Exploring the links between climate variability and maize Production in the Matelile Area in Lesotho

By

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I hereby declare that this manuscript is my own original work, and has not been submitted previously for any degree or examination at any other university.

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Abstract

Title:	Exploring the links between climate variability and maize Production in the Matelile Area in Lesotho
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This study examines the link between the climate variables and the maize yields in Matelile village in Lesotho. It also establishes the coping strategies adopted by the local inhabitants. Rainfall and temperature data from Mafeteng station from 1980-2004 were analyzed. Interviews were held with 80 local farmers and household representatives. The results from the interviews showed that most of the local farmers and the household representatives perceive a connection between the climate variables and maize yields. Farmers associate the increase in rainfall during the crop season with an increase in the crop yields. Analyzing the rainfall, temperature data and maize crop yields reflected no significant variation in all the variables over the period. Results from a Statistical Analysis System (SAS) indicate a very weak positive linear correlation of +0.26 between the mean seasonal rainfall and the maize crop yields in the area and a very weak negative correlation of -0.21 and –o.43 between the monthly minimum and maximum temperatures and the maize yields. The paper also presents the adaptation and coping mechanisms adopted by the communities in the area. These strategies however continue to be hindered by some socio-economic factors such as lack of access to financial resources. This raises the need for financial and technological assistance for farmers in the area in order to support their initiatives and therefore help them cope with the distress presented by unpredictable climate variation.

Key Words: Climate Variability, Maize Production and adaptation Strategies

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1. INTRODUCTION

Climate variability has severe effects on rural livelihoods and agricultural productivity (Ziervogel & Calder, 2003; Molua & Lambi, 2006) which are dependent on natural rainfall. The global food stocks are declining as a result of factors such as drought, climate change, and soil loss. These factors continue to threaten the global food security (Mkandawire & Matlosa, 1993).

Among the factors that contribute to food insecurity, climate variability is considered as a major determinant in those regions that depend on rain-fed and labour-intensive forms of agriculture (Parray et al, 1999 & 2004; Döös & Shaw, 1999 and IPCC, 2001a). This however, cannot ignore the fact that there are other factors that affect food security in Lesotho (Mphale *et al,* 1990 and Mkandawire & Matlosa, 1993). Notably, in Lesotho, the problem of food security is not only a rural and agricultural concern, (Van den Boogaard *et al*, 2004) but rather a great challenge for the country as a whole.

Future food predictions show that in about 25 years there will be an increased need to augment yields in major crops so as to provide for the up-surging populations (GGIAR, n.d). Only one study from a series conducted by International Panel on Climate Change (IPCC) indicates an increase in crop yields while the rest illustrate declining yields (Parry et al, 2004).

During the 20th century, Lesotho was referred to as the 'granary of Southern Africa' because the country could produce a surplus. Crop production has declined, the total yields in maize, which is the main source of food have decreased from 1,500Kg/ha in the 1970s to 450Kg/ha in 2005 (Mukeere & Dradri, 2006).

The condition of food security in Lesotho is also intrinsically linked to the available job opportunities. Families regarded as food insecure stay so because they cannot generate enough income to sustain their food needs. These kinds of families endure this situation even in those seasons when reasonable harvests and food prices can be claimed. These circumstances affect about two thirds of households throughout the year (FAO, 2002).

The agricultural sector is the main source of income for nearly 60% of households in Lesotho (Mukeere & Dradri, 2006). The most important crops in the country's economy are maize, sorghum, wheat, beans and peas. Maize is the staple food for almost all the country's people (Moeletsi, 2004) contributing a significant amount of calories protein to the daily intake of the people in the country (Mkandawire & Matlosa, 1993 and FAO, 2005). It constitutes about two thirds of the daily food calorie intake (Mqadi, 2005)

1.2 Climatic Parameters Necessary for Maize Production

As a plant, maize originated in Mexico, (Moeletsi, 2004). Initially, a large percentage of the crop was used for animal feed and just very little of it was used for human consumption (Tollenaar, n.d). Maize has become a staple and the most important food source for most people around the world (Martin, 1989 & Moeletsi, 2004). It is the most high yielding crop and easy to process and digest. Most of all, it is comparatively cheaper than most other cereal crops. (IITA, 2002).

According to Moeletsi, (2004) maize requires different temperatures during its growth as these play different roles in the process of growth of the crop. For best growth, maize requires an average temperature ranging from, 22-25°C, (Muloa & Lambi, 2006). An increase in temperature or decrease in rainfall from the optimum requirements would affect the crop evapotranspiration and therefore the crop output (Giorgis *et al*, 2006). Maize as a plant also has a preferential temperature, with optimum germination temperature of 20-22°c, Early Vegetative 25-35°c, Late vegetative: 24°c, Tasseling and Silking: 23°c, Graining: 6-21°c (Moeletsi, 2004). The process of growth of maize also depends on other factors such as soil type and soil nutrients (Moeletsi, 2004). Maize is well suited in the clay loam and sandy loam which would have the necessary aeration requirements (Muloa & Lambi, 2006). In Matelile, the maize crop season runs from Mid-October to April,[1] during which it is harvested. It is expected that germination of the crop will take place in November-December while January–February is the period during which flowering takes place and pollination can be expected to take place (Maes & Andes, 1983). Changes, particularly dropping temperatures of the favourable climatic conditions for maize growth, can result in a slower process of growth and therefore lower yields of the maize product (Maes & Andes, 1983).

Although there are various factors which play a role in maize production, like, poor land quality, decreasing availability of land and limited resources (Ziervogel, 2003), the focus of this study is on the mean monthly and seasonal rainfall, the mean monthly minimum and maximum as well as diurnal temperature as these climatic variables have great influence in the productivity and yield of maize crop.

This paper also presents the adaptation and the coping strategies adapted by the local farmers. Adaptation is described as a range of adjustments of the ecological and socio-economic environment, taken by individuals or communities to deal with

[1] Derived from the discussions with the local extension officer

possible and or experienced impacts of climate change (Pielke, 1998, Smit *et al*, 1999, Smit *et al*, 2000, IPCC, 2001, Adger *et al*, 2005 and Luers & Moser, 2006). This is a way in which households are able keep up the daily households needs. The adjustments are usually utilized as a response to seasonal hassles (Walker, 1989). Farmers also implement coping strategies which include some short term strategies which help them minimise the adversities of the varying climate (Thomas *et al*, 2005).

1.3 Aim

The study seeks to establish the relationship between climate variability and Maize production in Matelile area and to investigate the existing coping mechanisms of small scale farmers. To address the stated aim, the following objectives have been formulated.

1.4 Objectives

- To trace the pattern of climate variability in Lesotho
- To establish whether a link exists between varying climate and maize crop yields
- To investigate the existing adaptation strategies of the local people

2. MATERIALS AND METHODS

The study focused on the Matelile area which comprised of 11 Enumeration Areas (EA) with a total population of 4824[2]. Random sampling technique was used to select a total of 8 villages, one from each EA to represent the entire area and 10 people were interviewed from each of the selected villages.

A total of 80 people were interviewed. This comprised of 56% female and 44% male. The sample included married and single

[2] Bureau of Statistics, 1996, 1996 Lesotho Population Census Village List

adults who were household heads. The age composition of the study population ranged from 21 years to above 60 years. These were people who have stayed in the area for the period of at least 2 years and or more. The size of households of the respondents ranged from 2 members to 13 members with an average household size of 8 members.

2.1 Recorded Climate and maize Production data

Data on maize crop yields for 1980-2004, were acquired from the Bureau of Statistics Lesotho. The data used were averages at district level, which included the production at the least suitable, semi-arid areas in the district. This data was used because no records were kept at household-farm level in the area of study.

2.2 Field Data

Preliminary visits were made to the study area and the questionnaire was tested on a small group of people to test the clarity of questions. Discussions were held with farmer-groups and structured interviews were conducted with 80 household representatives (some of which are farmers themselves and others were just household representatives). These were guided by a finalized questionnaire (appendix 1). The discussions and interviews were used to elicit data from farmers. The interviews were conducted to establish the perception of the people on the changing patterns of climate and to gain an understanding of thee coping and adaptation strategies used by the local communities. Observations were also made on the current situation in the study area. The data was analysed on a spread sheet.

2.3 Rainfall and Temperature Data

The mean seasonal minimum and maximum temperature 1989-2003, and the mean seasonal rainfall for the Mafeteng weather station recorded from the period 1980-2004, were obtained from the Lesotho Meteorological Service (LMS) (Table: 1 on appendix).

2.4 Data Analysis Techniques

The data were analysed on a spread sheet and graphs were drawn using Microsoft Excel Software. The data were used to establish any relationship between the varying rainfall, minimum and maximum temperature and the maize crop yields. The average and the standard deviation were calculated in order to establish the variability of the crop yields from the average yield in the years.

Analysis of maize yields, rainfall for the period 1980/81-2003/04, minimum and maximum temperature for 1989/90-2002/03 was also made using the Statistical Analysis System (SAS) to determine the Pearson Correlation Coefficient (Table:2 Appendix). The SAS System is a computer program for entering and analysing data. According to Edwards, (1976) and Miles and Mark, (2001) SAS is the most commonly used type of correlation coefficient. The correlation coefficient determines the extent to which values of two variables are proportional to each other. This procedure does not depend on the specific measurement units of the variables being correlated. Used therefore in this study, the procedure would be appropriate in the analysis of the maize, rainfall and the temperature data which are measured in different units.

2.5 The Study Area

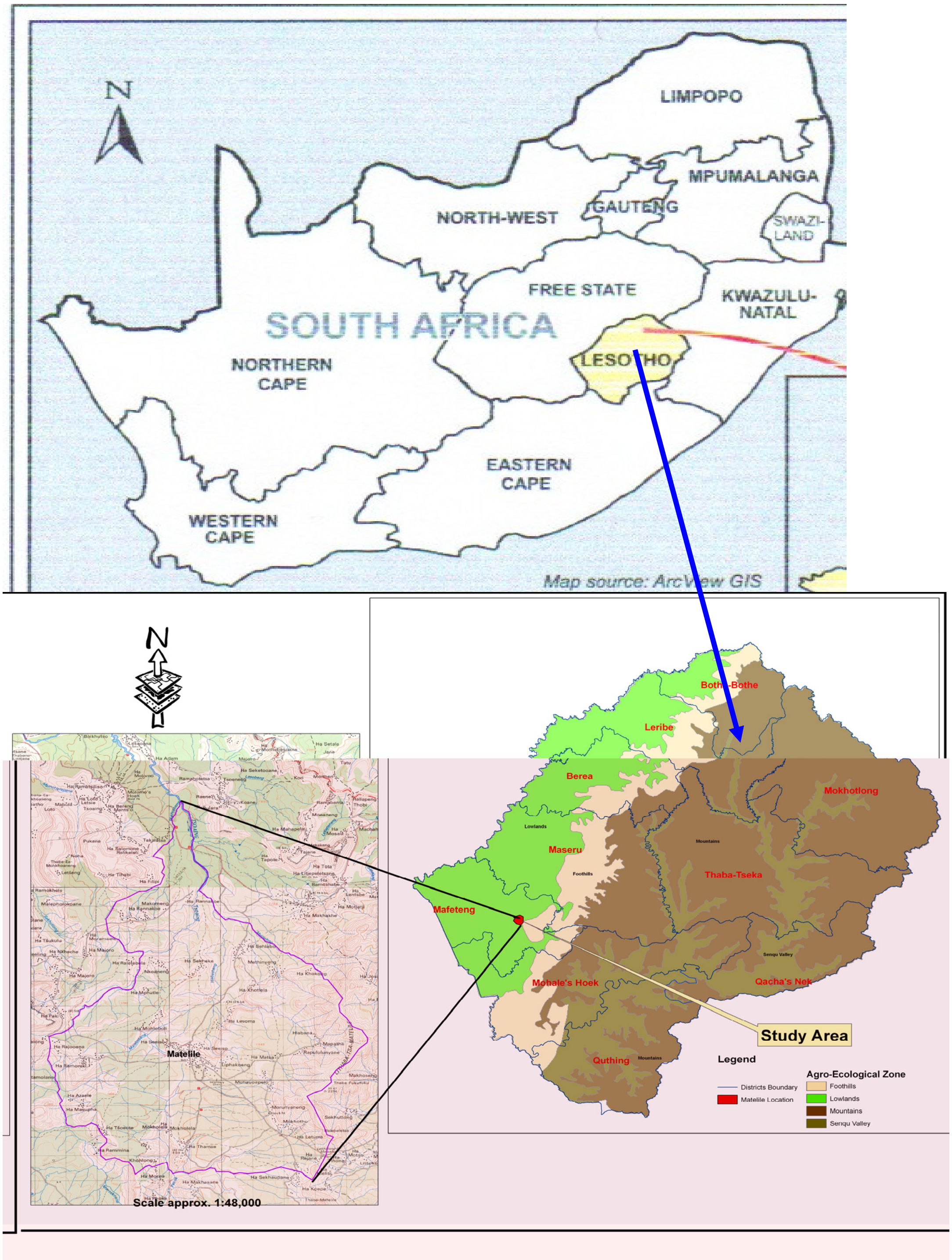
The area of study, Matelile, is located about 95km south-east of Maseru, the capital town of Lesotho. It is situated on the South-East of the Mafeteng district. The area is located on the edge of the foothills of the Maluti Mountains of Lesotho (Fig.1). According to the Lesotho Population census of 1996, the area had a population of

4824 people residing in 11 Enumeration Areas (EAs) (Bureau Of Statistics, 1997). The study area comprised several sub-villages which are dispersed within the area of study. The communities are homogeneous and they share the same cultural believes, except for a slight differentiation of church affiliation. The village also shares the same cultural believes.

The study area is characterized by the Clarens formation and is largely covered with thick layers of loam soil (McLeod, 1989). According to Matsoso, (Per. Com, 2007), the soil in the area is of the Clarens formation as the Leribe type (the main maize producing area in the country). This type of soil is said to be the most suitable for the production of maize and as a result makes the area a potentially valuable maize producing area in the district[3].

In this area, agriculture is the main economic activity. It involves both crop production and animal husbandry. Some farmers are also involved in small stock farming (piggery and poultry projects). According to Moeletsi, (2004), the area has potential for all major crops, maize, sorghum, wheat, beans and peas. The maize crop optimum yield per hectare, are estimated at approximately 3 tonnes per hectare (Molapo, Per. Com, 2007).[4]

[3] statement made by the local extension officer



Source: Drawn by (Moshabesha, 2008)

Fig: 1 Map of the Study Area

3. RESULTS AND DISCUSSION

The section will first examine the farmers' perceptions on the varying climate as gathered from the field work. It will then look into the trends in maize production over the period. Evidence of the effect of climate variability as reflected by the recorded climatic trends will be dealt with. These will be correlated with the farmers' perceptions. Farmers' coping strategies and their restricting factors will then be looked into and finally a conclusion will be made.

3.1 Comparing the Farmers perception and the Recorded data on the Maize Yields

The section intends to establish any connection between the farmers' perception and the recorded rainfall and temperature trends.

3.1.1 Socio-Economic Data

A total of 80 respondents were asked about their source of income, their responses indicated that, while there is an array of sources of income, 57.5%, which makes the largest percentage of respondents, have their household income based on farming (Fig:2)

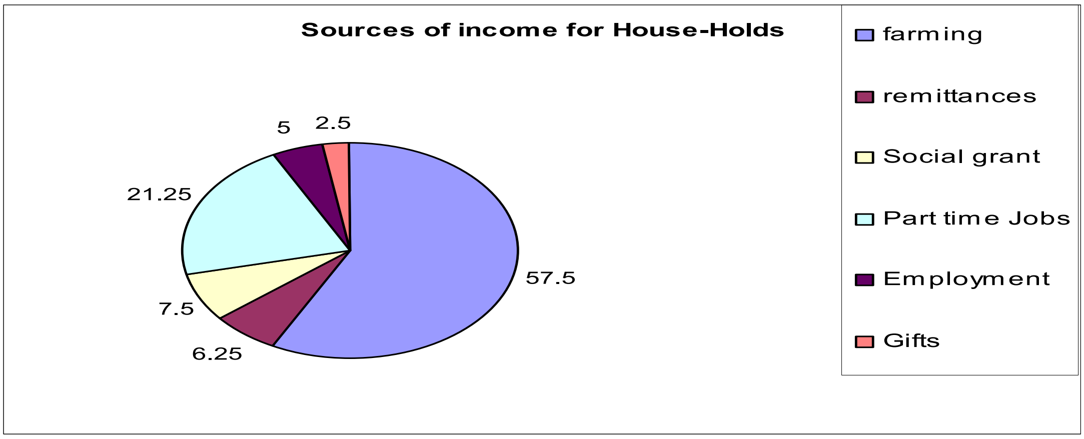


Fig: 2 Source of Household incomes

3.2 Farmers Perception on the Changing climate Patterns

Farmers were asked whether they had observed any change in the pattern of rainfall, and 22.5%, had observed no change in the pattern of rainfall while 77.5% noted a remarkable change in the pattern of rainfall. The implication here is that the majority of farmers in the area have observed a change in the timing of rainfall in the area. In the discussions with the farmer-groups, farmers commented that the change has actually led to a shift in sowing time as they sometimes have to wait for the first rains. A response from one of the farmers indicated that;

> *"We sometimes have to sow our maize in December and some of us opt for the indigenous seeds as those can sustain the drought"*

While some respondents could not exactly remember the occurrences of rainfall patterns in the previous year, Fig: 3 shows that, 7 respondents still indicated that rain came in time, 20 respondents said it came too early while 45 of them mentioned that rain came much too late in the crop season. A link can be made between responses in Fig 2 and 3 that farmers said there wasn't enough rain because it came late in the crop season. As indicated by Mrs Maphathe (a local farmer)

> *"Some farmers, who waited for the first rains, had their crops delayed and ultimately withered because of the early frost."*

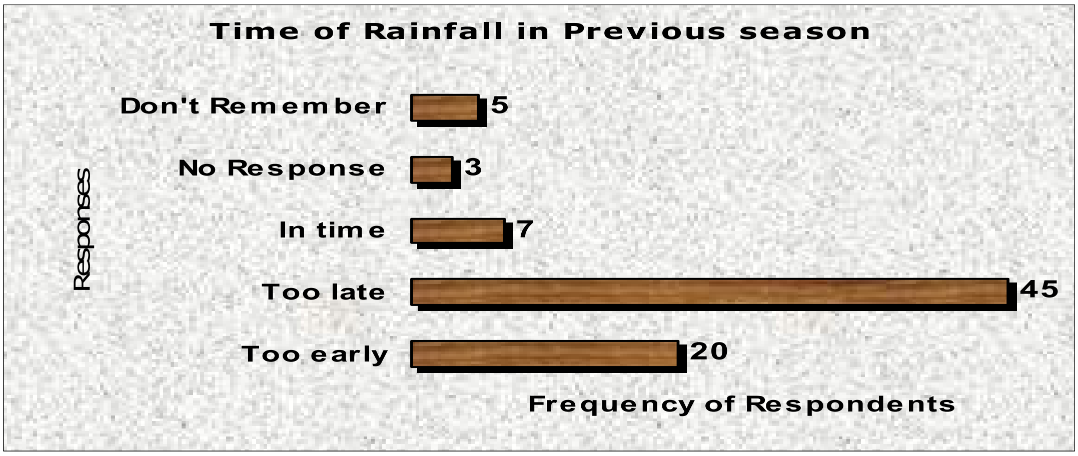


Fig: 3 Perception on the timing of Rainfall in previous crop year

In response to how and where they get weather predictions from, farmers indicated that they have three major sources of information. These sources includes, the radio programme on which weather is normally forecast, their own knowledge and interpretation of the conditions of the atmosphere, and hearing from others what they see or could have heard. Some farmers acknowledged getting the information from the local extension officer, while others did not have any idea but would only start sowing when they see others doing it. Although most farmers mentioned the use of radio weather forecast programmes, most of them indicated that, they are not usually able to follow the advice of the radio because of lack of funds. Those farmers who acknowledged use of their own knowledge also highlighted that their own interpretation of the weather is often not reliable as it sometimes mislead them and they are sometimes forced to leave their fields not cultivated.

When giving their perspective about the current pattern of rainfall in the area, farmers indicated they could not clearly trace the events from the past five crop seasons. They could only clearly remember the events of the previous season. Of the 80 farmers who were interviewed, only 31% of farmers (24 farmers) noted too much rainfall and a 56% (45 farmers) indicated that there was not enough rainfall. About 4% (3 farmers) observed enough rain (Fig: 4).

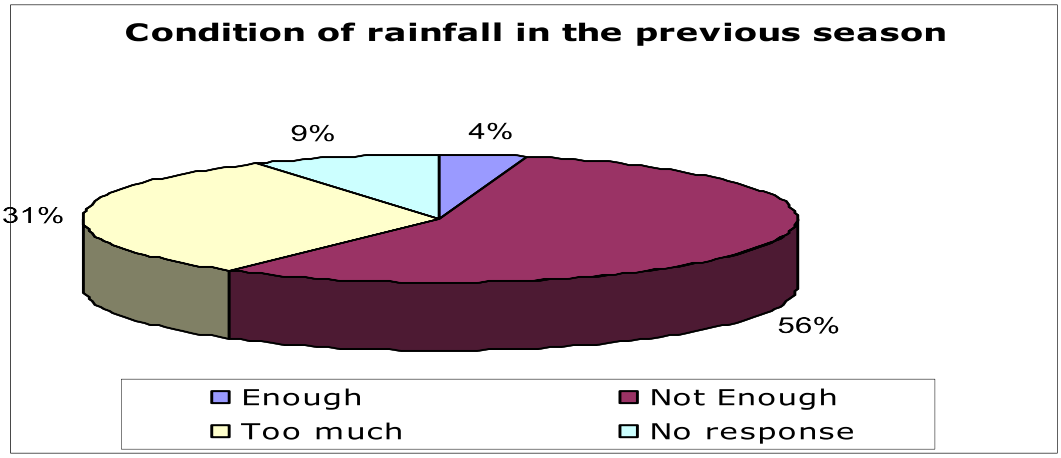


Fig: 4 Condition of Rainfall in the Previous Season

3.3 Analysis of Maize Production Trends

An analysis of the annual maize production data for the area reveals that maize output has varied during the study period (Fig: 5 & Table: 2 on the appendix). The average maize yield recorded during the study period 1980- 2004 is ±0.487 metric tonnes per hectare with a standard deviation of ±0.253. An observable trend in the recorded maize yields indicates a decline in the total production (Fig: 5), thus falling below the optimum output per hectare (3tonnes/h)[5] expected in the study area.

[5] Derived from a personal communication with the District Agricultural Officer

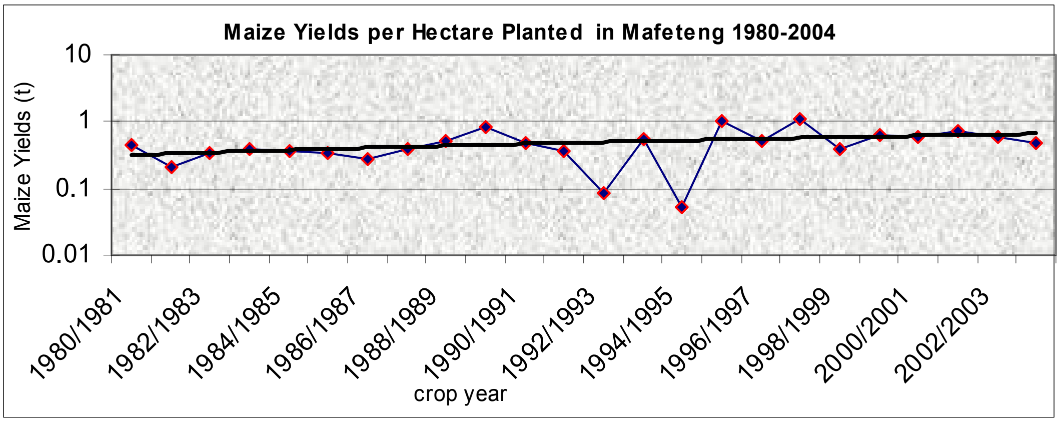


Fig: 5 Maize crop Yields in Mafeteng recorded over the period 1980-2004

3.4 Analysis of Recorded Climate

3.4.1 Rainfall

Fig: 6 reveal a mean seasonal rainfall distribution in the years from 1980-2004. A varying pattern in the seasonal rainfall can be observed throughout the period 1980-2004. This trend is also reflected in table 2 and Fig: 7 (a-h) of the appendix, which presents a noticeable monthly fluctuation of rainfall in the maize crop seasons (October-April) over the period. This can translate into an unstable seasonal water supply for the maize crop.

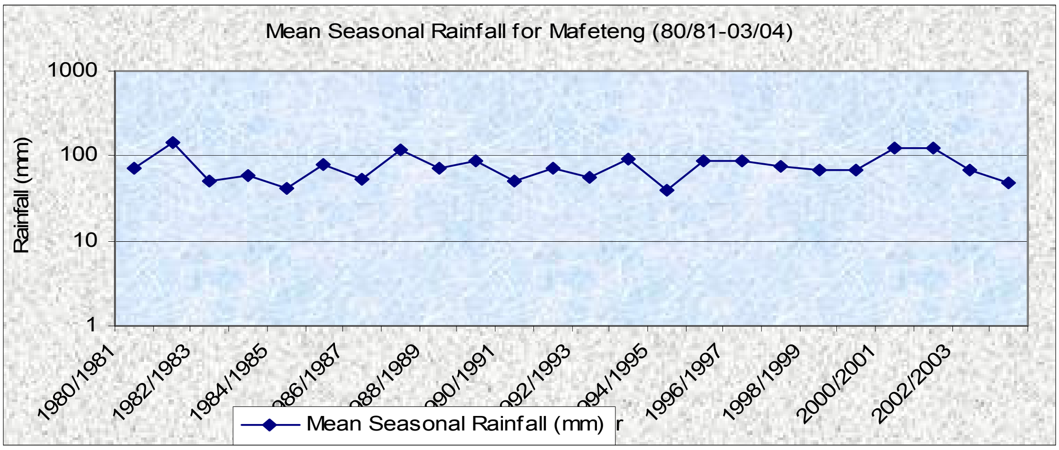


Fig: 6 Mean Seasonal Rainfall for Mafeteng for the period of 1980-2004

During the 1989/90 crop season, the September-October rains remained below normal during the germination. The flowering period up to the end of the season experienced increased rainfalls.

This relatively good rains, collate with a slightly higher average yield of 818Kg per hectare (Table: 2 on appendix).

The below average yields in the 1990/91 crop season can be linked to the pattern of rainfall distribution displayed in the crop season. Very low quantities of rainfall (10mm) are recorded for September, October and November. Adequate rainfall (100mm) was only seen late in February. The low rainfalls could have had an effect on the reduction in planted and harvested area and therefore also affected the total crop yield. It could also have affected both germination and flowering of the crop thereby reducing yields.

The crop year 1991/92, recorded good early rainfall in September and October period, yet this was followed by reduced rainfall during the flowering season and right through the crop season (appendix:2). The overall yields in the year remained below average (Fig: 8 on appendix). The 1992/93 period experienced poor crop yield. The rainfall in the crop season remained very limited throughout the season. The 1994/95 experienced the poorest average crop yield of all the years under study. This can be ascribed to the poor distribution and quantity of rainfall in the season where in the period from September to December, rainfall remained far below normal with a slight increase in January and later in March.

The crop years, 1995/96 and 1997/98 produced the highest yields in the period. Although both years experienced limited early rainfall, they both recorded slightly higher quantities of rainfall in the flowering period and across the crop season. This could have had an effect on the total output in these years. The season 2001/02 also recorded slightly higher than average yields and this can be linked to adequate rainfall that is seen to have spread throughout the crop year.

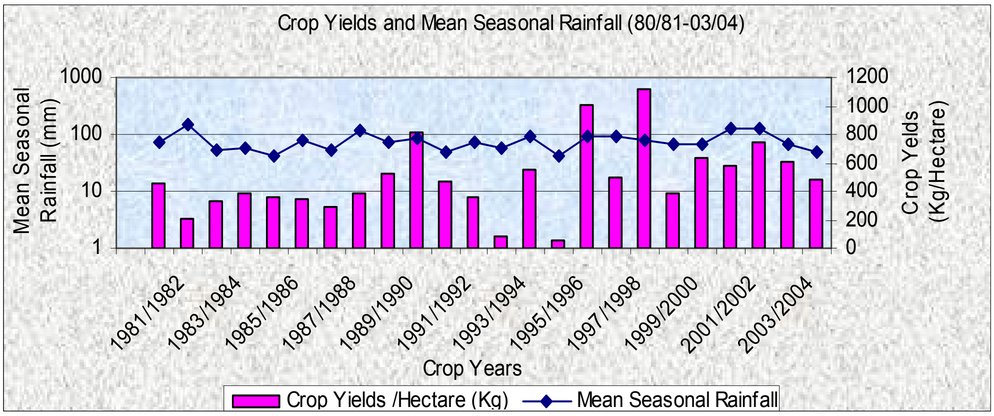


Fig: 7 Mafeteng Crop Yields and Rainfall Distributions 1980/81 2003/04

3.4.2 Temperature

Fig 8(a-n) on the appendix, presents the monthly minimum and maximum temperature for the maize crop season in the years 1989-2007. In the 1991/92, the season experienced temperatures at 29°C-30°C during the flowering period of the plant and yet the same season experienced very poor rainfall during the same stage. A link between these variables and the crop yields can be established. Since it can be expected that high temperatures and limited rainfall could result in higher plant evapotranspiration, this can therefore lead to plants withering and decreasing yields. The low yields in this season can be explained by this kind of climate. This was the case also in the years 1992/93 and 1994/95

The two crop years 1995/96 & 1997/98, during which the highest yields were obtained, reflect temperatures ranging above the optimal temperature during the flowering period. This together with the adequate rainfall as shown in Fig 4 can be used to explain the increased crop output in these crop seasons. During the crop season, 2001/02, the high temperatures in the tasseling period accompanied by sufficient rainfall can also be used to justify the above average yields.

3.5. Correlation of Climate and Maize Production

As gathered from the farmers' responses on the issue of the changing patterns of rainfall periods, it is clear that 75% of farmers are aware and believe that the rain-season has shifted a bit and thus has affected the sowing periods for the maize crop and other cereal crops in the area. This is also confirmed by the local district extension officer who stated that the maize crop was sown starting in October to mid November. From their responses, farmers give the impression that the decline in the crop yields in the area can be attributed to the variability of the climate which sometimes bring late onsets of rainfall, dry spells causing plants to wither and sometimes early frosts thereby affecting the crop productivity.

According to the farmers, if rainfall comes at an appropriate time and in good quantities during the crop season, it implies good harvests for them. Based on fig: 4, it can be deduced that farmers are concerned with the varying rainfall patterns received during the planting season. This determines farmers' decisions on whether to plant or not to plant their crops. Farmers are sometimes forced to leave their land fallow for fear of taking a risk on the unpredictable weather conditions.

The meteorological data used reflect a fluctuation in the amounts and the distribution of rainfall during the period (Table 1 Fig: 6 and Fig: 9 (a-h) on the appendix). An observation made on the monthly rainfall distribution graphs show that during the planting seasons, throughout the period 1980-2007, there is a great deal of variation in the quantity and the timing of rainfall. The monthly rainfall distribution shown on appendix 2 reflect inconsistency in the rainfall with some seasons such as, the 1991/92 experiencing good early rainfall, 1992/93 starting off with limited rains and continuing right through the season, the 1994/95 continuing with inadequate rainfall, 1995/96 and 1997/98 with limited early rains and slightly higher rains during the flowering period of the plant. This verifies the farmers' perceptions on the unreliability of rainfall and consequently influences the farmers' decisions on when to started planting.

3.4.1 Statistical Correlation

Pearson Product Moment Coefficient of Correlation procedure (Edwards, 1976) was run for the four variables to determine any form of association between the variables

The statistical finding for the correlation coefficient between maize yields and seasonal Rainfall is +0.26, which is weak. This is a weak positive linear relationship between the two variables. The implication here is that, with an increase in the independent variable (Rainfall) there would be an expected increase in the dependent variable (maize). The correlation between maize crop yields and minimum temperature and Maize crop yields and maximum temperature reflect a coefficient of -0.21 and -0.43 respectively, thereby denoting a very weak negative linear relationship. This however does not necessarily reflect a causal factor. It denotes that an increase in the independent variable (Temperature) would be associated with a decrease in the dependent variable (Maize yields).

A Regression procedure modelling minimum temperature, maximum temperature and rainfall as explanatory variables for maize crop yields, results in an insignificant model. The variability of maize crop yields that is explained by explanatory variables is

30%, which is not a good fit of test. The model of the rainfall against minimum and maximum temperature is not significant. This model has low R-squared and all the parameters are not significant at a 5% level of significance. However, even though there are no statistically significant differences for small scale farmers, any changes at family level is individual and should be treated at individual level.

3.5: Adaptation and Coping Mechanisms

The section will present some of the farmers' adaptation and coping strategies as established through interviews and discussions. From the interviews conducted, respondents mentioned different adaptation and coping strategies they have adopted to cope with the perceived and the actual climate variability in the area. Table: 3 presents some adaptation strategies used by the local inhabitants. Some activities appear to be common to most households while others are adopted by only a few house holds. However as stated by the respondents, even those activities frequently mentioned, sometimes cannot be sustained due to shortage of money.

Table: 3 a set of Adaptation Strategies adopted by Farmers

Adaptation Strategy	No. of Times mentioned	% of Farmers
Change in planting season	13	16
Leaving fields uncultivated	43	54
Use of technology	23	29
Use of agro chemicals	16	20
Diversification of crops	06	08
Use of small plots for vegetable production	08	10

** Some farmers adopt more than one of the strategies

3.5.1 Change in planting season

Farmers have opted for the shift in the sowing times. As they put it, farmers have realised the need to shift from sowing maize in the September month to sowing in the October month. This is to try and meet the changing rainfall seasons. When asked of the means they use to cope with the varying climate in the area, one of the farmers indicated that the Matelile area has different zones. In the one area, lying on a higher altitude (along Ha Hlabana- Mohau-oa-Pelo) frosts tend to catch up earlier, while in another, on a lower altitude, (along Ha Sekheke-Ha Thamae) frost comes a bit later. The farmers have learned to sow their seeds in the areas at different times, starting with the area that catches frost first.

3.5.2 Leaving Fields uncultivated

Farmers were also asked to indicate what decisions they would take if the rainfall was either too late or too early. Their responses reveal 16% would not planting, that 27% would continue to sow the seeds when the season begins regardless of the rain and 40% would wait if the rains were perceived to be late. The fact that most of the farmers would wait for rains to come implies that farmers use the arrival of rain to decide on their planting and that they consider availability of rain as crucial for planting.

3.5.3 Technology

Adaptation of the new maize seeds and some pesticides helps some farmers to increase their productivity. Some farmers have engaged in some seed multiplication activities. Derived from the respondents, farmers formed the Common Interest Groups (CIG) in which farmers with common interest come together and establish projects, for example, the seed multiplication process which is supported by the local department of Agriculture who assist the farmers with the necessary skills and equipment.

3.5.4 Use of Agro chemicals

As an attempt to improve fertility of soil in the area farmers sometimes opt for the use of organic manure as well as ashes (see fig: 9). This is particularly the case with those farmers who cannot afford to buy artificial fertilizers.

3.5.5 Diversification of Crops

This refers to the growing of a variety of crops over two or more ecological zones (Sahn, 1989). Farmers have adapted the idea of switching from one maize cultivar to another depending on the cultivars ability to resist drought and or grow faster. One farmer, Mrs Mokone, has involved herself in a seed multiplication project which helps farmers with drought resistant varieties of maize.

3.5.6 Use of Home Stead Gardens

The Mantloane[6] initiative (small plots) (Fig: 10) was meant to help women grow vegetables on small manageable plots in order to minimise water requirements. Some households who occasionally depend on the production of vegetables from their homesteads indicated that they got frustrated by the drought and shortage of portable water.

Farmers were asked about what other activities they carry out to maintain their household income and food. Farmers indicated that coping with the varying climate has forced local small scale farmers to employ some short term. These activities include among others, joining self help groups which help farmers raise money to buy household groceries. These activities are meant to support the

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[6] The Idea of mantloane was introduced by the World Vision Project as a way to help women to improve their household food Consumption by producing vegetables in the yard.

local households' livelihoods. However, the activities still cannot bee sustained due to financial restrictions. For example, those respondents who mentioned women self-help groups indicated that the initiatives sometimes fail because members cannot afford to pay the monthly subscriptions. The short term jobs are also very unreliable as means of coping as they are only very temporary and sometimes seasonal (hoeing, ploughing) and also depend on whether the providers can afford to pay for such services.

Table: 4 List of Coping and Adaptation Strategies used by Respondents

Coping Strategy	No. of Times mentioned	% of Farmers
Joining Women Self-help groups	22	27.5
Short-Term jobs (laundry, Hoeing, Ploughing, Rehabilitation Projects, building,)	14	17.5
Renting or Share cropping (plough, planter, Oxen)	14	17.5
Renting out farm equipment	13	16.25
Vegetables Around Home stead	11	13.75
Home Brewing, Selling Fruits and Vegetables, mealie-meal	14	17.5
Remittances	9	11.25
Raise and sell Live-stock, poultry, piggery	14	17.5
Hand-outs from family members	2	2.5
Knitting & Sewing, Hawkering (selling clothes)	2	2.5
Traditional Healer	1	1.25

Source: Responses from the sampled population.

** Some farmers adopt more than one of the strategies

3.5.7 Seeking Short-Term Jobs

On different occasions men and women are recruited from their communities to participate in the government initiated donga Reclamation Projects (Fato-fato) Fig: 11. Villagers take it in-turns to work in the projects. This activity is very short lived as the people can only join once in year, for period of a month, for a wage of

M850.00[7]. Although this is a short-term opportunity, residents see it as a way through which they are able to add to their household incomes and therefore improve their food consumption.

3.5.8 Off- farm Activities

Some residents, who were contacted, reported that, at the end of farm activities, they involve themselves with some part-time jobs where they maintain and sell their livestock, and sometimes wait to be hired by other affording households. Farmers who do not own fields often go to help those who have fields so that they get paid either in cash or kind. At the end of harvest women often join hands in threshing grains (Fig:12a-b) and those helping would get the maize cabs to use as fuel for fire and then can also receive food grains in payment. Some members carry out some fire-wood collection, which they use for their own food preparation and to sell to those who brew beer in the village (Fig: 13). This is their way of making money. This however is hindered by the fact that walking to the nearest mountain to fetch the wood is very tiring and that there isn't as much wood on the mountain as there used to be.

3.5.9 Sharecropping

Some farmers indicate that, because they cannot afford to cultivate their own pieces of land, they often opt to rent out or share-crop in their fields with others who can afford to cultivate but do not have fields of their own. The government of Lesotho has since the 1980s been subsidizing seeds and fertilizers as a way of assisting farmers[8]. However, despite these subsidies, most people still cannot afford to purchase the inputs[9]. Evidence from the study

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[7] M, represent Maloti, the currency of Lesotho which is dispensed as equivalent to South African Rand. Loti (singular) Currency of Lesotho L1.00 = R1.00. South African Currency Maloti (plural)

[8] Discussion with the local Extension Officer

[9] Comment from the District Agricultural officer

site show that, 68% of the respondents confirmed use of farmer saved seeds from previous crop. The subsidized inputs have therefore not made any significant effect on the productivity of the area. On the other hand, the farmers who have received subsidized inputs have the tendency to consume the subsidized inputs particularly when the inputs come later than are expected, (Matsoso, Per. Com, 2007)

3.6 Factors Hindering Coping Strategies

While farmers have adopted an array of adaptation and coping strategies, a number of factors still hinder effectiveness of these strategies in the area.

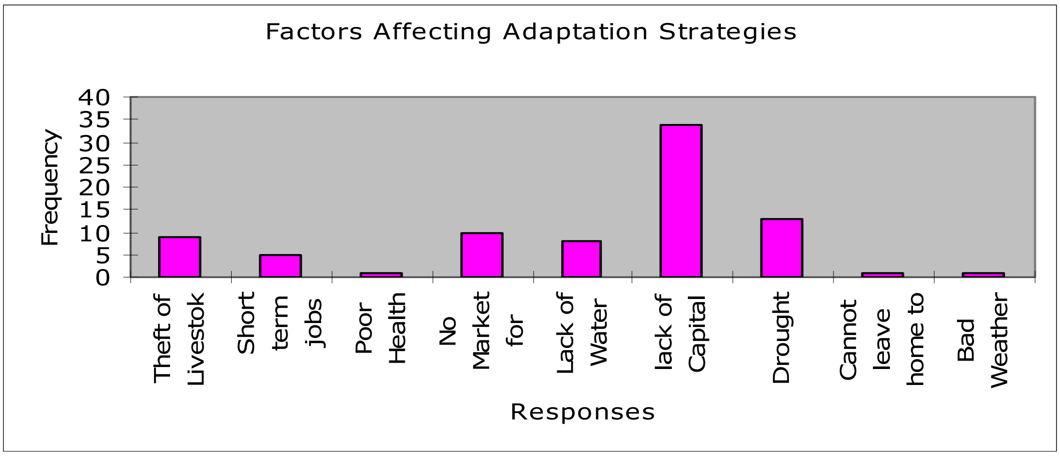

Fig: 14 Factors Affecting Adaptation strategies

Fig: 14, illustrates the responses of farmers on the question on what factors restrict their adaptation strategies. The most frequently mentioned factor that hinders the effectiveness of the adaptation strategies is lack of money capital to start the supporting projects.

Lack of storage also places a major problem for farmers in situations where they have gained reasonable harvests. This sometimes forces farmers to put their harvest in unprotected places (Fig:15) and to either sell their crops usually at low prices in order to protect themselves from losses as a result of bad weather, thieves and from being attacked by pests such as weevil.

Shortage of portable Water

The shortage of portable water around the area is most evident (see Fig: 16) and restricts the production of supplementary food such as vegetables. Farmers who have been involved in homestead vegetable production claim that they are often restricted by lack of water.

As a result of the topology of the area, soil is lost through water run-off, (Fig 17 a-b). This washes away large quantities of top-soil thereby reducing arable land that in turn affects crop production.

4. CONCLUSIONS

Observation is made from the data presented that the overall food production in the area has declined throughout the period under study.

While it can be concluded that climate variability have some impact on the issue of food production, this cannot be over emphasized as there are other factors that also play a significant role in enhancing the maize crop yields.

Farmers' perceptions do not correspond with the recorded climate data as most farmers' cannot recall the incidences of the previous crop seasons. According to farmers, most of them make their decisions about cultivating and sowing based on the conditions of the weather which they either get from the forecast or from their own indigenous interpretation of the weather. Farmers have a perception that rainfall is unpredictable and therefore it is influencing the crop yields because they then decide to plant.

The pattern of rainfall and temperature in the Matelile area presented by the meteorological data indicates a significant fluctuating pattern in rainfall that varies from year to year and from season to season. This can be used to support the farmers' perception. However, results from the Statistical Analysis programme indicate a very weak positive and negative correlation between the climatic variables and the maize yields. This therefore implies that for farmers, their perception is more of a variable than it can statistically be proven. However, any change at individual family level need not be generalized but instead it should be looked at individual level.

Farmers in the Matelile area have acquired several adaptation and coping strategies. Most farmers are forced to leave their fields uncultivated if their interpretation of the possible weather is not favourable. Farmers also have adapted some off farm activities which help them cope with the implications of the varying climate. However, some of the strategies are more often than not hindered by a lack of capital. The government initiated efforts such as the provision of subsidized inputs often fail to reach farmers in good time and so they have not shown any effect on the increase in output. In some cases farmers who fail to get the seeds at the right time even go to the extent of washing off the chemicals from the subsidized seeds and consuming those. Farmers believe that the use of subsidized inputs could help boost crop productivity if they are applied within the appropriate crowing season.

5. RECOMMENDATIONS

Although farmers have a fair knowledge in climatic change and have even adopted some adaptation and coping mechanisms, devoting more resources in farming is very important. This could assist the rural farmers to generate their own income and therefore be able to secure their own food and or supplement the food requirements with food from the market.

There is need for improvement in the generation of employment, particularly for the poor rural communities if they have to overcome their problem of food insecurity. This would boost their purchasing power and therefore their access to food sources.

A review of policies is critical to ensure promulgation of policies which accentuates technology that will incorporate indigenous solutions through the participation of residents in the decision-making that involve them. A change in policies needs to be backed-up with the basic assets. Legal institutions can be put up within rural communities to promote accountability especially of funds in the self-help projects.

There may also be a need to divert farming towards some more suited cash crops or vegetables like cabbage and spinach which do not need intensive irrigation. However, this also calls for provision of basic services such as portable water structures within rural communities so as to assist the farmers in maintaining the short season crops.

There is need for further studies on the issue of factors affecting the productivity of the different maize crop cultivars in the country. The use of crop simulation models such as the CERES-Maize Models (Conde et al, 2005) can be recommended to ensure that predictions of maize yields in the country under the different scenarios is accurate. Models can also be run to evaluate the appropriate water and temperature requirements for the maize crop. This would help farmers make informed decisions in terms of what cultivars to use and when to use those.

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7. APPENDICES:

Appendix 1

QUESTIONNAIRE

A. Household Information

Age of Household Head

Gender of Household Head

Male	
Female	

Marital Status

Married	
Widowed	
Single	

Educational level

Primary	
Secondary	
Tertiary	
None	

B. Socio-Economic Status of Household

How long have you stayed in the area?

Number of people who live in the house

Household income

Source of Household income

Farming	
Remittances	
Full-Time employment	
Part-time employment	
Trading	

C. Livelihoods/Assets

Do you own a field?

Yes	
No	

If Not, How do you access one?

Renting	
Sharecropping	

How big is the field you are using?

For how long have you been using the field?

Have you always been able to cultivate your field?

Yes	
No	

Do you keep records of your yearly produce?

Yes	
No	

Use of Inputs

What type of seeds do you use?

Hybrid	
Recycled	

What kind of equipment do you use?

Tractor	
Ox driven plough	

How do you get the seeds and the fertilizers?

Purchase	
As government supply	

Do you have access to any extension services?

Yes	
No	

What kind of services do you receive?

On kinds of seeds	
On types of soil	
On time of sowing	

How often do you meet the officer?

Seasonally	
On appointment	

C. Perception and Awareness on Climatic factors

In your opinion, are the conditions of the planting season still the same?

Yes	
No	

How do you get to know what kind of weather to expect during a crop season?

Through the radio programme	
By Hearing from others	
Through looking at the condition of the sky	
From the extension Officer	

What was rainfall like in the previous crop season?

Too much	
Enough	
Not enough	

When did the rains come in the previous season?

Too Early	
On Time	
Too Late	

If the rain was to come too early or too late, what decisions would you take?

Wait for the rains	
Continue sowing	
Do not sow altogether	

How do the variations in the pattern of rainfall affect your crop yields? I

D. Adaptation and Copying mechanism

What actions do you take to ensure that your farming activity is not severely affected by the erratic climate?

What other activities do you carry out to maintain your household income and food?

What problems do you encounter in carrying out these activities?

How has the government helped you to adapt to the varying climate conditions?

Table: 1

Number of observation	Crop Year	Crop Yields /Hectare (Kg)	Mean Seasonal Rainfall (mm)	Mean Seasonal Maximum Temperature (C°)	Mean Seasonal Minimum temperature (C°)
1	80/81	461	70.51		
2	81/82	202	146.75		
3	82/83	333	50.94		
4	83/84	391	57.95		
5	84/85	365	40.63		
6	85/86	340	79.62		
7	86/87	283	52.71		
8	87/88	391	119.25		

9	88/89	524	70.43		
10	89/90	818	85.73	23.8	9.87
11	90/91	466	50.33	23.98	8.6
12	91/92	360	70.15	24.9	10.9
13	92/93	88	55.55	25.4	10.6
14	93/94	548	90.62	24.8	9.9
15	94/95	54	40.37	26	11.9
16	95/96	1012	88.89	24	11.1
17	96/97	500	88.97	23.97	10.5
18	97/98	1118	77.17	25.26	10.6
19	98/99	389	69.43	23.87	10.8
20	99/00	631	69.43	24.18	10.5
21	00/01	578	125.5	24.3	10
22	01/02	744	122.89	24.1	10
23	02/03	603	69.75	24.9	10.7
24	03/04	488	48.42		

Table: 2 A Statistical Model for the Correlation between Maize Crop, Seasonal Rainfall, Minimum and Maximum Temperature

Variable	**N**	**Mean**	**Std Dev**	**Sum**	**Minimum**	**Maximum**
maize yields	24	486.95833	252.99518	11687	54.00000	1118
seasonal rainfall	24	76.74958	28.16425	1842	40.37000	146.75000
maximum temperature	14	24.53286	0.68067	343.46000	23.80000	26.00000
minimum temperature	14	10.42643	0.75555	145.97000	8.60000	11.90000

	maize_ yields	**seasonal_ rainfall**	**max_temp**	**min_temp**
maize yields	1.00000 24	0.25569 0.2278 24	-0.42940 0.1255 14	-0.21053 0.4700 14
seasonal rainfall	0.25569 0.2278 24	1.00000 24	-0.47401 0.0868 14	-0.25534 0.3783 14
maximum temperature	-0.42940 0.1255 14	-0.47401 0.0868 14	1.00000 14	0.53844 0.0470 14
minimum temperature	-0.21053 0.4700 14	-0.25534 0.3783 14	0.53844 0.0470 14	1.00000 14

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	366081	122027	1.49	0.2756
Error	10	817522	81752		
Corrected Total	13	1183603			

Root MSE	285.92333	R-Square	0.3093
Dependent Mean	564.92857	Adj R-Sq	0.1021
Coeff Var	50.61230		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2827.73921	3435.94491	0.82	0.4297
seasonal rainfall	1	4.97071	3.70522	1.34	0.2094
maximum temperature	1	-113.17708	151.81218	-0.75	0.4731
minimum temperature	1	11.65243	124.55503	0.09	0.9273

Model: MODEL1
Dependent Variable: seasonal rainfall

Number of Observations Read	24
Number of Observations Used	14
Number of Observations with Missing Values	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1725.69182	862.84591	1.59	0.2467
Error	11	5954.86626	541.35148		
Corrected Total	13	7680.55809			

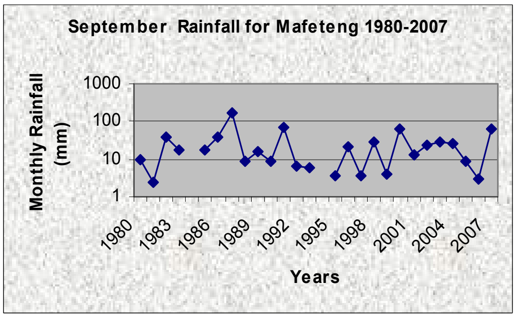
Root MSE	23.26696	R-Square	0.2247
Dependent Mean	78.91286	Adj R-Sq	0.0837
Coeff Var	29.48437		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	494.15108	236.59495	2.09	0.0608
max_temp	1	-16.92360	11.25062	-1.50	0.1607
min_temp	1	-0.00517	10.13564	-0.00	0.9996

Appendix: 2

(a)



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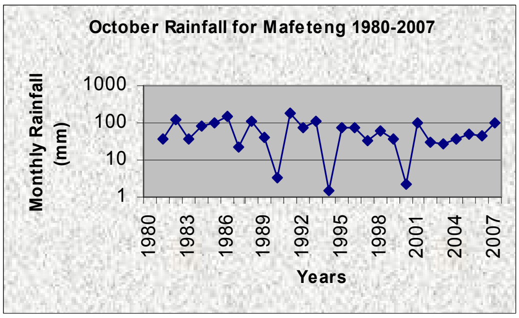
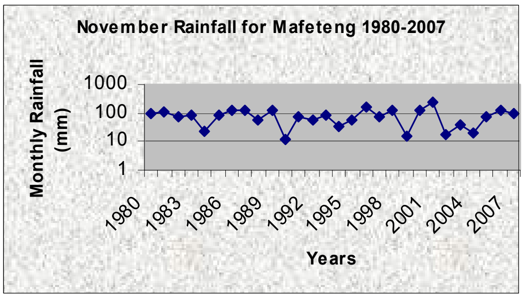
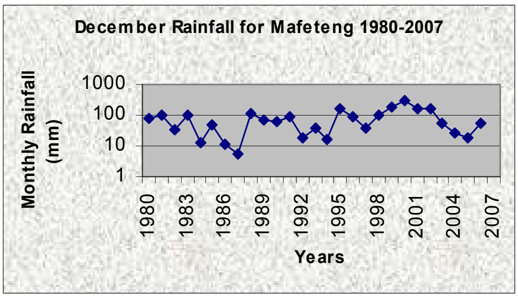


(c)



(d)



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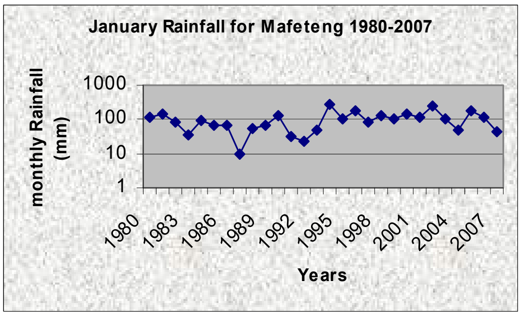
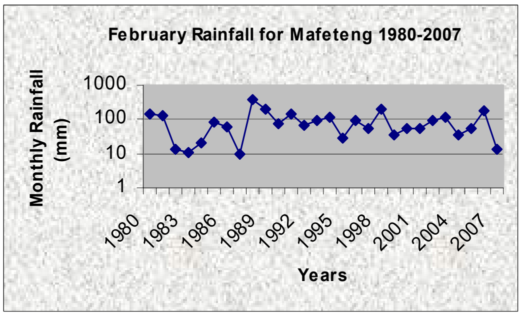
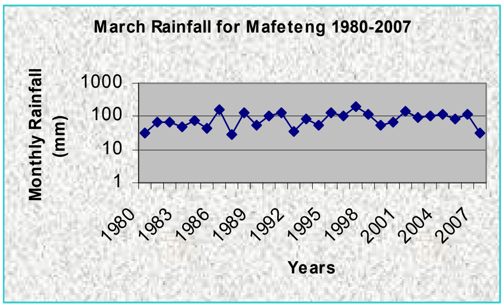


(f)



(g)



(h)

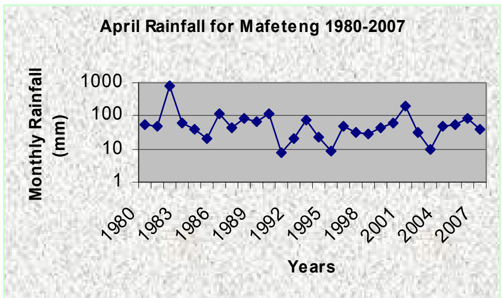
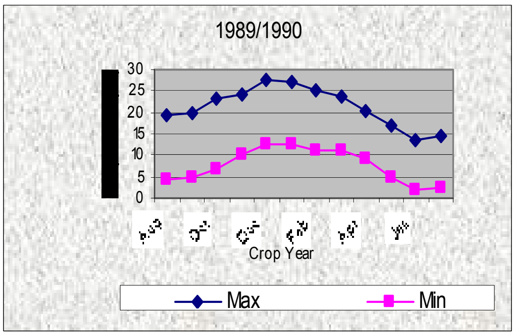


Fig: 9 (a-h) Summary of the monthly Rainfall for Mafeteng 1980-2007 as reflected in Table 2 above.

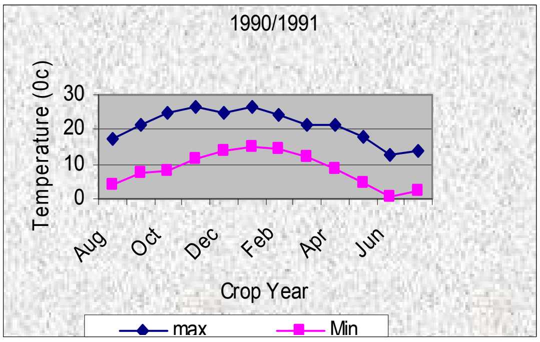
Appendix: 3

Fig: 8(a-n) Minimum and Maximum Temperature for the Maize crop seasons in Mafeteng (1989-2004)

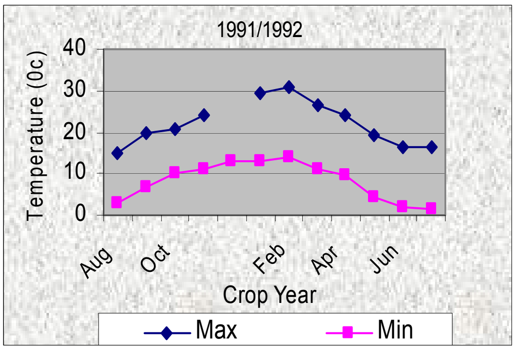
(a) (b)


1989/1990
30
25
20
15
10
5
0
Crop Year
Max
Min

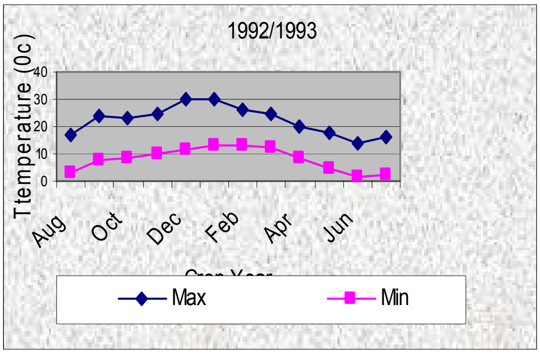
©


1990/1991
Temperature (0c)
30
20
10
0
Aug
Oct
Dec
Feb
Apr
Jun
Crop Year
max
Min

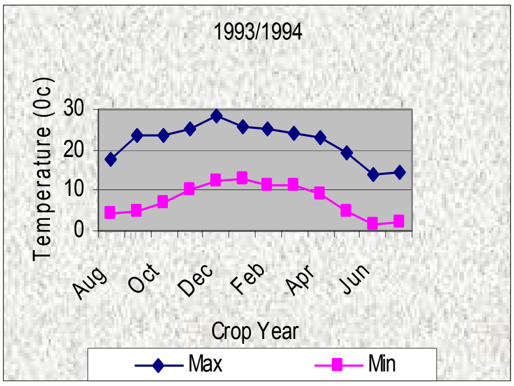
(d)

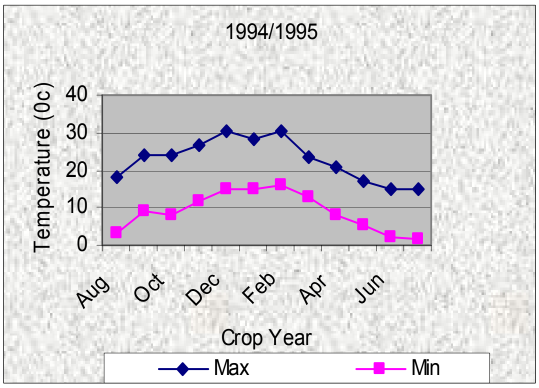

1991/1992
Temperature (0c)
40
30
20
10
0
Aug
Oct
Feb
Apr
Jun
Crop Year
Max
Min

(e)


1992/1993
Ttemperature (0c)
40
30
20
10
0
Aug
Oct
Dec
Feb
Apr
Jun
Max
Min

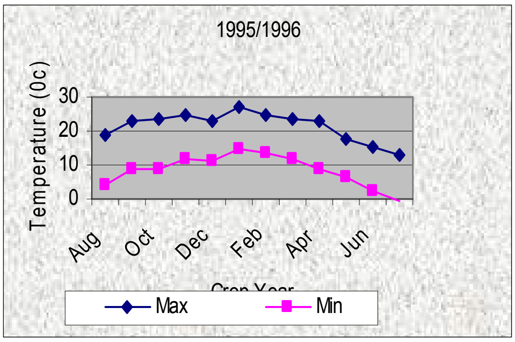
(f)


1993/1994
Temperature (0c)
30
20
10
0
Aug
Oct
Dec
Feb
Apr
Jun
Crop Year
Max
Min

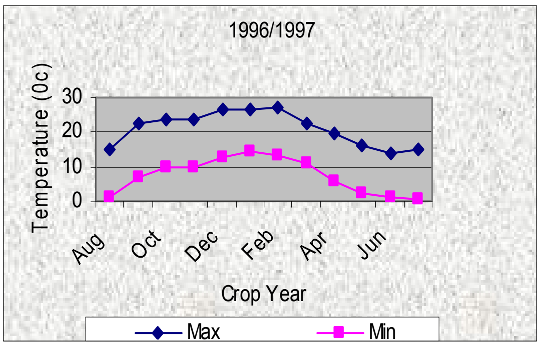

1994/1995
Temperature (0c)
40
30
20
10
0
Aug
Oct
Dec
Feb
Apr
Jun
Crop Year
Max
Min

(g)

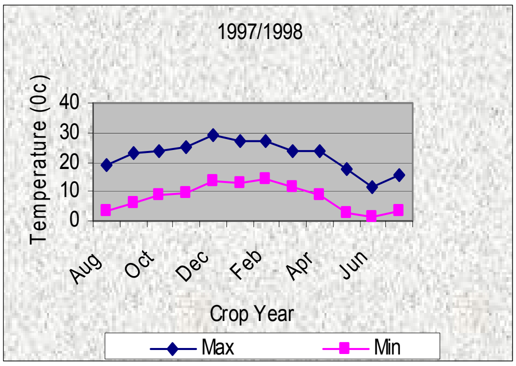
(h)


1995/1996
Temperature (0c)
30
20
10
0
Aug
Oct
Dec
Feb
Apr
Jun
Max
Min

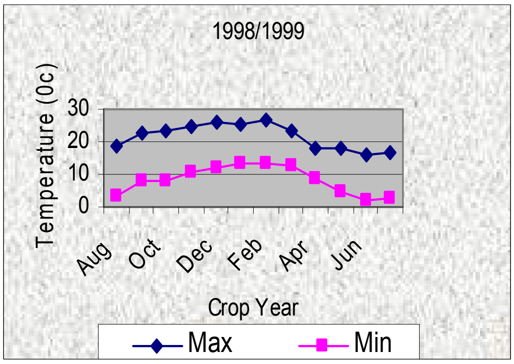
(i)


1996/1997
Temperature (0c)
30
20
10
0
Aug
Oct
Dec
Feb
Apr
Jun
Crop Year
Max
Min

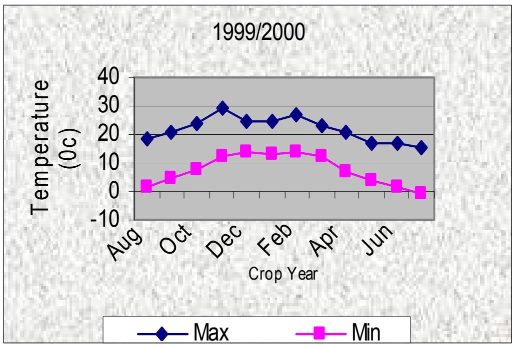
(j)


1997/1998
Temperature (0c)
Crop Year
Max
Min

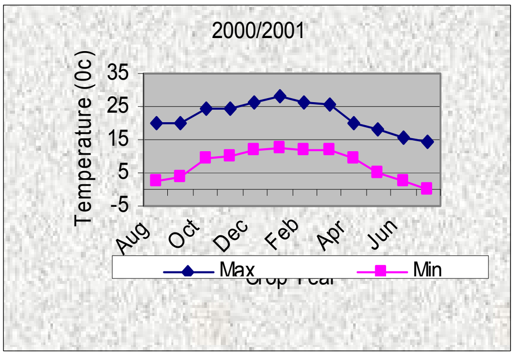
(k)


1998/1999
Temperature (0c)
Crop Year
Max
Min

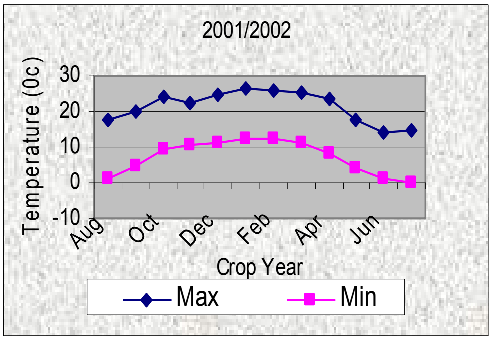
(l)

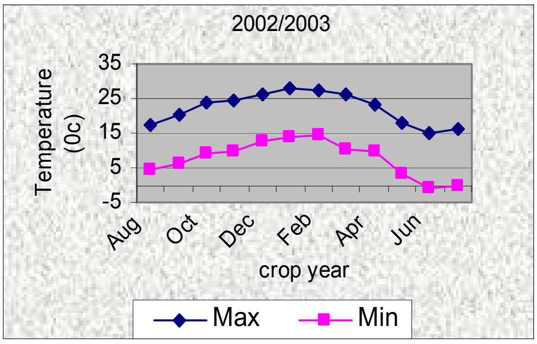

1999/2000
Temperature (0c)
Crop Year
Max
Min

(m)


2000/2001
Temperature (0c)
Max
Min

(n)


2001/2002
Temperature (0c)
Crop Year
Max
Min


2002/2003
Temperature (0c)
crop year
Max
Min

Appendix: 4

Source: Site Photographs (2007)

Fig: 9 Households collect animal manure and wood ashes which they use as means to improve fertility of the soil in the home garden

Source: Site Photographs (2007)

Fig: 10 Home-Stead plots (Mantloane) used for vegetable production in the home garden.

Source: Site Photographs (2007)

Fig: 11   Villagers involved in the government initiated Soil Reclamation Project

Source: Site Photographs (2007

Fig: 12 (a) (b) Women threshing maize either to get corncobs as fuel or as a way of getting some money

Source: (Ministry of Natural Resources, 2000)

Fig: 13 women carrying bundles of wood on their heads to sell or to use for household food preparation.

Source: Site Photograph, (2007)

Fig: 15 Maize Stored on an Open Area

Source: Site Photographs (2007)

Fig: 16 A woman drawing drinking water from a pond because lack of tap water in the area

Site photograph, (2007)

Fig: 17 (a) (b) an illustration of the extent of soil erosion in the area