Investigating the Sufficiency of Geographic Diversification in Limiting Contract Grower Risk

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EXECUTIVE SUMMARY

As the global economy experiences the current credit crisis and global warming continues to wreak havoc on the weather and global climate, farmers are faced with a particularly volatile situation at the mercy of both forces. Despite this instability, lending institutions continue to seek methods of expanding their portfolio into agriculture but because of the risks associated with lending to farmers who lack traditional forms of collateral and face price and yield risk, these inroads have been limited. However, market-based instruments are readily available for price risk. Organized exchanges offering the most basic of these instruments, futures and options, have operated for a long time, providing transparency to the market, and low-cost risk transfer tools for those able to access them. While use of price risk management instruments is an incomplete solution, it has sufficient merits on its own and will make the overall burden of risk more bearable. The use of these instruments as well as multi peril crop insurance products is expensive and does not provide full protection for financial lending institutions to limit their credit risk exposure. The article determined whether geographic diversification would be sufficient for lending institutions as a risk management tool to limit credit risk.

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ABSTRACT

Despite the volatile environment farmers are exposed to, lending institutions continue to seek methods of expanding their portfolio into agriculture. These inroads have been limited due to the risks associated with lending to farmers who lack traditional forms of collateral and face price and yield risk. However, market-based instruments are readily available for price risk. The use of these instruments, and multi peril crop insurance products, is expensive and does not provide full protection for financial lending institutions to limit their credit risk exposure. The article determined whether geographic diversification would be sufficient for lending institutions as a risk management tool to limit credit risk.

Key words: geographical diversification, contract grower risk

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INTRODUCTION

South African agriculture is in the process of transformation and agribusinesses need to take proactive action to cope with the new challenges and expectations. It needs to reposition itself in many ways and also develop new strategies and products in changing supply value chains. The risk environment is changing, and especially in developing agriculture, a more innovative approach is required to deal with the new challenges, pressures and risks. The process of BEE also requires a more proactive approach and many stakeholders in the agriculture value chain is impacted upon in various ways.

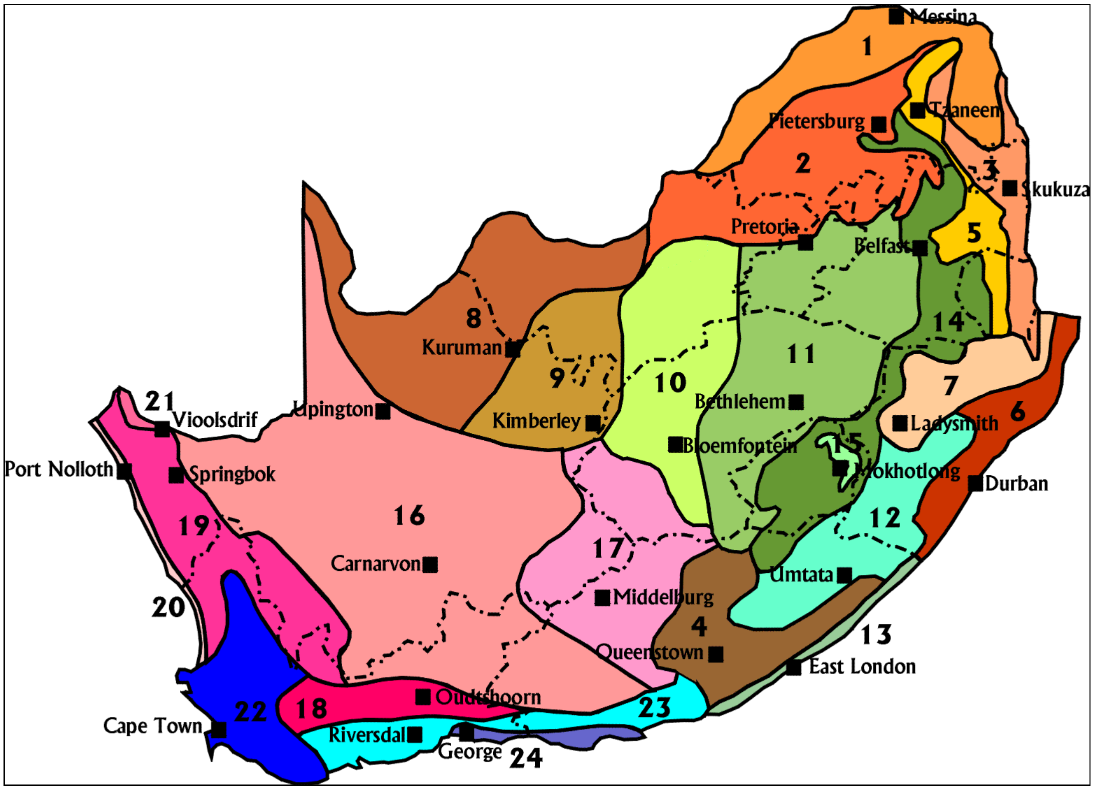
New products are required to use for BEE projects. No reliance can be placed on tangible security other than Multi Peril Risk Insurance but pre-emergence risk needs to be mitigated by, for example, diversifying into different geographic areas as well as minimizing pre- plant costs on projects. The purpose of this article is to identify the risks and risk mitigating solutions for the agricultural projects in which financial institutions is involved in geographical dispersed areas (Lichtenburg and Heidelberg). It involves the risks during different phases of sowing and establishment, growth and flowering, yield formation and harvest. The purpose is to minimize the value at risk for the different stakeholders of financial institutions at acceptable costs. This can impact on the design of current and future solutions.

OBJECTIVES

The specific objectives of the article is to determine the probability of all risks related to hail, drought, flooding, heat, frost and other risks that may occur as well as occurring simultaneously on all the areas planted, to focus on the uninsured part of the risk and to make some recommendations on possible risk mitigation strategies regarding weather.

RAINFALL ANALYSIS

South Africa lies in the semi-arid subtropics where the rainfall is strongly seasonal over much of the region, and is subject to marked internal fluctuations causing periods of drought or above average rainfall. Various studies of rainfall also indicate that the summer rainfall over large parts is influenced by the phase of the Southern Oscillation (see Nicholson & Kim, 1997; Mason, 1995; Cook, 2000 and Nicholson, 2003). The latest climatic classifications figure 1 done by Kruger (2004) and published by the South Africa Weather Service are in general agreement with the above. Rainfall stations used in this study are in regions 10 and 11.



1. Northern Arid Bushveld 2. Central Bushveld 3. Lowveld Bushveld 4. South-Eastern Thornveld 5. Lowveld Mountain Bushveld 6. Eastern Coastal Bushveld 7. KwaZulu-Natal Central Bushveld 8. Kalahari 9. Kalaharu Hardveld Bushveld 10. Dry Highveld Grassland 11. Moist Highveld Grassland 12. Eastern Grassland 13. South-Eastern Coast Grassland 14. Eastern Mountain Grassland 15. Alpine Heathland 16. Great and Upper Karoo 17. Eastern Karoo 18. Little Karoo 19. Western Karoo 20. West Coast 21. North-Western Desert

Figure 1: The climatic regions of South Africa

Source: Kruger, 2004

Temperature and rainfall are the two most important climatic factors to impose restrictions on human exploitation of soil through either under or over supply, or by fluctuations in time. In South Africa temperatures are generally suitable for most agricultural activities during the summer rainfall season. On the other hand rainfall is extremely variable from place to place, day to day, month to month, and season to season, and is the major factor to impose limits on agricultural development and water availability during the growing season.

RAINFALL DISTRIBUTION

The purpose of this section is to statistically analyze and investigate the rainfall distribution with reference to the interactions between rainfall and agriculture for the selected districts, Lichtenburg and Heidelberg, in different geographical and climatic rainfall regions in South Africa. The main aspects of rainfall that are commonly required by agriculturists, land-use planners and farmers concern the various rainfall characteristics such as quantity, spatial distribution, intensity and variability which make up the overall rainfall pattern. This information is also helpful for financiers who would like to know what the risk of their investment is.

Rainfall variability is one of the most important factors determining variability in agricultural production. Economic pressure on farmers often exacerbates the downward spiral of land degradation via irreversible trade-offs between short term economic gains and long term sustainability. In this context Basher (2000), Hammer (2000), Hansen (2002) and Podesta et al. (2002) show that an understanding of rainfall variability is essential for appropriate agricultural risk management, and Nelson et al. (2002) describe how understanding of ENSA-related rainfall variability is becoming increasingly accepted in tactical risk management approaches to agriculture.

The analyses were carried out in two phases, the descriptive and predictive. The descriptive analysis seek to reveal year to year anomalies and variations in a number of rainfall characteristics based on historical data, for stations with records greater than 30 years, under the assumption that weather and rainfall patterns will continue to behave as in the past. The predictive phase is based on describing rainfall in terms of probabilities. Such probabilities can be used to the advantage of and in decision making on a variety of agricultural problems e.g. the selection of appropriate dates for planting, the field – drying of hay and in solving problems of land use and water resources management.

Due to the complexity of the effect of rainfall on agricultural development, interpretation of the results obtained in both phases of rainfall analyses depend on the quality and quantity of available rainfall data and statistical methods used.

DATA AND METHODS

Rainfall, which is the amount of water falling as rain and occasionally as hail or snow over an area and given time, is measured by collecting it in a container and expressing it in millimeter of depth of water per unit surface water in a given time. In the South Africa, rainfall is usually measured at 08:00 by lay observers, individuals and various institutions and organizations.

Rainfall data is sparse and in some areas long term records are unavailable. The probability that some of the rainfall measurement is not made at 08:00 or even on a daily basis, or that small amounts have been allowed to accumulate, gives reason for some uncertainties. Rainfall data could also include missing values which may influence probability studies. Another problem in South Africa is that the rainfalls are mostly of convective origin. Topography also has a major influence on the rainfall pattern, especially over the high ground and Drakensberg regions.

Bearing the above in mind for this study seasonal decadal rainfall totals were calculated from September to April for six selected stations with more than 35 years of rainfall records. A decadal rainfall period can be defined as the period of 10-days between the 1st and the 10th and the 11th and 20th of each month, the last decade of the month having 8, 9, 10 or 11 days (WMO, 1966).

In view of some gaps in the continuity of the data, it was also necessary to fill in some missing values. First, decadal rainfall data values for nearby stations in the same rainfall region were calculated correlated and compared with individual stations data. Missing data was then interpolated. Since the rainy season is from September to April, seasonal monthly and combined 3-monthly rainfall totals covering the seasons were also calculated. The selected stations, their geographical co-ordinates as well as first and last seasons' data available are shown in table 1.

Table 1: Selected stations used in this study

Station	Longitude	Latitude	Season start	Season end
Lichtenburg	26.00	-26.80	1960/61	1999/2000
Heidelberg	28.37	-26.50	1960/61	1999/2000

STATISTICAL PARAMETERS

Standard statistical parameters (average, standard deviation, coefficient of variation (CV)) were used in this study. Also, due to the fact that the rainfall is not normally distributed, a simple method of calculating rainfall probability in the form of cumulative frequency distribution was used.

Probabilities of rainfall in the form of decile/percentiles were calculated for each period by ranking the rainfall from the smallest to the greatest. Decile values divide a set of observations into ten parts so that the nine deciles D1, D2…D9 are such that 10 percent of data falls below D1; 10 percent falls between D1 and D2 and 10 percent falls above D9 as so forth.

The median or the 50% probability or the 5th decile is the middle value of an ordered series of observations that divide the series into two halves: 50% above and 50% below. In arid to semi arid regions the arithmetic mean is not representative of the actual situation and can be misleading and the median is preferred.

The coefficient of variation can be expressed as a function of the standard deviation to indicate the variability of rainfall. However the use of the coefficient of variation has serious disadvantages, as the rainfall data is generally skewed especially when used for short periods. Coefficient of variation exceeding 0.30 tends to indicate a substantial order of aridity with an unreliability factor which will render dry land cultivation exceedingly risky.

RESULTS AND AVERAGE CLIMATOLOGY OF SOUTH AFRICA

AVERAGE SEASONAL RAINFALL

The agricultural significance of rainfall is closely related to its seasonal distribution, specifically where limited seasonal rainfall is reduced by high evaporative demands associated with semi arid climates. In general, the rainy season commences in September with isolated falls over most of the country and last until April. Agriculturally, October to December is taken as the early season (frequently the planting and growing season), and January to April as the late season (the ripening season). The seasonal rainfall distribution is shown in figure 2 and shows that rainfall decrease from east to west and that the eastern parts receive the most rainfall, just over 600mm.

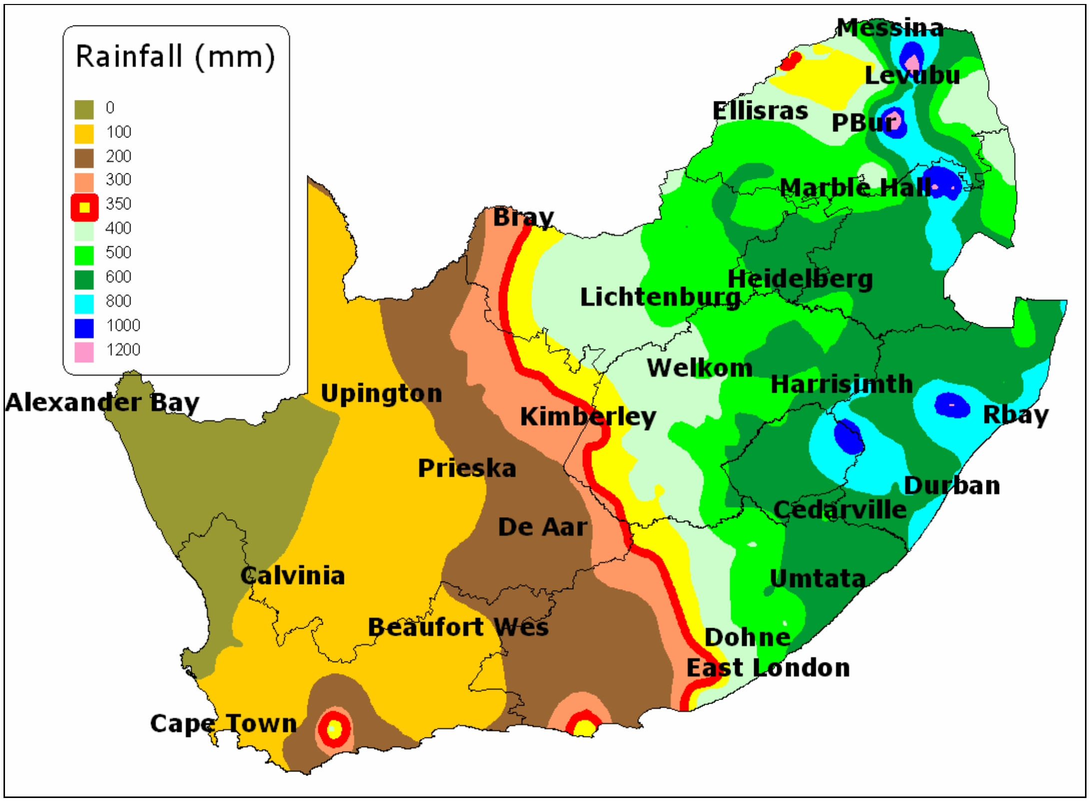


Figure 2: Mean seasonal rainfalls (mm) April-September

Taljaard (1986) found that areas with most rapidly increasing rainfall during monthly intervals are found to follow almost a circular path. Rainfall commences in September over the east coast of the Republic of South Africa (RSA) and is then successively displaced westwards over the central and western parts ending in the Cape Provinces in March. December January and February are the wettest months.

Since the availability of water is a major factor limiting production in dry land farming, the uneven distribution of rainfall and also because only a single crop can be grown during the season, there is an inherent risk involved for dry land farming. A potential geographical area where non-irrigated farming may be practiced, is therefore of utmost importance to land-use planners and farmers in general. As 350mm are generally required for successful cultivation of dry land crops the 350mm isohyets is also shown. This implies that the area right to the red line in the above figure indicates the area where climatic conditions are suitable for the planting of maize.

The study of the seasonal distribution and variability of rainfall will generally start from a monthly or 10-day periods of rainfall. The seasonal distribution and variability of rainfall for the selected stations are best illustrated by the movement of the rainy areas, on a 10-day basis and are shown in figures 3 and 4.

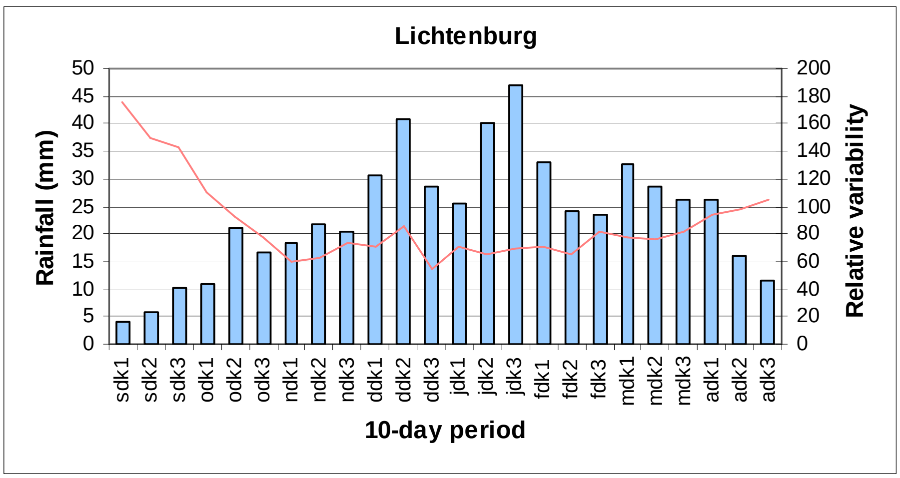


Figure 3: 10-day rainfall and relative variability for Lichtenburg.

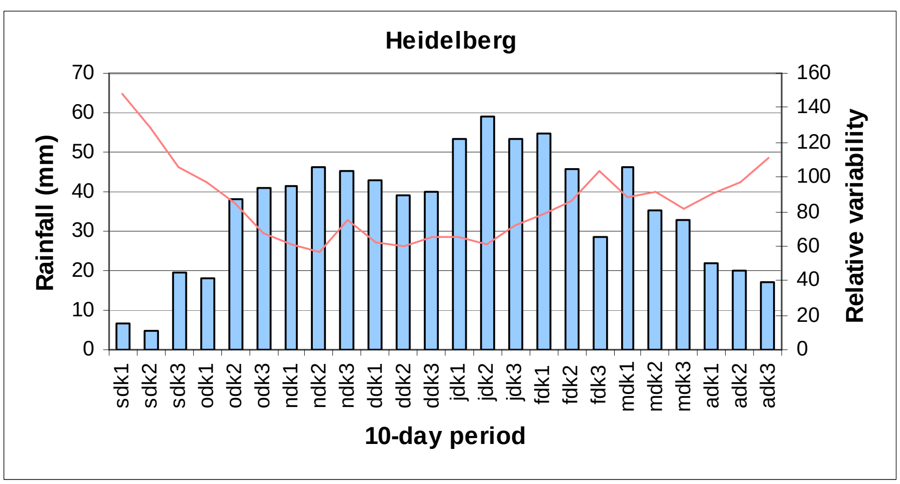


Figure 4: 10-day rainfall and relative variability for Heidelberg

From the figures it is evident that the lower the rainfall during a decade the higher the variability. It also shows clearly that there is a correlation between variability and amount of rainfall. Therefore, the rainfall received during decades that are usually dry (at the beginning and end of rainfall seasons), are more variable.

ONSET OF THE GROWING SEASON - DRY LAND FARMING POTENTIAL

Farmers' cropping strategies are undoubtedly influenced by the variability in rainfall they experience at the onset and at the end of the rainy season. As the first seasonal rains fall on soil which is generally dry at the surface and has a large soil moisture deficit, land preparation and the planting dates of crops depend entirely on the amount and frequency distribution of these early rains. It is therefore important for farmers to know when on average, the beginning of the moisture growing season can be expected, when it ends how long the growing season is.

Kummerow & Giglio (1995) have developed a method of summing forwards and backwards daily rainfall (or 10 day totals), until a certain amount is accumulated. Probabilities of having received given amounts of rain are then calculated. For this study 10-day rainfall totals for the six stations were summed forward and backward (April-September), until a certain amount (25mm, 75mm, 200, 350, 400, 500mm) has accumulated. The values of decades were then ranked in ascending order from the first date that a certain amount had been accumulated, to the latest date that these amounts were accumulated. Probabilities were then calculated of having received different amounts and certain amounts to be received during the growing period.

As maize is the most important dry-land crop grown and cultivated, the threshold for the onset of the rainy season was set at 75mm accumulated rainfall in a decade. The termination of the growing season was terminated by backwards summing of decadal data. The results obtained are shown in table 2.

These results lead to the conclusion that one may expect that in 3 out of 4 years (a probability of 75%), at least 75mm has accumulated by the first decade of November at Heidelberg and two decade later at Lichtenburg where it is the third decade of November.

Similarly there is a 75% probability that 350mm, the requirement for dry land farming, can still be expected by the second and third decade over Heidelberberg. At Lichtenberg 350mm can still be expected by the first decade of November indicating the high risk for dry land cultivation the further west one goes.

This presentation, based on rainfall totals, gives a good overall picture of the risk factor involving agriculture in South Africa. However, the production of crops does not only depend on rainfall but also on the moisture status of the soils, i.e. water balance interaction between rainfall and evapo-transpiration.

Table 2: Onset/end of rainy season based on forward/backward accumulation of 10-day rainfall totals

Lichtenburg								
Probability	25%	50%	75%		Probability	25%	50%	75%
25mm	odk1	odk2	ndk1		500mm	ddk1	odk3	sdk1
75mm	odk2	ndk1	ndk3		400mm	jdk1	ddk2	odk2
100mm	ndk1	ndk2	ddk1		350mm	jdk3	ddk3	ndk1
200mm	ddk2	ddk3	jdk2		200mm	fdk3	fdk1	jdk2
350mm	jdk3	fdk2	mdk1		100mm	mdk3	mdk1	fdk2
400mm	fdk1	mdk1	adk1		75mm	adk1	mdk3	fdk3
500mm	mdk1	adk3	adk3		25mm	adk2	adk1	mdk3
Heidelberg								
Probability	25%	50%	75%		Probability	25%	50%	75%
25mm	sdk3	odk1	odk2		500mm	ddk3	ndk2	odk3
75mm	odk2	odk3	ndk1		400mm	jdk2	ddk2	ndk3
100mm	odk2	ndk1	ndk2		350mm	jdk3	jdk1	ddk1
200mm	ndk2	ndk3	ddk2		200mm	fdk3	fdk1	jdk2
350mm	ddk3	jdk2	fdk1		100mm	mdk3	mdk1	fdk3
400mm	jdk1	jdk3	fdk2		75mm	mdk3	mdk2	fdk3
500mm	jdk3	fdk1	mdk3		25mm	adk2	adk2	mdk3

CROP PRODUCTION AND MONITORING

Maize is the most important crop grown in South Africa and has shown some striking progress in increased yields as a result of the evolution of new drought resistance cultivars and farming techniques. As a result of the evolution of new techniques and cultivars the living conditions of large numbers of farm workers increased causing a migration from rural areas to the cities and a greater consumption of other products such as wheat.

The study analyzed the yields[1] obtained in the two regions over a period of 26 years to determine whether strong correlations exist between the yields obtained in the various areas. Figure 5 shows the yield production for the selected stations for the seasonal period 1980/81 to 2003/04.

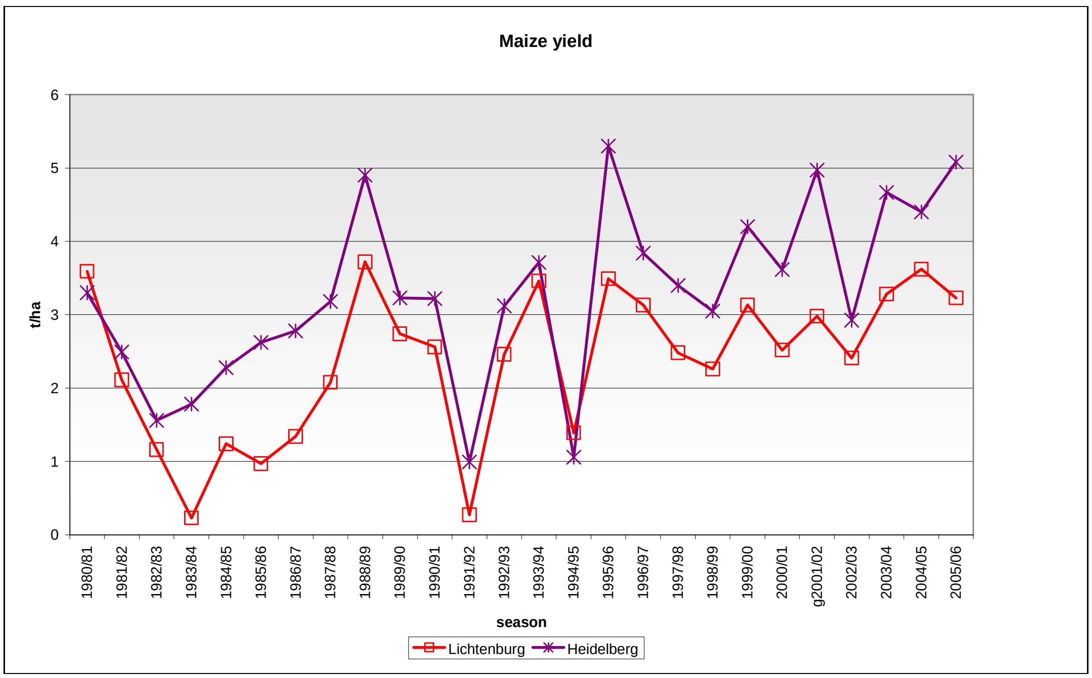


Figure 5: Maize yields for selected stations.

Table 3 indicates the average yields obtained during the period of investigation.

[1] Appreciation is expressed to the National Department of Agriculture for providing the selected data

Table 3: Average maize yields obtained in the selected areas

	1980/81-2005/06	1980/81-1998/99	1999/00-2005/06
Heidelberg	3.3	2.9	4.3
Lichtenburg	2.4	2.1	3.0

A considerable difference between the different periods exists. The next step was to determine the correlation between the various areas based on yield. Table 4 indicates the correlation for the period 1980/81 to 2005/06 showing the relationship between climate variability, like drought, or extreme wet conditions affecting yield at the same time.

Table 4: Yield correlations from 1980/81 to 2005/06

	Lichtenburg	Heidelberg
Lichtenburg	1	0.862923
Heidelberg	0.862923	1

There exists a strong positive correlation between the geographically dispersed areas. Based on the above table, it is clear that diversification based on yields between the areas is of limited benefit. The next step was to break the total data period into two groups, i.e. data for the period prior to 1999/00 and data for the period after 1999/00. Tables 5 and 6 show the results.

Table 5: Yield correlations from 1980/81 to 1998/99

	Lichtenburg	Heidelberg
Lichtenburg	1	0.858377
Heidelberg	0.858377	1

There is again a strong positive correlation between the two stations. For this period, the same argument based on geographical diversification is true. Table 6 analysis the areas based on the last seven years.

Table 6: Yield correlation for the period 1999/00 to 2005/06

	Lichtenburg	**Heidelberg**
Lichtenburg	1	0.736754
Heidelberg	0.736754	1

It is interesting to note is that during this period the correlation between the two areas diminish, although still strongly positive correlated. However, possible climate change and frequent droughts over the same area the past years are of serious concern to the Government, land-use planner's financiers and farmers. This concern is not only because climate change/drought may reduce all crop and livestock yields, but because of the related effects it has on the majority of people and the economy of a country.

Therefore, the monitoring of the growing season and the growth of cultivars (maize and wheat) is an important process in risk management and food security. Forecast of possible yield size in advance becomes a necessity.

CONCLUSIONS & RECOMMENDATIONS

Rainfall is and always will be the main climatic element effecting agricultural and economic development in South Africa. The high frequency of drought and possible climate change plus the present increase and migration of large masses of people can have catastrophic economic and social implications. To safeguard against future famines and possible food and water shortages it is necessary that more research be done on the affect of climatic variations on water food security.

This study consisted of two parts, the first which involved the reconstruction of missing decadal data for six selected stations. Secondly statistically analysis of the 10-day data for the selected stations was done in order to present general aspects, probabilities, rainfall tendencies and possible projections.

From the study the maps and statistical analysis of selected stations, it is clear that that the rainfall distribution is highly variable and varies greatly from the east to west and southwest which makes dry-land farming, especially over the western parts, extremely risky. By employing the method of forward and backward summing of 10-day rainfall for selected stations at the onset of the growing season, when at least 75mm may be expected, is from the first decade of November and the cut-off date by the first decade of March. Temperatures are suitable for most crops grown but a possible increase in temperatures due to climate change will increase evaporation and needs to be investigated.

The study clearly illustrates that more research in crop monitoring, by using the water model in estimating regional crop production, is needed. Risk can be quantified better with a PET model if specific planting dates are available. It is clear from the study that the selected regions have limited risk diversification based on geographic dispersion. It is also clear that the uninsured part of the production season can be better managed with planned planting dates based on a required minimum and probabilities of sufficient follow-up rainfall during the following decadal. More in-depth research might provide insurers with a product focusing only on the un-insured part of the growing season. Based on the average yields obtained during the period 1999/00 to 2005/05, limited risk exists for a total crop failure. With good price risk management strategies financial institutions can most likely obtain a price sufficient to cover the costs even if insurers should pay out due to a bad crop.

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