months for which both areas have data. So if the variable of interest is represented by k, then:

$$k_{i,\bar{a},\bar{t}} = k_{j,\bar{a},\bar{t}} * \frac{\sum_{p=1}^{P}\left[\frac{k_{i,\bar{a},p}}{k_{j,\bar{a},p}}\right]}{P} \qquad [2]$$

The subscript p for the year time period represents the subset of years {1,2,3,….,P} for which there is recorded data for month $\bar{a}$ for both areas i and j. Annual rainfall from 2009 to 2018 is plotted for each municipality in Figure 10.

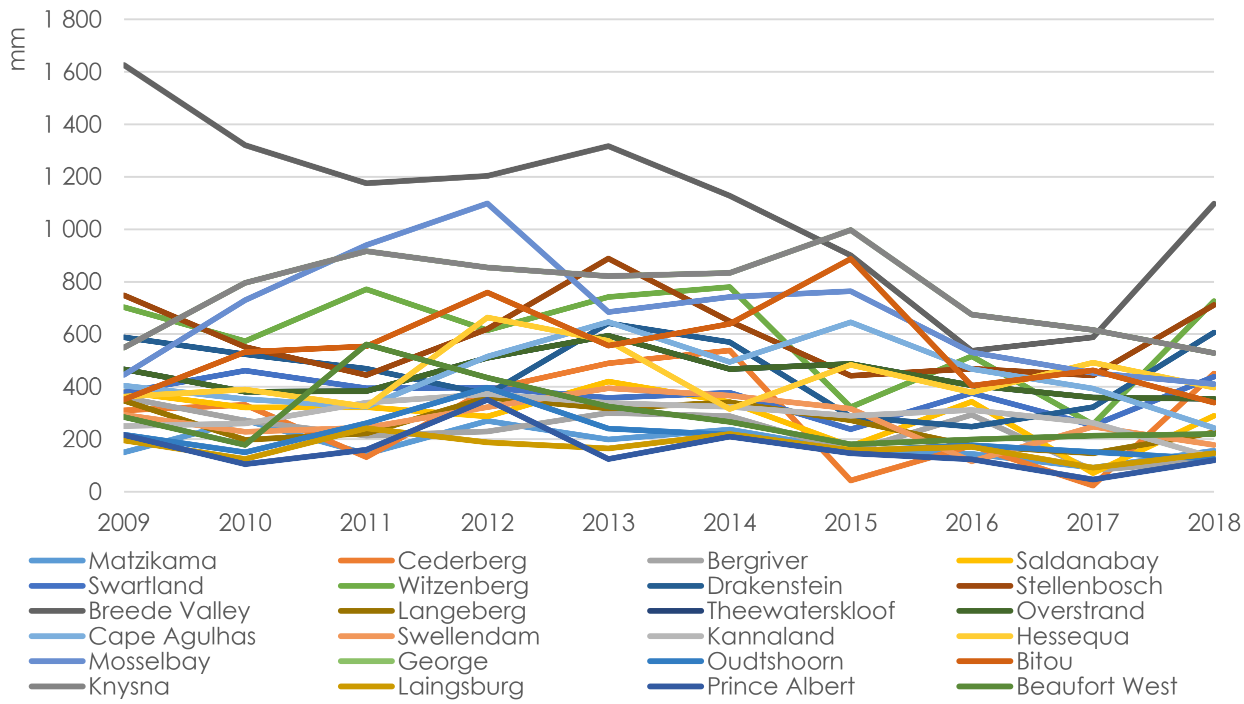

Figure 10: Annual Rainfall by Western Cape Municipality, 2009-2018

Data Source: Own Calculations using WCDoA (2019)

Whilst the result of having 24 series, one for each municipality, results in quite a messy visual, the drop in the years around 2016 is very clear. There are other definite periods of "drought" where annual rainfall fell very low but this occurs at different times for different municipalities. The annual rainfall per municipality is provided in table format in ***Appendix B: Annual Rainfall per Municipality with Full Imputations***.

Agricultural Insurance in South Africa

Despite the obvious need, there appears to be very little take-up of agricultural insurance amongst South Africa's smallholder farmers. The country's agricultural insurance industry has developed based on serving commercial farmers and there are no special delivery channels to serve smallholder farmers despite the need being recognised (Mahul & Stutley, 2010). In 2013 the South African Insurance Industry Association stated a penetration rate for MPCI for commercial farmers of 17% of the planted surface area. For smallholder farmers the penetration rate was deemed negligible (SAIA, 2013).

For the agricultural sector as a whole there does appear to be some take up of formal insurance schemes. However, this has been declining relative to farm incomes in recent years and is mostly for life insurance or the insuring of assets. According to South Africa's Agricultural Survey farmers currently spend approximately 1.32% of their total income on insurance, down from 2.35% in 2002. This can be seen in Figure 11 which shows the portion of farm's total income spent on insurance according to the census of commercial agriculture conducted by Statistics South Africa in 2002 and 2007, as well as the Agricultural Surveys, also conducted by Statistics South Africa for each year from 2011 to 2017.

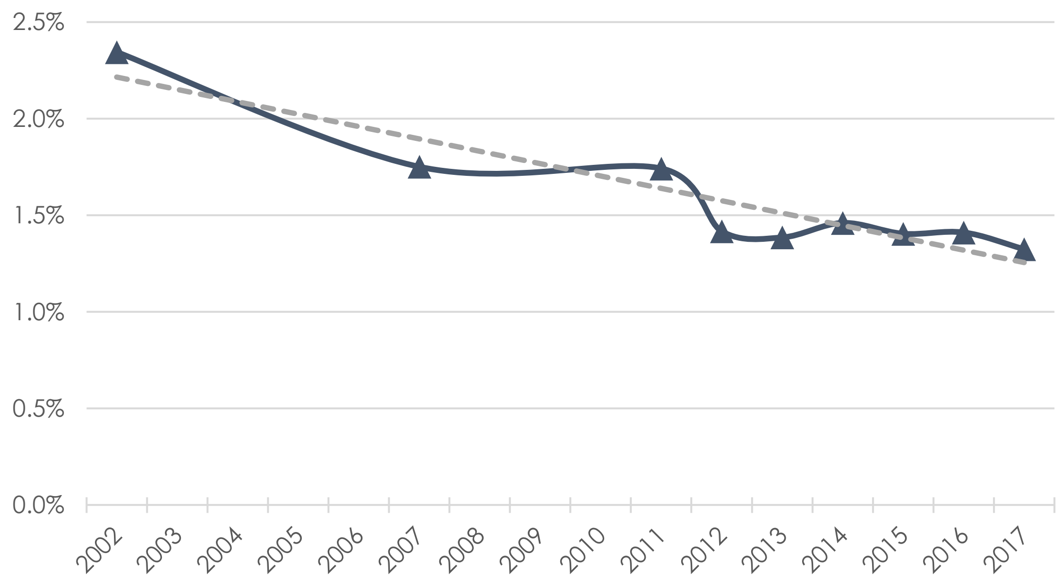

Figure 11: Proportion of Total Farm Income Spent on Formal Insurance in South Africa, 2002-2017

Data Source: (Stats SA, 2002; Stats SA, 2007; Stats SA, 2018)

The linear trend indicated by the grey dashed line in Figure 11 is clearly downward sloping. The coefficient on the time variable under ordinary least squares shows that on average between 2002 and 2007 the proportion of income spent on insurance has been declining by 0.064 percentage points. This means that the proportion will decline by more than one percentage point over a 16 year period. This may not seem high but considering that the share is currently only 1.32% it is a very significant downward slope.

In 2010, FinMark Trust commissioned the Centre for Inclusive Banking in Africa to undertake a study on the state of agricultural and rural finance in Southern Africa, in order to better understand the nature and extent of challenges faced in accessing and making use of financial services. This study provides a benchmark for agricultural and rural finance in South Africa and seeks to contribute to making financial markets work for the poor. Although there has been an improvement in accessing a range of financial services among the poor, it was found that there is still a need for more specialised financial services for emergent and small commercial farmers, especially with regards to insurance (FinMark Trust, 2013).

The FinMark Trust (2013) report draws on the findings of three surveys, the FinScope Consumer Surveys 2010 and 2011, and the FinScope Small Business Survey 2010. The FinScope Small Business Survey 2010 survey found that small-scale agriculture is a significant component of livelihood strategies and that approximately 30% of small-scale farmers utilised formal insurance services. However, further investigation reveals that this was primarily personal life insurance cover and only a negligible proportion is noted for agricultural insurance. A more recent study confirmed that still take up of agricultural insurance amongst small-scale farmers is less than 1% (SAIA, 2019).

The FinMark Trust (2013) report identifies significant financial service needs of emerging and smallholder farmers in terms of savings, transmission, credit and insurance services, and highlights the stark contrast between insurance accesses for smallholder farmers when compared to the commercial farming sector. About 40% of commercial grain farmers have crop insurance. For small and emergent farmers, less than 1% reported even having insurance to cover agricultural equipment. Own funds and loans from family and friends remain a main source of funding. At the same time, many smallholder farmers (transferred under the land reform programme) do not own the land that they farm. Therefore they are unable to use the land as collateral for working capital advances for unforeseen circumstances (such as extreme weather events) (FinMark Trust, 2013).

An opportunity exists for emerging black farmers to join the MGK development programme, TEMO Agri Services financing scheme. The services on offer include production loans, crop insurance (Santam), production inputs, marketing, logistics and mentorship towards becoming self-sustaining commercial farmers. At the time of the FinMark Trust (2013) study, the programme reached 272 farmers, involving R155 million in loans.

Table 9: Temo Agri Services' BEE financing assistance scheme

Season	Number of Farmers	Hectares ('000)	Crop Loans (R'000 000)	Government Grant (R'000 000)	MGK loan (R'000 000)	Insurance
2003/2004	22	2	0,4	0	0,4	Hail
2004/2005	45	4	3,0	0	3,0	Hail
2005/2006	75	9	7,1	2,8	4,3	Hail
2006/2007	128	16,3	21,1	5,8	15,3	Hail
2007/2008	129	17,1	41,7	6,2	35,7	Comprehensive
2008/2009	175	17	60	0	60	Comprehensive
2009/2010	272	42	155	?	155	Comprehensive

Source: (FinMark Trust, 2013)

Santam only offers insurance to emerging farmers that are affiliated to NWK grain and MGK sunflowers, with no plans to expand the portfolio due to the challenges involved in insuring the emerging market in SA.

A recent survey of smallholder livestock farmers in the North West Province asked farmers about their willingness to pay for index based agricultural insurance on a four point scale:

1. Not willing: Farmer is not at all willing to pay for index insurance
2. Less willing: Farmer is willing to purchase, but not for 100% of their stock. These farmers harbour doubt over the feasibility of such schemes but would be interested in such a scheme if it were subsidised.
3. Moderately willing: Farmer is willing to purchase index insurance for 100% of stock
4. More willing: Farmer is willing to purchase index insurance for 100% of stock even with a 10% increase in the premium.

The breakdown of responses is provided in Figure 12 below.

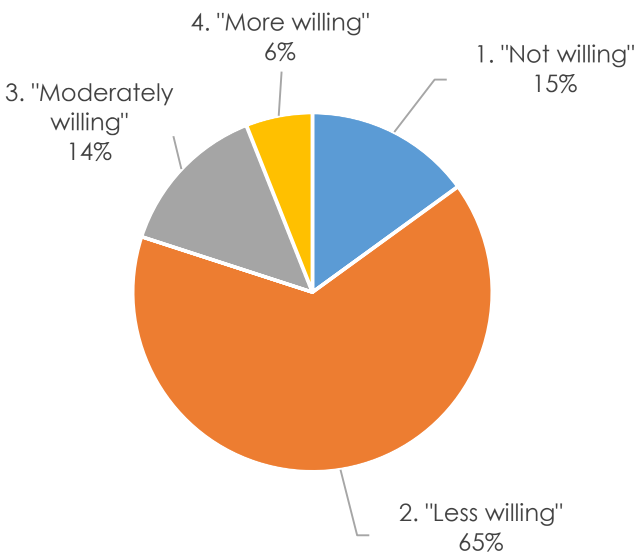

Figure 12: Smallholder Farmer's Willingness to Pay for Index Insurance

Data source: (Accenture, 2018)

The majority of respondents fell into the "less willing" category. This means that generally there is interest in insurance but there are significant concerns over the feasibility and affordability of such a scheme. It has been noted that whilst the study was based on smallholder livestock farmers in one province, the findings can be extended to smallholder farmers generally in South Africa (Accenture, 2018).

Interestingly the main reasons for a lack of willingness of responses was primarily not due to a perceived lack of need for insurance, but rather due to a lack of affordability or lack of an appropriate scheme. The breakdown of responses on the reasons for unwillingness are displayed in Figure 13 below. The biggest reason cited was that the farmer is not making enough money to be able to afford insurance, cited by 37% of respondents with a further 15% citing a lack of money as the main reason. There were also significant conerns that the nature of conventional insurance schemes made them unfeasible, specifically 27% claiming their herd size is too small to work with such a scheme and 13% citing a lack of trust of insurance schemes. Only 2% of farmers claim the relevant risks are manageable without insurance and 6% claim to have enough capital to tide them over in times of hardship.

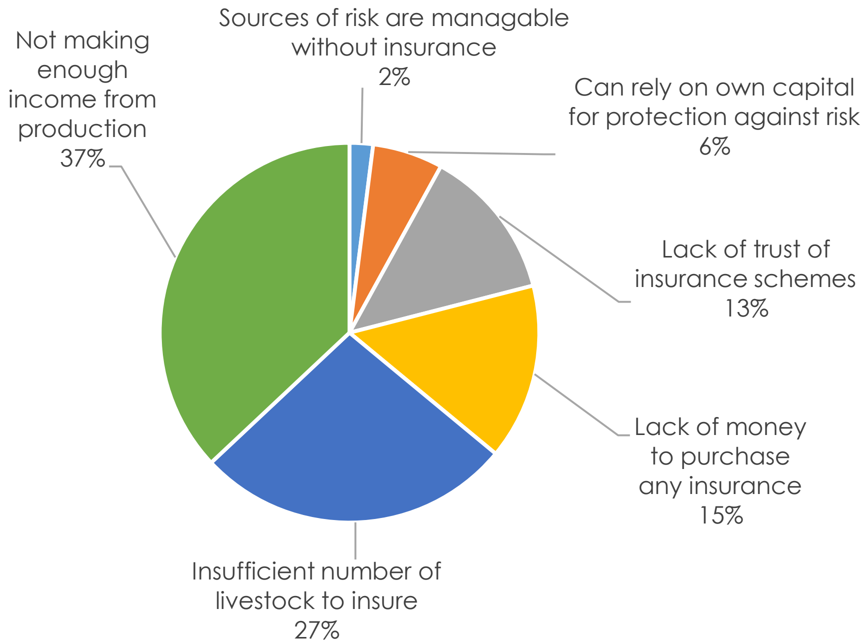

Figure 13: Main Reason for Unwillingness to Purchase Index Based Agricultural Insurance

Data Source: (Accenture, 2018)

In addition to the need for agricultural insurance specifically tailored to meet the needs of smallholder farmers, the following challenges need to be addressed in order to serve the emerging market with appropriate agricultural insurance:

- Poor management and farming practices;
- Security of tenure (in former traditional homelands);

- Lack of resources, experience and skills;
- Absence of suitable technical mentorship;
- Reduced risk (from smaller farms); and
- Institutional structure of farms (leading to management complications)

At the core of these challenges is the lack of an agricultural finance policy framework driven by a single coordinating body (FinMark Trust, 2013).

Without appropriate agricultural insurance packages for smallholder farmers, in the face of increased occurrences of natural disasters as a result of climate change, the attractiveness of agriculture as a livelihood activity will deteriorate which could lead to the shrinking of the country's smallholder farming sector. Evidence in recent years seems to suggest that this process has already begun to happen with an observed movement of South Africa's rural dwellers away from agricultural activities (Daniels, et al., 2013).

In response to these known challenges, discussions surrounding the potential of a public private partnership for agricultural insurance has been ongoing in SA for a number of years. In SA, there are no government subsidies available to commercial farmers, who play a significant role in national food security, in contrast to other countries such as the USA (where subsidies can be up to 60%). In the absence of financial support from government, transaction costs of traditional insurance remain high and to a large extent unaffordable and financially unsustainable. With the goal of supporting food security under changing climatic conditions, SAIA, National Treasury and DAFF have spearheaded research in identifying priority insurance interventions in the agricultural sector (SAIA, 2019).

In 2016, the National Treasury submitted a request to the World Bank for technical assistance in identifying critical issues to be considered for policy development (World Bank, 2016a). The resulting diagnostic provided costings for risk financing, start-up and operating costs for three insurance scenarios:

- Commercial farmers: risk-sharing to re-build MPCI market, (specifically drought) for commercial farmers producing maize, wheat and barley
- Smallholders crop producers: area yield index insurance or weather index for farmers producing grain and oilseed
- Smallholder livestock producers: pasture index insurance (World Bank, 2016a).

The details of the proposal, in terms of structure, costs and timeframes, are subject to approval by the Reserve Bank and the Financial Sector Conduct Authority and are not yet available publically. The proposed schemes are based on a five-year (2020-2024) horizon for low coverage, baseline coverage and the recommended scenario. Recommendations on a further ten-year view is also subject to approval.

Stakeholders that were consulted to inform the World Bank (2016a) study offered suggestions for what the insurance solution should include. Popular suggestions included:

- Crop insurance compulsory for farmers accessing formal credit to increase uptake and reduce adverse selection (e.g. as is practised in Mexico and Brazil)
- Provide disaster relief to farmers who purchased crop insurance to increase uptake and reduce adverse selection (e.g. USA, Turkey)
- Set uniform MPCI policy and standard premium rates to eliminate price competition (e.g. USA, Turkey)
- Act as reinsurer for catastrophic events to reduce insurer capital requirements and premium costs (e.g. USA)
- Provide premium subsidies to increase uptake by reducing premium costs (e.g. USA, Brazil, Turkey) (World Bank, 2016a)
- The timely establishment of a coordinating body (PPP) is thus seen as critical to the successful implementation of the proposed agricultural insurance solution.

4. Case Studies

The countries selected for further investigation are intended to enhance the understanding of agricultural insurance systems. With limited information on agricultural insurance take up, the selected countries serve as examples of countries that offer information on where agricultural insurance has been successful in the African context (Zambia and Kenya) and where it has not been as successful (Malawi). Leading players in the developing world, such as Mexico, are considered in addition to developed countries such as Australia and the USA.

Zambia

Zambia is a landlocked country in sub-Saharan Africa. With a total surface area of 752 614 square kilometres, the country ranks among the smaller countries in South-Central Africa. Zambia has an abundance of natural resources including major lakes and rivers, savannah woodlands and grasslands, and is well-endowed with minerals. Zambia enjoys a tropical climate made up of three seasons: cool and dry, hot and dry and the hot and wet season. Zambia is experiencing high population growth, averaging approximately 3% per year (ZamStats, 2018). There has also been an observed increasing rate of urbanisation with rising per capita income. As the main support of the rural economy in Zambia, and contributing 4.8% to GDP in 2017, the agriculture sector has been identified as key to unlocking economic growth (IAPRI, 2017).

The agricultural sector in Zambia recognises the increasingly unpredictable climate and identified the need for Climate Smart Agriculture to improve the climate resilience of farmers. The government has been working on bringing solutions to smallholder farmers through the Farmer Input Support Programme (FISP) since 2002, the Lima Credit Scheme since 2008, and a particular focus on weather index insurance since 2013 (IAPRI, 2017). The FISP was put in place to increase private participation in the supply of agricultural inputs to smallholder farmers, increase food security and agricultural productivity and income (IAPRI, 2017). In 2008, insurance was provided as part of a credit package under the Lima Credit Scheme. At this stage the premium was 5% (reduced to 4% from 2011) for food and cash crops (FARMAF, 2019).

Table 10: Key outcomes of Lima Credit Scheme and Indemnity-based insurance in Zambia 2008-2014

Year	Number of Farmers	Hectares	Premium (%)
2008/2009	600	600	5
2009/2010	1334	2229	5
2010/2011	1511	3320	5
2011/2012	4723	10300	4
2012/2013	9767	21000	4
2013/2014	16780	36700	4

Source: (FARMAF, 2019)

In 2015, under the Farmer Input Support Programme, Government piloted the e-voucher system in 13 districts. The programme was set to support 241 000 smallholder farmers and expand to 39 districts in the 2016/2017 farming season. However, the programme was reported to have failed as it was not deemed ready for implementation. The e-vouchers were to be loaded with a set amount to purchase seeds and fertilizer. However, before the launch of the Programme, input prices also increased due to a weakening currency. As a result, support was then distributed via cooperatives (Agro Insurance, 2015).

In the 2015/2016 farming season, Zambia experienced a long dry spell that affected cotton and maize crops, however, over 60 000 farming households (of which 58 800 were smallholder farmers) insured themselves against drought to an economic value of K70 million (Mulenga, 2017). This was made possible through the collaborative efforts of Mayfair Insurance, Musika, Financial Sector Deepening Zambia and Focus General Insurance Limited. In 2016, Mayfair Insurance Company introduced weather index insurance for farmers that was supported by the Farmer Input Support Programme by e-voucher. The insurance cover offered by Mayfair uses satellite technology with a 20-day dry condition threshold, with automatic pay-outs being linked to the e-voucher system. A Cabinet decision was made to expand the FISP e-voucher system in the 2016/2017 farming season.

The e-voucher system was rolled out country wide in the 2017/2018 farming season following two pilot phases of the FISP e-voucher programme. Allocation increased by 33% from 2016 to 2018 to service one million beneficiaries (IAPRI, 2017).

Take home messages:

- Public private partnerships contributed to the success of agricultural insurance which is available and accessible to smallholder farmers.
- Technology can assist in bringing agricultural insurance solutions to smallholder farmers.
- The success in increasing uptake is said to be attributed to the development of tailor-made products that cover the value chain.

Kenya

Kenya is located on the equator in East Africa, spanning more than 582 000 square kilometres of land of medium to high agricultural potential and reliable rainfall (ACCI, 2013). Kenya is geographically diverse from high mountain peaks to wide open plains, rich in wildlife and geographical attractions (Kenya Information Guide, 2015). The agricultural sector plays a major role in the rural economy with a GDP contribution of approximately 26% and another 27% indirectly linking through other sectors (FAO, 2019a). The sector employs more than 40% of the population (FAO, 2019a) and more than 75% of farmers in Kenya are smallholder farmers (Oxford Business Group, 2017).

As the population is increasing, agricultural land potential is decreasing and agriculture continues to expand to more marginal land with increased competition for resources (FAO, 2019a). With Kenya's agriculture being mostly rain-fed, farmers are highly vulnerable to extreme weather events, unreliable, erratic rainfall and changes in climate (Oxford Business Group, 2017), especially farmers that are moving into more arid and marginal areas (FAO, 2019a).

Northern Kenya experiences a drought every three to five years. Between 2008 and 2011 a severe drought resulted in estimated losses of US$121bn with the GDP growth rate dropping from 5.5% to 3.8% and the agricultural sector GDP growth rate dropping from 3.6% to 0.6%. The expenditure on crops and livestock over the 2008-2011 period amounted to only 17% of the total value of the losses and damages (Osumba, 2016). With climate change expected to exacerbate the challenging farming conditions, a gap in agricultural funding and the uncertainties brought about by extreme weather events, there is a clear opportunity for agricultural insurance.

Agricultural insurance products have been largely geared towards medium and large scale commercial farmers (in dairy and cereals) with some local insurers offering multi-peril insurance products to smallholders for crop yields below 80% of expected harvest due to disease, insect damage and climate among others (Oxford Business Group, 2017). In 2014 the gross written premiums for agricultural insurance totalled U$2.6m growing to US$3.5m in 2015. Of the gross written premiums, 59% was made up of crop insurance and 41% livestock insurance (Oxford Business Group, 2017).

Kenya is a leader within Africa in promoting participation in the emerging insurance sector (IIED, 2017). In 2009, the International Livestock Research Institute developed the index based livestock insurance scheme for pastoralists to insure against drought related deaths to livestock. Since 2006 there has been increasing interest in agricultural insurance in Kenya, largely stimulated by international agencies being willing to partner with local companies to develop pilot products and programmes to support smallholder farmers (Osumba, 2016).

Livestock farmers face another challenge where payments after disaster are often too late. Under the Kenya Livestock Insurance Programme, introduced in 2015, satellite imagery is used to determine whether enough forage is available and pay-outs are triggered when too little rain means grazing is less than 20% of ideal conditions (Oxford Business Group, 2017). Here the government purchases insurance from private insurance companies, together with donor funding, to support poor households. There has been an increase in sales and it is expected that demand will continue to grow given the increased changes in climate conditions (World Bank, 2016b). Over US$1.6million has been paid in premiums with a total sum insured of US$10million, benefitting 15 000 households (IIED, 2017).

In 2016, Kenya experienced its worst drought in 16 years. Through the Kenya Livestock Insurance Programme, government made payments up to US$4million to 33 000 pastoralists directly to their bank accounts or mobile phones. By making use of financial and technological innovation, 100 000 people and 70 000 livestock units could be assisted and protected in this challenging time (USAID, 2018).

Index insurance such as ACRE (previously known as Kilimo Salama) was put in place to offer weather index, area-yield index and satellite based index insurance for a number of crops. By 2013 the programme covered 5-25% of insured harvests (Oxford Business Group, 2017) and by 2017 more than 950 semi-commercial maize farmers were reported to have purchased insurance (IIED, 2017). Despite numerous pilots being implemented in Kenya, these programmes have yet to reach significant scale (Osumba, 2016). Index insurance has benefits of faster pay-outs and reduced administrative costs (Syngenta Foundation, 2014), however, the programme has received some criticism for not covering crop failure due to pests or weather being measured at stations a distance from the insured farm.

Osumba (2016) notes the following challenges:

- Data gaps (weather, yield)
- Low density of reliable weather stations
- Weather data not reliable or properly archived
- Satellite data needs ground truthing
- Financial literacy among targeting farmers is low, affecting demand
- Index based insurance is specific to location (i.e. every locality has different product and premium rating) therefore difficult to scale up
- Low capacity of national insurance (and re-insurance) sector to develop the right products
- Pilots lack strategic plan; dependence on donor funding
- Delivery channels to remote areas
- Small market resulting in high premiums make it difficult to expand the market.

Following a request from the Kenyan government, an appraisal of different agricultural insurance options for Kenya was published by the World Bank in 2015, covering the costs and benefits of large scale agricultural insurance that involves the public and private sectors.

In 2015/2016 the Kenyan government and the World Bank entered into a public private partnership to make agricultural insurance more affordable for vulnerable farmers that are exposed to production shocks such as floods and droughts. It was recommended that government subsidise 50% of crop insurance (for wheat and maize) and 100% of livestock premiums of pastoral herders, depending on income (Oxford Business Group, 2017).

Table 11: Institutional options proposed for Kenya

Option	Remarks
Private sector to spearhead process	Index based insurance systematic but not attractive to re-insurers.
Public sector to intervene and lead process, create a public sector entity to spearhead process.	Nearly all public sector agricultural insurance programmes have failed across Africa and Asia due to poor governance and conflicting intentions. Public sector should intervene in case of market failure, research, catastrophic insurance.
Design suitable PPP using strengths of private sector and governments support as a promoter/facilitator.	Most widely adopted model internationally. Mechanisms can include premium subsidies, operating costs, re-insurance etc. Recommended for Kenya.

Source: (Osumba, 2016)

As part of the Kenya Agricultural Insurance and Risk Management Programme, a combination of collecting yield data, statistical sampling methods, GPS tracking and mobile phones is used to support area yield index insurance, for wheat and maize harvests. This pilot programme divides farming areas into insurance units where as little as one hectare can be insured against extreme weather conditions via mobile handsets. When average production falls below a certain threshold on one unit, all insured farmers in the unit receive a pay-out (World Bank, 2016b). Government's role is to provide core support services such as agricultural statistics, capacity building, awareness, networking and monitoring and evaluation. In 2016, an estimated 161 000 producers were covered but the lack of knowledge about how insurance mechanisms work is a major factor for the low take up of agricultural insurance (AKI, 2016). The programme is still in implementation stage and should be completed in 2020 (Osumba, 2016).

In 2017 the UN World Food Programme introduced the R4 Rural Resilience Initiative (R4) in Kitui County with the pilot programme supporting 963 farmers. The programme is a combination of four risk management strategies: asset creation (risk reduction), insurance (risk transfer), livelihoods diversification and microcredit (risk taking) and savings (risk reserves) (World Food Programme, 2018). Crop insurance is accessed by participating in risk reduction measures for water and soil conservation. Farmers are required to adopt dryland farming methods such as moisture conserving pits and growing at least one drought resistant crop (such as sorghum, cowpeas, green grams or millet). Farmers receive cash transfers for time spent on these risk reduction measures to protect their assets, as a contribution to the insurance premium. The programme was extended to cover 5200 farmers in late 2017 by means of collaboration with the national and local government as well as partners in the private sector. The Ministry of Agriculture committed to a 50% insurance premium subsidy. The programme continues to grow and has been further scaled up in 2018 to support 10 000 farmers (Karimi, 2017).

Take home messages:

- Good data is required
- Technology blended with financial innovation can support vulnerable farmers
- Partnerships are key to success and reducing the financial burden of natural disasters
- An integrated approach to climate risk management gives poor farmers access to insurance whilst protecting assets and reducing vulnerability over time.

Malawi

Malawi is a landlocked country in South Eastern Africa, diverse in agro-climatic zones and well-endowed with fresh water, however, challenged with low nutrient soil and dry conditions. Malawi is ranked as one of the most food insecure countries in the world (FAO, 2019b). Between 1967 and 2003 the country experienced six major droughts, affecting over total of 21 million people, and 18 floods, killing at least 570 people and affecting a total of 1.8 million people (World Bank, 2010a). The threat of extreme weather events in such vulnerable farming communities can trap farmers in a cycle of low agricultural productivity. The country's economy is largely driven by agriculture with the sector accounting to a third of the country's GDP and more than 80% of exports (FAO, 2015); however, population growth has placed pressure on agricultural resources and has led to increasing land degradation. Rain-fed cultivation is common practice leaving farmers vulnerable to the effects of climate change and extreme weather events (FAO, 2015). Since 2015, the food securities of more than 8 million people have been affected by drought conditions related to El Nino (FAO, 2019b). Despite Malawi's high risk profile and exposure to climate condition, the budget for contingency funding has been minimal with a high dependency on international aid and disaster relief (Syroka & Nucifora, 2010).

Smallholder farmers in Malawi contribute considerably to the country's economy; however, prior to 2005, these farmers had minimal agricultural insurance experience and were unable to access bank loans and/or credit from financial institutions to safeguard against periods of drought and invest in productive farming practices (Mapfumo, 2007; World Bank , 2009). In 2005, the pilot project, that combined micro-lending with mandatory crop insurance, was launched with groundnut farmers. The participating farmers entered into a loan agreement with a substantially higher interest rate which included the insurance premium.

In 2005, the World Bank in collaboration with Malawi's National Association of Small Farmers (NASFAM), piloted index-based weather insurance to reduce climate related risks in the agricultural sector (IFPRI, 2011) to reduce risk to weather shocks and also to increase the farmers' ability to access credit in the future. The Malawi index-based crop insurance measures the amount of rain recorded at local weather stations. In case of severe drought, it is assumed that all farmers within a 20-30 kilometre radius will be similarly affected. The insurance contract is bundled with loans to farmers that cover the cost of high-quality seeds, providing the opportunity to invest in higher yield and higher return activities (Mapfumo, 2007).

The selection criteria for the pilot was applied to crops handled by NASFAM; the main criterion was drought sensitivity. Other criteria included input usage, marketing system, high value and suitability for smallholders (FANRPAN, 2007). Initially the programme targeted groundnut farmers, with 892 groundnut farmers purchasing weather-based crop insurance policies for a total premium of US$36,600. In 2007, cover was expanded to maize and tobacco farmers (IFPRI, 2011). As the crop insurance contracts mitigated the weather risk associated with lending, local banks started to offer loans to insured farmers. The farmers used these loans to purchase certified groundnut seed. The arrangement of lending coupled with crop insurance allowed farmers to access finance that would not have been available to them otherwise. Access to credit provided the opportunity to invest in higher yield, higher return activities.

By 2008, the number of participants had increased significantly, with ~2600 smallholder tobacco farmers insured for a sum of U$2.5 million and 1700 farmers (maize and groundnuts) insured for US$310000 (Makaudze, 2018). The table below illustrates the take up of weather index insurance since its pilot inception in 2005 to 2011/2012. Without heavy government subsidies, there is limited to no uptake of climate related insurance (Clarke, 2012).

Table 12: Weather Index Insurance Portfolio, Malawi 2005-2012

Crop season	**Number of farmers**	**Crop**
2005/2006	892	Groundnut
2006/2007	1800	Groundnut & maize
2007/2008	605	Tobacco
2008/2009	2606	Tobacco
2009/2010	766	Tobacco
2010/2011	~1000	Tobacco
2011/2012	0	N/A

Source: (Clarke, 2012)

Despite being off to a promising start, the demand for weather index insurance in Malawi did not increase significantly for the pilots to successfully be scaled up. Weather index insurance is said to have failed largely due to lack of adequate infrastructure (Mnela, 2015) and low demand that is exacerbated by basis risk (Makaudze, 2018). In some cases, farmers may have the misconception that insurance is a type of investment and therefore dissatisfied with the poor return on investment, not seeing insurance as a means of transferring risk. In the case of Malawi, without the incentive of the pilot programme, voluntary take up is limited. Added to this, many smallholder farmers receive subsidised inputs under the Farm Input Subsidy Programme which leads to further reluctance to pay a premium for insurance (Makaudze, 2018). Reinsurance is another challenge in the country, given the high likelihood of extreme weather events such as droughts and floods. It has been suggested that a more feasible approach may be to bundle insurance with farm inputs to reduce transaction costs, reduce the risk of defaulting and to reach more farmers (Makaudze, 2018) and to build resilience of vulnerable farming communities so that insurance premiums can be profiled accordingly (Mnela, 2015).

In October 2008 the Malawian government (with support from the World Bank's Agricultural and Rural Development Department and Treasury, and the UK Department for International Development) purchased a weather derivative: the National Drought Insurance (also known as the Malawi Maize Index). The index was modelled using rainfall data from 23 weather stations across the country and the national maize yield assessment tool. The model captured the total amount of rainfall received at each station and its distribution during the agricultural season, and how these rainfall deficits impact maize yields (Syroka & Nucifora, 2010). This scheme was designed as a contingency fund, up to US$4.41million (Clarke, 2012) in the event of a severe national drought in the 2008/2009 season. The pilot had an objective to secure drought financing in a timely manner and establish a price for Malawian drought risk (Syroka & Nucifora, 2010). By comparison the 2004/2005 drought cost the Malawian government US$200 million (Syroka & Nucifora, 2010).

Clarke (2012) refers to concerns regarding claim pay-outs in catastrophic years, as there had been no pay-outs for 2008-2012. However, there had not been a drought with a national impact similar to the droughts of 1991/2 and 2004/5. Another concern was that although the government had a National Drought Insurance policy in place to provide a claim payment in the catastrophic years, no mechanism was put in place to finance 1-in-3 or 1-in-5 year events. In most years, at least one district in Malawi is hit by flooding, drought, or pestilence/disease outbreak. A one in ten-year drought insurance policy does not offer protection for these events. Clarke (2012) argues that the National Drought Insurance cover may not match government's fiscal liability well but may serve as a commitment device for donors. Syroka and Nucifora (2010) suggest that several piloting seasons will be necessary to understand the scope and limitations of contracts under this scheme, and their role in the government's strategy, contingency planning, and operational drought response framework.

In 2015, Malawi signed up to the African Risk Capacity (ARC) insurance scheme that allows governments to pool climate risk, coupled with a promised timely pay-out (Rumney, 2017). Backed by the World Bank, G7 and the African Union, the US$5 million scheme could, in principle, effect faster pay-out in an emergency than humanitarian aid. However, following the 2016 drought, Malawi experienced severe economic loss and a funding gap of nearly US$400 million. Malawi suffered this major loss due to major defects in the model, data and process used to determine the pay-out. Under this scheme, the ARC's index based model measured rainfall to trigger automatic pay-out, however, the model incorrectly indicated a low number of affected farmers (only 20 594 people) and not enough to trigger a pay-out (ActionAid, 2017). The model assumed one kind of maize (long-cycle maize) associated with a longer growing cycle that would be less impacted by the rainfall pattern at the time. However farmers had switched to another type of maize (short-cycle maize) in the 2015/2016 season (Rumney, 2017). Long cycle maize survived the drought while the short-cycle maize that most farmers grew did not (Suliman, 2017).

After reviewing the assumptions of the model, ARC agreed to a pay-out of US$8.1 million in November 2016. The pay-out was made in January 2017 and by then was deemed, too little and too late, to effectively assist the 6.5 million people left food insecure due to the impacts of the drought (ActionAid, 2017). The policy was discontinued.

Further to this, the ARC insurance scheme offered maximum coverage of US$30 million per country per season for drought when an index of rainfall falls below the median for the past five years, raising the benchmark for subsequent pay-outs. If Malawi had continued with this policy, US$24 million could have potentially been paid in premiums without being fully covered in another disaster (Rumney, 2017).

In the Malawian context, not all maize production deficits are caused by drought and the impact of other risks such as pests and flooding should be considered. Index based insurance does not capture risks associated with poor farm management or quality of inputs and as such should be applied in contexts that have made progress in managing these kinds of risks, amongst others. It is also important to ensure that the opportunities and limitations of index based insurance is communicated to relevant stakeholders. ActionAid (2017) reported that the Malawian government should invest in a more integrated social protection system that is adaptive and scalable. It is suggested climate smart agriculture approaches should be supported and linked to disaster risk reduction activities. Contingency funds for disasters and the importance of a dense network of reliable weather stations is also emphasised.

Take home messages:

- Pilots in Malawi illustrate that problems related to production, marketing, and sale of crops can undermine credit repayment.
- Insurance products should be designed to include agronomic features of crops as well as climate conditions
- Lack of infrastructure and basis risk results in ongoing low demand
- Insurance programmes must be integrated into supply chains so that other risks related to agricultural production can be managed.
- Lack of understanding of insurance can lead to dissatisfaction with the programme and resistance to insurance purchase.
- It is important to choose the correct model for country specific risk conditions, especially with high frequency of extreme weather events.
- Response costs should also be considered.

Turkey

Turkey's varied landscapes and climates are matched by rich biodiversity and natural resources; as well as varying risks. With changing climatic conditions, weather is becoming more extreme, leaving one of the world's largest agricultural sectors more exposed to drought, high temperatures and harsher winters. Agriculture producing areas cover about 24 million hectares and the sector that makes up approximately 23% of the Turkish economy. To grow and support the sector, the Turkish government established the National Agricultural Project to improve risk management (crop diversification) and support risk transfer (subsidies) (ADAMA, 2017).

Traditional agricultural insurance dates back to 1957. In these early years, two programmes were available for protection against extreme weather events, namely:

- Government Aid Programme: Ad hoc financial assistance, primarily as direct crop disaster payments and emergency livestock assistance.
- Private insurers: low risk customers or those with specific risks (Bora, 2010).

Though showing much promise, only around 0.5% of agricultural areas in Turkey were insured. The system was based on limited data, under-funded and development lacked experience and expertise. For many years, attempts were made to establish a public private partnership to establish a more appropriate and sustainable system (Bora, 2010). In 2005, the Agricultural Insurance Act was passed, creating an environment for the successfully implemented agricultural insurance pool (PPP) known as TARSIM.

Under this new risk transfer mechanism, government subsidises between 50% and almost 70% of premiums for named perils (to varying degrees in different regions). Insurance companies issue insurance contracts with their own name and transfer 100% of the risks and the premiums to an Agricultural Insurance Pool. Through retrocession insurance, companies individually can take share optionally from the Pool (TARSIM, 2016). Inspectors in the Pool perform risk and damage assessments (Tekin, et al., 2017). Bora (2010) noted some of the benefits of the programme: covers main products, payments are not delayed and farmers also have the option to insure part of a field. TARSIM places emphasis on sound and sufficient data to inform the programme's development and as such data is collected for hail, frost, storm and flood zones (to village level where applicable). The programme also utilises geographic information systems to collect, store and distribute information to make insurance more affordable, efficient and sustainable (Bora, 2010). In 2010 flood and inundation were added to the scope of cover. In 2011, the scope of cover was further extended to include flowering periods of fruit grown in an open area and livestock fattening (Ministry of Food Agriculture and Livestock, 2013). TARSIM continued to diversify products, including cover for additional livestock types, greenhouses and bee hives (TARSIM, 2016). Between 2006 and 2012 take up grew from 12 330 to 744 093 policies totalling a premium of 499TL million (US$278m) by the end of 2012 (SAIA, 2013).

Agama (2017) notes that through the National Agricultural Project, the Turkish government aims to support and grow the sector by dividing the country into agricultural basins based on soil type and climate; allocating specific crops to each basin and moving away from planting water intensive crops in drought-prone areas. The idea is that wheat and forage crops will be subsidised in every basin and government will only provide support to farmers producing crops from the specified list. More recently, studies are carried out to introduce producer income stability insurance (Tekin, et al., 2017).

The TARSIM model has proved successful for Turkey and is being referenced in other countries such as Romania and Azerbaijan. It is expected that with more awareness and product diversification, TARSIM will continue to experience greater uptake of agricultural insurance going forward.

Take home messages:

- Data and sound actuarial risk calculations is critical.
- Risk management should include climate smart practices and not depend on risk transfer.
- Insurance offerings need to meet the needs of the farmer.

Latin America

The Latin American region is made up of 32 countries and covers 205 million hectares, the region includes of the world's most populous countries as well as countries with less than 100 000 people. With a wide range of ecologies, in the tropics to arid lands, the region has high levels of biodiversity and an abundance of arable land. Over 160 million hectares is cultivated across that region in a highly complex farming system and well established agribusinesses particularly with Brazil's soybean and Chile's wine (SwissRE, 2016; World Bank, 2010b). The agriculture sector is key to the economy and livelihoods of Latin American countries that are exposed to many risks that affect agricultural production. Across most Latin American countries, the agriculture sector faces perils such as drought and flood. Hailstorms, tropical storms and tornadoes that are frequently experienced along the Andes Mountains, in the Southern Cone countries and parts of Mexico whilst winter storms are common in Uruguay, Argentina and Chile, and coastal areas are at risk of tidal waves and tsunamis (World Bank, 2010b). In response to these risks and extreme weather events occurring in these parts, agricultural producers and governments have various risk management strategies that vary across the affected countries.

Agricultural insurance systems include formal and informal risk sharing and risk transfer, private insurance schemes and post-disaster government relief. The most common model in the region is a public private partnership that combines public sector support for premiums and technical support, together with private sector provision (SwissRE, 2016). The losses of more severe events that cannot be mitigated for in this manner are pooled into cooperative schemes whilst government support, acting as reinsurers, offer support in response to major disasters (World Bank, 2010b). Public sector involvement in agricultural insurance varies across the region. In some countries, the public sector offers technical support to insurance companies whilst in others, government entities subsidise insurance premiums. Overall, the public sector's role is to create an enabling environment for the promotion of agricultural insurance. There is a movement towards public private partnerships, however, agricultural insurance penetration is not homogenous across the Latin American countries with plenty potential for development in this space. The World Bank (2010b) study states that 89 percent of the countries that have agricultural insurance have some form of public sector support, including subsidies (Brazil and Mexico with highest levels of support).

Agricultural insurance has a long history in Latin American countries, provided by public sector companies between the 1950s up to the 1980s. During this period, MPCI experienced major growth linked to small farmer seasonal production programmes (World Bank, 2010b). Due to high operating costs, low premiums coupled with poor management, most public sector agricultural insurance programmes were discontinued by 1990. In recent years, public-private partnerships have gained more traction with agricultural insurance now available in most (over 70 percent) Latin American countries with an agricultural base and is considered to be relatively well developed in comparison to African countries. Crop insurance is the most developed line of agricultural insurance in the region, with yield-based multiperil being the most common type followed by the growing trend in index-based crop insurance, and then crop revenue insurance. Livestock insurance is a relatively small segment of the agricultural insurance market in Latin American countries, largely offered by the private sector (World Bank, 2010b). Crop insurance is well developed in Argentina, Uruguay, Brazil, and Paraguay; however, it is not as well developed in Chile. Named-peril hail insurance for annual crops and fruits are the main type of crop insurance in Argentina, Uruguay, and southern Brazil. Multi-peril insurance products are the main type of crop insurance in Paraguay, Brazil, Chile, and the northern Mexico.

In terms of access to finance and credit, agricultural producers use different sources of finance, depending on farm characteristics. Commercial farmers access formal financial institutions and sources of credit while emerging farmers can access credit via supermarkets, input suppliers or informal credit. Smallholder farmers generally access the informal credit market and are largely dependent on public sector support (World Bank, 2010b).

The World Bank (2010) notes that promoting agricultural insurance in the region requires bridging the existing gaps in the market by overcoming challenges in the following categories: institutional, financial, technical and operational. The study unpacks the need to understand the characteristics of agricultural producers in order to define an agricultural insurance strategy that would serve either commercial or social objectives. The importance of identifying and understanding the region's risk profile is further noted in order to develop modelling tools to determine probable losses. Weather and production data is critical for the development of index-based products.

Traditional subsistence farming is characterised by a large number of sparsely distributed smallholder farmers, utilising family labour and operating with limited production technology. Most production is for self-consumption and any surplus may be sold at local markets. These smallholder producers generally do not access formal banking and insurance sectors. On the other end of the spectrum, the commercial farmers have large asset bases with investments in expensive technology, and access to the formal financial sector (SwissRE, 2016). Multi-peril insurance products are generally suited and accessible to this sector (World Bank, 2010b). Semi-commercial farming in the Latin American countries includes medium-sized holdings with some investment in production technology. The challenge in this sector is the high transaction costs of insurance products coupled with high transport costs. The World Bank (2010b) suggests that index based (area-yield, rainfall or vegetation indices) could be a potential solution for semi-commercial producers. Though not new to the region, index-based insurance programmes, such as used in Brazil and Argentina, were discontinued in the early 200s due to a lack of demand. An example of successful implementation of a weather based index insurance product is that of Mexico that has been running since 2003. A vegetation-based index was also introduced in 2006, which allows for the insurance of livestock units too (World Bank, 2010b).

Given that more than 80 percent of the total cropped land of the Latin American countries remains uninsured, this offers immense opportunity to develop agricultural insurance in the region. According to the World Bank (2010b), the process will require significant effort from the private and public sectors to overcome various challenges faced by the diverse regional landscape. Agricultural insurance products need to be tailored to the varying needs of clients.

The diversity of the Latin American region has been alluded to and as such some governments (e.g. Costa Rica) have developed variable premiums that take into account different types of farmers, crops and regions. It is suggested that countries offering subsidies should consider modifying programmes along these lines. Offering more sophisticated products is a way of increasing penetration levels beyond named peril products. For example, revenue crop insurance is available for soybeans and corn in Brazil, Mexico and Argentina, and in Chile the industry is offering insurance for high value products (such as avocado and berries). Here is also a need for insurance across the value chain as risk transfer extends beyond production, to volume and quality as well as business continuity. Coinsurance pools is another suggestion for reducing the costs of investment in agricultural insurance in order to reach economies of scale and sustain insurance schemes.

There are also benefits for integrating insurance with other products and services required by farmers. For example, in Brazil even though there are subsidised premiums, farmers are required to purchase crop insurance as a prerequisite for accessing rural credit. Similarly, in parts of Chile insurance is linked to loans.

Latin American countries have seen continued growth in the uptake of agricultural insurance and is expected to experience further growth attributed to increased penetration or the introduction of new products. The challenge is sustaining the current levels of government support for agricultural insurance if the market continues to grow at current rates. Ongoing improvements in product design and delivery mechanisms are expected to increase for the commercial and subsistence farmers (SwissRE, 2016). Brazil, Mexico and Argentina are the three largest agricultural markets in Latin America and are also the largest agricultural insurance markets, with Brazil and Mexico accounting for 90% of Latin America's government expenditure on agricultural insurance. Brazil and Mexico have the most sophisticated financial systems in the region and are among the markets where MPCI has reached the most advanced levels of development (World Bank, 2010b).

Mexico

Agriculture is important to employment and food security in Mexico. However, the sector is vulnerable to a range of shocks. Agricultural producers face some significant perils which include frost, tropical cyclones and drought. Producers have developed ways to mitigate some of the risks by crop diversification and intercropping. In addition, risk transfer measures include crop sharing and cooperative risk pools (SwissRE, 2016). Mexico is said to be leading the way in terms of macro-level market based insurance in Latin American countries. Catastrophic insurance has been offered to government since 2003 and in risk prone areas government carries the premium cost (90:10 split between federal and state governments) (World Bank, 2010b).

Agricultural insurance in Mexico dates back to 1942, established in the private sector, and to date is of the more advanced of developing countries in terms of agricultural insurance products. In 1961 the Crop and Livestock Insurance Act was passed to establish the government run National Crop and Livestock Insurance Company (ANAGSA). The programme included subsidies, of between 45% and 60% of the gross premium rate, for multi-peril cover of large commercial operations. An important feature of this programme was that crop insurance was a prerequisite for the approval of loans (Mahul & Stutley, 2010). However, in 1988 the company then closed due to fraudulent claims, poor underwriting, high administrative costs and excessive losses (Wenner & Arias, 2011).

In the early 1990s private commercial insurers entered the market to offer crop and livestock insurance (Mahul & Stutley, 2010). To replace the ANAGSA programme, the government insurance company Agroasemax was formed to reinsure local private insurance companies and mutual insurance funds ("Fondos") as well as to provide technical advice to the mutual fund. Under this programme, local government purchase insurance from Agroasemax (or private insurers) to indemnify low income, smallholder farmers. In cases where the local government fails to purchase coverage, the federal government steps in with direct support (SwissRE, 2016). In 2001, the Mexican government changed the role of Agroasemax to a national agricultural reinsurer and manager of the federal insurance subsidy scheme. Agroasemax also served as a provider for research and development in agricultural insurance. Since 2003 Agroasemax insured a macro level rainfall deficit insurance cover for government under the Programme to Assist Climatologic Contingencies (PACC). By 2006/7, in addition, Agroasemax launched a remote sensing/ normalized difference vegetation index (NDVI) index product to government, Pasture Satellite Insurance Programme, to measure biomass available for fodder. By 2008, Mexico had a well-developed public private partnership called the National System for Insurance of the Rural Sector (SNAMR) comprised of the three key entities: Agroasemax (as reinsurer), private commercial companies, and mutual companies (including the Fondos funds to support smallholders) (Mahul & Stutley, 2010).

In the early 2000's, Mexico established two emergency funds to provide post-disaster financing: the Agricultural Fund for Natural Disasters (Componente de Atencion a Desatres Naturales, CADENA), and the Natural Disaster Fund (Fondo de Desastres Naturales, FONDEN) (SwissRE, 2016). The fund aimed to focus on property insurance to protect the infrastructure and public assets. The fund expanded to include a Fund for Disaster Prevention which includes risk identification, risk reduction strategies together with capacity building programmes (SwissRE, 2016). CADENA was established to subsidise vulnerable smallholder farmers using index based insurance in a way that allowed for government to be more predictable. CADENA began with drought index insurance for small maize and sorghum farmers but now offers weather index insurance for a range of perils, including flood and hail. The programme was also expanded to include area-based yield index insurance and a remote sensing index for livestock (de Janvry, et al., 2016). By 2013 CADENA insured more than 6 million hectares of cultivated land. Another innovation led by Mexico was to look into linking rainfall index with water rights, as water quotas vary from year to year. The de Janvry et al. (2016) study on the impact of CADENA shows that index insurance has the potential to improve rural welfare and increase agricultural production. However, the study emphasises the need for data in evaluating programmes such as these. Despite some data issues, on a range of their estimates the benefits of index insurance outweighed the costs.

Take home messages:

- The size of the market presents an opportunity for product development
- Product bundling with existing services and products can aid distribution
- Data and innovation in index-based insurance is required to extend coverage

- Governments have a role in providing an enabling environment which includes a regulatory framework and provision of public goods (e.g. weather station infrastructure) and human capital (e.g. training and extension services)
- Index insurance should be used in conjunction with other approaches.

Brazil

Latin America's largest country both by geographical size and population size; Brazil spans 8.5 million square kilometres with over 200 million people. Diverse in terrain and ecosystems, the country's climate comprises a wide range of weather conditions. Agricultural producers are highly exposed to numerous perils such as drought in the eastern states; hailstorms, above normal temperatures and tornadoes in the south (Prevention Web, 2014). The agricultural sector comprises traditional subsistence farming in the high altitude areas of northeastern Brazil, semi-commercial farming systems in the southeastern states and commercial farming towards the south eastern and central parts.

Agricultural insurance was introduced in Brazil as early as 1938, in the form of hail coverage, however, poor performance and high loss ratios led to the discontinuation of the programme. Private insurance dates back to 1997/8 in the form of cover for fruit producing areas of southern Brazil.

In 1954 the federal government established the Agrarian Insurance Stability Fund for market stability and to cover catastrophic risks. This programme was unsuccessful and was succeeded by the Farming Activity Guarantee Programme (PROAGRO) in 1973.

PROAGRO served as a national MPCI programme linked to crop credit to cover settlements affected by natural disasters, pests and diseases. Premiums were further reduced by subsidies to family farmers under the PROAGRO Mais programme (2005) but ultimately, PROAGRO was terminated in 2008 (FAO, 2014). While PROAGRO was in place, State governments followed by establishing their own, heavily subsidised, crop and livestock insurance schemes such as COCAMIG in Rio de Jeneiro and COSESP in Sao Paulo (discontinued in 2005). In 2010, the government also created a Fund for Rural Catastrophe, a supplemental cover for climatic disasters, available to insurers and reinsurers (FAO, 2014).

The current Programme of Support to Rural Insurance Premium (PSR) became operational in 2006, established to assist in financing production costs, reduce cash flow volatility and improve general risk management. The main products offered are MPCI, named peril and crop revenue insurance, largely distributed through the banking system. The split between the indemnity products and index products range from 85% to 90% for indemnity cover and about 10% to 15% for index products. Basis risk[2] of index insurance remains a concern of the banks. By 2016 48 000 farmers were insured with premium subsidies amounting to US$ 107 million. Premium volume for the rural sector grew from US$90 million in 2006 to US$1.1 billion in 2017, 25% of which was related to the current scheme (AXA XL, 2018).

Brazil has a variety of funding sources and programmes for rural credit for different income levels and farm sizes; however, the distribution channels could be improved and policy is fragmented. A further challenge is the uncertainty attached to the fluctuating credit supply that changes from year to year (Agroinsurance, 2018). The study by AXA XL (2018) notes that Brazilian insurers are concerned by the lack of data reliability, distribution channels and products lacking innovation. Given the links to access credit, producers are under obligation to buy agricultural insurance. Producers' access to credit is limited by the financial institutions in their vicinity, which is more readily available in the South and Midwest. The banks access different funds under varying conditions which means that the credit line available across the different regions is a function of the system and not necessarily based on agricultural potential. Further to this, the policy structure also limits balance between agricultural productivity and natural resource conservation (Agroinsurance, 2018).

Take home messages:

- Policy should support simplified access to credit and optimal resource allocation
- Government should support the producers' needs, not only production mix
- Subsidies may have an impact on innovation
- Facilitating the development of index insurance can reduce systemic risk (and reliance on reinsurance)
- Making agricultural insurance schemes compulsory for all farmers (Hatt, et al., 2012).

USA

The USA, with its large size (9.8 square kilometres) and geographic variety includes most climate types, well endowed with natural resources. Cropland covers over 100 million hectares and the agricultural sector is heavily exposed to perils including hail, drought, excessive rain and flooding. In the US, MPCI and crop revenue insurance products are the main forms of protection against these risks, corn and cotton are the main crops covered (Statistica, 2016). Payments are based on the pre-harvest price and the expected yield. However, the payment distributed is for the expected yield at the post-harvest price, which will tend to be higher if supply of a specific crop has become limited (Soil Association, 2017).

Crop insurance in the US began as early as 1938 with the signing into law of the Federal Crop Insurance Act. Operating under high costs and with low take up, the Federal Crop Insurance

[2] *Basis risk in index insurance arises when the index measurements do not match an individual insured's actual losses*

Programme was not particularly successful and as such, under the Crop Insurance Act of 1980 (and later under Agricultural Appropriations Act) government made changes to policy on disaster assistance to encourage participation (Smith, et al., 2017; Nieuwoudt, 2000).

In 1980 a public private partnership was established to improve efficiency of distribution, and make insurance more accessible and affordable (Nieuwoudt, 2000). Low take up rates persisted and in the early 1990s, participation rates were around 30%. An additional programme was rolled out based on group yield risk (risk calculated for areas not individuals), allowing information to be more accessible to insurers and mitigating issues of asymmetric information (Skees, et al., 1997).

Under the 1996 Federal Crop Insurance Reform Act, the programme was restructured to introduce subsidies that significantly increased participation. By 1998, more than 72 million hectares of farmland was insured (Crop Insurance in America, 2019). The 1999 Farm Bill introduced significantly higher subsidies together with increased coverage levels; (Wirtz, 2018). The Agricultural Risk Protection Act of 2000 made further provisions for farmers to access different types of products and increased premium subsidies even further driving down the cost of premiums from 67% to 42% by 2001 (Wirtz, 2018). The 2014 Farm Bill strengthened crop insurance to assist producers in expanding protection against price declines and natural disasters (Crop Insurance in America, 2019). In 2015 coverage levels were more than 70% of expected yields or revenues (Smith, et al., 2017) and by 2018 more than 135 million hectares of farmland was covered under the support programme with premium costs driven down to 33% (Wirtz, 2018).

The US uses the crop insurance programme as its primary risk management tool, albeit as more of a support programme. The safety addresses risks of price volatility and exposure to natural hazards. Highly subsidised crop insurance encourages more production but can also lead to production on marginal land, making the area more vulnerable to extreme weather events.

Take home messages:

- Large subsidies can create a safety net for farmers and impede sustainable use of resources
- Government support should not discourage climate change adaptation and conservation agriculture systems

Australia

Australia spans an area over of 7.6 million square kilometres, with topographic regions ranging from low sandy coastal areas, eastern highlands to vast desert plains. The country generally experiences warm and dry conditions but is also subject to hail and frost, variations in rainfall, frequently experiencing severe periods of drought and floods. Agriculture has played an important role in the development of the country with its dominant farming activities in wheat and sheep production

(Nations Encyclopaedia, 2019) and is also known for its extensive arable land; large beef ranches, wheat and barley fields (Chepkemoi, 2017). Today this diverse agricultural sector contributes approximately 2.7% to the national GDP, employing 2.5% of the population (Binks, et al., 2018).

Changing climate conditions are set to exacerbate drier, hotter conditions and extreme weather events (Nations Encyclopaedia, 2019); already impacting agricultural production. For the 2018-19 period, summer crops have decreased by 23% to 1 million hectares and are predicted to decrease even further, by 33%, meaning a decrease of 2.7 million tonnes. The winter crop area is believed to have decreased by 18% for the 2018-19 period to 18.2 million hectares under production (ABARES, 2019).

The agriculture sector functions in an uncertain climate, as well as uncertain market conditions and as such, farmers increasingly need to manage their risk that partly includes transferring risk in the form of agricultural insurance. In Australia, crop farmers are experiencing higher levels of weather-related risk compared to livestock or horticulture farmers and therefore focus on crop insurance products, representing 90% of the total value of global agricultural insurance policies (NRAC, 2012).

Agricultural insurance in Australia is purely supplied by the private sector, with no government support to insurance schemes. Support, insurance and reinsurance are given by general and or specialist agricultural insurance companies (NRAC, 2012). The MPCI products that failed in Australia were the ones that calculated risk at regional level. Farmers exposed to more risk than the regional average have an incentive to join, leading to adverse selection. In 1974, an area yield scheme was introduced, for Western Australian farmers, where farmers could nominate cover for less than the 75% average yield at a reduced premium. Adverse selection and insufficient, reliable farm data led to low uptake and the schemes termination. A MPCI product was introduced in 1999 to cover fire, hail, crop failure and sprouting downgrade but after only a year it was discontinued due to low demand for the product and difficulties in securing reinsurance. 2011 saw the establishment of a cost of production cover allowing producers to cover production costs if the yield fell below a specified threshold, as a result of drought, frost, hail, fire or flood risks. Individual premiums were offered based on historical production records but are said to be high. The scheme was discontinued in 2012 (Hatt, et al., 2012).

Crop insurance has been around for many years with named peril insurance popular amongst producers. Index based insurance schemes have become available, including weather- and yield-index products, but with limited uptake (NRAC, 2012). An available yield-index product (i.e. YieldShield) combines named peril (for hail and fire) with yield index insurance for excessive or insufficient rainfall, for wheat and sorghum. Uptake has been low due to concerns around basis risk, data; and lack of understanding and trust in the modelling. A weather-index product (CelsiusPro) has pay out structures for a variety of conditions (dry day, dry spell, rain day, rain season, heat, frost).

Demand for the product suite is said to be promising but given the range of applications it could support, it is susceptible to systemic risk (Hatt, et al., 2012).

The demand for MPCI is relatively low due to the insurance premiums being too high and therefore most farmers opt for named peril insurance products; index insurance penetration is limited. The uptake of the latter is more than 75%. MPCI products, and awareness thereof, are limited to winter crops (wheat, barley, oats, triticale, lupine and canola); and as noted by Deloitte (2017) more sustainable MPCI products could increase uptake. In 2003-2007 named peril insurance crop claims amounted to US$70 million (Hatt, et al., 2012) whilst premiums in 2007 were US$ 202 900. By 2009, premium volume decreased by 29% to the amount of US$ 144 000 (FAO, 2011).

Systemic risk is another factor affecting the take up of insurance given the continents susceptibility to drought and excess rainfall that likely affects numerous farmers at the same time (Deloitte, 2017).

Take home messages:

- Awareness creation of MPCI products can create an increase in the uptake of this product amongst farmers.
- Better access to data will support an increase in farm-level data and reduce irregularity of information.
- Government intervention can take the form of:
- Premium subsidies – lowering the cost without causing market failure and without countering efforts to adapt to climate change
- Facilitating information sharing amongst the farmers and insurers.

Lessons from Case Studies

The provision of financial services to the agriculture sector in developing countries is largely constrained by the high transaction costs of serving clients in remote areas where there is limited infrastructure. Technology will become increasingly important to serve these farming communities. Coupled with these constraints are other risks associated with agriculture such as weather, pests, diseases and market fluctuations. For smallholders, the lack of knowledge regarding financial services and the lack of collateral (fixed assets) is a further challenge in obtaining access to credit and building resilience against climate related risks. To build higher participation, the benefits of insurance needs to be promoted and be made affordable and attractive to a wider segment of the population.

The above case studies illustrate that the burden of climate related risks cannot be shifted to the most vulnerable communities at high premiums and at the same time risk transfer measures should be coupled with risk reduction activities to improve resilience and protect agricultural resources.

Options for reducing premiums that are more affordable for vulnerable farming communities need to be considered. No one product is better than the others and different types of products are more suitable in different contexts. However, across the board, affordable solutions need to be based on sound actuarial pricing.

Multi-peril insurance can be suitable for large commercial farmers that are able to mitigate risk exposure and where monitoring can be done in a cost-effective manner. However, South Africa is one of few countries to not receive government support for MPCI.

Innovative technology used with index-based insurance products aim to minimize administrative costs and simplify the assessment process. Area-yield index crop insurance is most suited to combinations of crops where hazards simultaneously affect a crop in a particular region. However an efficient crop-yield sampling and loss adjustment system is required. Weather index insurance has been extensively piloted in Africa but in the absence of large government subsidies, has not proven to be commercially sustainable. Weather index can protect farmers against losses due to extreme weather events but the localisation and low uptake at market prices suggests an alternative approach is needed in developing countries. Weather index crop insurance offers some promise for certain hazards, such as drought, wind, or frost, that have a direct and simple impact on crop-yield losses. Effective weather-based crop insurance products are difficult to design if losses are caused by a complex interaction of weather variables.

For the scaling up of index insurance, governments (and donors) need to actively play a role in enabling and facilitating roles and supporting the development of the sector. Policy makers also need to understand whether insurance subsidies have more influence on farmer's production decisions than cash transfers.

Lastly, there is a need for research in estimating the socio-economic return and the total costs of weather based index insurance (research, infrastructure, technical assistance, premium subsidies, etc.) compared to competing subsidies aimed at strengthening the resilience of small farming production in developing countries (Arce, 2016).

5. Conclusions and Recommendations

Agriculture is becoming more and more at risk from the increase in both the frequency and severity of natural disasters as a result of climate change. The fact that most of South Africa's farmers have no protection from these extreme events means that one of the country's important sectors, which also provides livelihoods to the country's rural dwellers, and food security in the country, are in danger. A lack of insurance also negatively affects a farmer's perceived creditworthiness by lenders. Without insurance farmers struggle to access credit and investment into the sector is constrained.

A key challenge in this area of study is the lack of relevant data and information. It is difficult to measure the impacts of insurance in the unique South African setting when there is so little insurance take up. The use of information to accurately create risk profiles is also a core component of how insurance companies are able to gain a competitive advantage in the industry, thus information sharing is constrained and most of what little information there is on agricultural insurance is not available.

These information gaps should be addressed in two ways. Firstly, an insurance information database could be developed through collaboration between Government Departments, NGO's, academia and the private sector. The first point of call when there is no data is to collect data. Having this centralised point will prevent organisations collecting the same data, or collecting data that was already available. It will also provide a platform to coordinate data collection activities so that data collected to inform one issue can also be used to inform others.

Secondly, to get an estimate of the true causal effects of different insurance schemes will require an experimental initiative such as a randomised control trial (RCT) or a pilot project focusing on one particular commodity or a particular geographic area. The information gained from such an initiative would be extremely valuable to the questions being asked around agricultural insurance in South Africa, and would also help to identify potential issues which would lead to better planning if a scheme is rolled out at the national, or provincial, level. It should be emphasised here that this should be properly planned out and implemented in order to ensure that the data will be able to produce robust research outcomes that are able to speak directly to the issues at hand.

The high transaction costs associated with traditional insurance programmes render them unaffordable to the majority of South Africa's farming community. There are also inherent economies of scale in the way these costs are structured, meaning that they are disproportionately higher for smaller producers. Recent developments and technological innovations provide opportunities to overcome these issues. Of particular note are schemes that base insurance payouts on a weather index, or something similar such as satellite imagery, rather than actual losses. Not only does this reduce the transaction costs associated with agricultural insurance but it also allows farmers to receive payouts before they suffer the loss and use it to take action to avoid said loss. This is a very positive aspect as it means that the economic loss a country suffers as a result of an event such as a drought can be avoided, maintaining the country's domestic food supply and ensuring the sustainability of the country's agricultural sector.

The case studies highlighted how modern agricultural insurance programmes can be highly effective in helping farmers deal with the adverse effects of climate change. However, they also highlight the important role government should play in the rolling out of such programmes. Even with the advances in technology, agricultural insurance schemes are not financially sustainable as a stand-alone and there is a need for government assistance, at least for the implementation phase.

Asides from financial assistance, key roles for government as highlighted from international experiences would include:

- Providing ongoing technical assistance, training, and product development
- Educating clients about insurance
- Facilitating access to reinsurance
- Developing national weather services, infrastructure, data systems and research.
- Creating an enabling legal and regulatory environment, and designing sound national rural risk-management strategies.
- Supporting impact studies and promoting innovation (IFAD, 2010).

There is still a lot of work to be done in this space but it is work which needs to be done. The Actuarial Science discipline is ideally positioned to answer many of the research questions. However, to translate this into a holistic plan will require the cooperation of a diverse group of experts. Government, farmers, financial institutions, NGO's, academia and others will all need to play a role if the desired outcomes are to be achieved. Climate change started a long time ago and the negative impact of the increased risk is already evident. Urgent action is required and it is important that the relevant players get the ball rolling.

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7. Appendices

Appendix A: Municipal Reference Areas for Rainfall Data

District	Municipality	Primary Reference	Supplementary Reference
West Coast	Matzikama	Lutzville	Vredendal
West Coast	Cederberg	Sandveld	Elandsbaai
West Coast	Bergriver	Aurora	n/a*
West Coast	Saldanha Bay	Hopefield	Piketberg
West Coast	Swartland	Malmesbury	Piketberg
Cape Winelands	Witzenberg	Koue Bokkeveld	n/a*
Cape Winelands	Drakenstein	Paarl	Stellenbosch
Cape Winelands	Stellenbosch	Stellenbosch	Paarl
Cape Winelands	Breede Valley	Rawsonville	Worcester
Cape Winelands	Langeberg	Robertson	n/a*
Overberg	Theewaterskloof	Caledon	Riviersonderend
Overberg	Overstrand	Caledon	Riviersonderend
Overberg	Cape Agulhas	Bredasdorp	Caledon
Overberg	Swellendam	Swellendam	n/a*
Eden	Kannaland	Ladismith	Oudtshoorn
Eden	Hessequa	Heidelberg	Riversdal
Eden	Mossel Bay	Mosselbay	George
Eden	George	George	Mosselbay
Eden	Oudtshoorn	Oudtshoorn	Ladismith
Eden	Bitou	Joubertina	George
Eden	Knysna	George	Mosselbay
Central Karoo	Laingsburg	Merweville	Prince Albert
Central Karoo	Prince Albert	Prince Albert	n/a*
Central Karoo	Beaufort West	Murraysberg	Prince Albert

Appendix B: Annual Rainfall per Municipality with Full Imputations

District	Municipality	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
West Coast	**Matzikama**	150	272	144	270	199	237	158	144	92	157
West Coast	**Cederberg**	311	331	132	389	490	538	43	176	24	450
West Coast	**Bergriver**	359	271	214	229	301	288	154	293	82	120
West Coast	**Saldanha Bay**	380	322	322	287	420	342	173	344	71	289
West Coast	**Swartland**	379	462	394	397	358	377	238	376	253	438
Cape Winelands	**Witzenberg**	704	574	771	615	742	780	323	517	257	726
Cape Winelands	**Drakenstein**	588	524	469	371	642	570	286	248	323	606
Cape Winelands	**Stellenbosch**	748	552	444	620	888	650	442	469	443	711
Cape Winelands	**Breede Valley**	1 625	1 321	1 175	1 203	1 317	1 127	901	537	588	1 097
Cape Winelands	**Langeberg**	347	198	222	359	318	341	272	175	147	226
Overberg	**Theewaterskloof**	467	382	384	510	594	468	487	406	359	355
Overberg	**Overstrand**	467	382	384	510	594	468	487	406	359	355
Overberg	**Cape Agulhas**	404	353	323	515	646	494	646	468	393	243
Overberg	**Swellendam**	293	228	244	323	395	367	316	117	248	179
Eden	**Kannaland**	251	260	339	373	339	324	289	311	263	129
Eden	**Hessequa**	362	390	324	663	575	315	483	378	492	397
Eden	**Mossel Bay**	445	730	940	1 098	684	742	764	532	454	411
Eden	**George**	549	795	916	855	822	833	997	675	616	528
Eden	**Oudtshoorn**	218	150	261	397	240	218	156	177	152	124
Eden	**Bitou**	352	532	554	759	557	640	887	404	463	340
Eden	**Knysna**	549	795	916	855	822	833	997	675	616	528
Central Karoo	**Laingsburg**	196	124	242	188	166	220	158	171	92	147
Central Karoo	**Prince Albert**	216	105	161	351	125	210	147	123	46	120
Central Karoo	**Beaufort West**	284	179	562	435	324	267	181	199	213	221