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Farmers' Perception of Climate Change a Case Study in Swaziland

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Abstract This study was designed to establish farmers' perception on climate change and weather variability and its impacts on input investments, crop yields and food security. The study was conducted in the Middleveld of Swaziland were three constituencies were selected within the region. Three communities were selected spatially from each constituency. Purposive sampling was used to select 30 households from each community to make a sample size of 270 households. Information was collected from heads of households using a questionnaire and information obtained from focus group discussions with elders in the communities. The results showed that farmers perceived climate change and weather variability correctly although some perceived rainfall conditions at the beginning of the farming season incorrectly. Farmers' perception on rainfall influences their investment decisions. When good rains are perceived, they invest more and vice versa. Poor input investment influences yields and contributes to food insecurity. The study concluded that farmers' perception of climate change and weather variability, in particular rainfall, influence investment decision and the resulting crop yield and food insecurity. Therefore, this study recommends that local government should provide accurate weather forecasting to farmers on time before the onset of every farming season as well as to give them relevant meteorological advice that will help them make informed farming options in each farming season.

Keywords: *food insecurity, climate change and variability, farmers' perception on rainfall, impacts, investment decisions*

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1. Introduction

The world is still facing with a serious challenge of food insecurity and this continues to pose a challenge to both developed and developing nations. The difference lies in the magnitude of the problem in terms of its severity and proportion of the population affected. Food insecurity exists when people lack physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs. Levels of food insecurity differ and that can be categorized as either chronic food insecurity or transitory food insecurity [1].

Food insecurity is driven by different socio-economic and political factors such as political instability (wars), climate change and environmental stressors and use of insufficient agricultural inputs in most African states and also relevant for Swaziland [2]. Climate change has seen to have significant effects on food availability as it affects crops. For instance, long-run climate exerts significant influence on agricultural decision-making and affects what farmers grow and when and where they grow it [3]. The rapid pace of climate and its anticipated large negative effects on many agricultural systems suggests a broader and pressing need for adaptation [4].

Many studies indicate that farmers perceive climate change differently and further show that they tend to overestimate the negative impacts of variable climates and their misperception affects crop production and eventually contributes to food insecurity since it is the condition for their initiation of adaption practices [2,3,5]. Thus, it is important that farmers perceive climate change correctly in order to make appropriate decisions. Rainfall variability, which is the short-term variation in rainfall, is another critical aspect of climate change that also has a significant impact on crop yield, food insecurity especially for rain-fed agriculture since it influences rainfall intensity, and duration, which is crucial for rain, fed agricultural systems. Rainfall variability also disturbs the farming calendar by making the onset of rainfall highly unpredictable [1,4].

Scholars argued climate is the primary determinant of agricultural productivity, there is need for proper adaptation strategies, which may include utilization of opportunities in favorable years or seasons (wetter years/seasons). It has also been argued that the widespread food insecurity in Africa is not because of climate change but rather due to farmers' failure to utilize opportunities in wetter years [6].

Both transitory and seasonal food insecurity has been experienced in Swaziland for many years. It has been argued that although there are other contributing factors, the poor performance of the agricultural sector lies at the heart of the problem of food insecurity with erratic weather conditions fuelling food insecurity in the country. The other factors, which are known to impact negatively on food insecurity in Swaziland, include the HIV/AIDS (poor human heath), poverty and increase in food prices.

Food insecurity in developing countries has been a challenge and addressing it in its totality has remained one of the current issues in Swaziland. While attempts to address food insecurity in the country have been made, they have yielded little or no results especially given the new crisis of climate change. Climate change is seen to fuel food insecurity to the extent that it has captured and shifted the attention of scholars and farmers towards the damaging effects of climate change on agriculture (major source of livelihood). Thus, farmers could see little or no opportunity to alleviating food insecurity amidst the climate change crisis.

Majority of scholars concur on the view that climate change could be particularly damaging to countries in Africa, in particularly those dependent on rain fed agriculture. Others, however, argue that low crop yields in Africa are not due to climate change but rather farmers fail to exploit opportunities in wetter years [6]. This in turn contributes to food insecurity. For example, farmers might regard large spending on costly items such as fertilizers as "too risky" since it goes to waste when there is no rain [4,6].

Food insecurity has affected by climate change-the potential shifts in the long-run mean and extremes of temperature, precipitation and other meteorological variables in a given area. Climate change, therefore, has significant effects on food availability since it affects crop yields either positively or negatively [3,7]. Long-run climate change exerts significant influence on agricultural decision-making in that it affects what farmers grow and when and where they grow it [7].

Food security exists when all people, at all time, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life [8].

There is another type of food insecurity, 'seasonal food insecurity', which falls between chronic and transitory food insecurity. Seasonal food insecurity is predictable and follows a sequence of known events and is more similar to chronic food insecurity [1]. Seasonal food insecurity is of limited duration, recurrent and transitory. It is associated with fluctuations in climate, crop patterns, work opportunities (labour demand) and disease and occurs when there is a cyclical pattern of inadequate availability and access to food [1].

Agriculture plays a major role in alleviating food insecurity in two ways. It produces the food people eat (ensuring food availability) and (perhaps even more important) it provides the primary source of livelihood for a majority of the people in developing nations. This is true of most developing countries. Majority of the total rural population in developing countries depends almost exclusively on agriculture for their livelihoods [9] for that reason, rural people are the hardest hit and most affected by food insecurity.

Agricultural inputs determine the productivity of the agricultural sector thus a shortfall in such inputs will result to low productivity. Lack of access to sufficient agricultural inputs may result in low crop yields hence accelerates food insecurity. What matters the most is not just access but the quantity and quality and/or type of the inputs used is also an issue of concern. For example, Cooper argues that an ICRISAT study revealed that farmers in Zimbabwe ignored recommendations to apply more nitrogen fertilizer to maize crops in case there was no rain, which resulted in low crop yield [6]. Cooper concludes by making a recommendation that, measures such as lowering the price of fertilizer would help farmers cope with climate variability. Copper denies the general belief that food insecurity in sub-Sahara Africa is widespread because of climate change but argues that farmers fail to utilize opportunities in wetter years pointing out that they may not apply necessary inputs (such as fertilize) which they regard as 'too risky' in case there was no rain [6].

The debate over the causes of consistent food insecurity between regions and communities has fuelled highly contested viewpoints between the academic disciplines and in developing thinking over the past few decades, giving rise to a proliferation of demographic, economic, and political emphasis across the food insecurity literature. Different drivers of food insecurity have been identified as: climate change and environmental stressors, poverty, increase in food prices, poor human health, poor market access, low regional cereal availability, pests and diseases of crops and livestock, lack of education, unavailability of employment, absence of property rights and land access, poor distribution networks, formal and informal government policies, in-and out-migration, inflation, social and political unrest or war, sale of assets, insufficient agricultural inputs [2], macroeconomic imbalances in trade, natural resource constraints, poor human resource base, gender inequality, natural disasters such as floods, the absence of good governance [9] and lastly, failure to practice crop specialization [10]. Therefore, this study was designed to determine how farmers' perception of climate change and variability influences investment decisions and the resulting crop yield and food insecurity in Swaziland.

1.1. Frameworks for Assessing the Relationship between Climate Change and Food Security

Food insecurity is a complex phenomenon that is not only determined by the level of production (food availability) but rather by many other different factors Among the existing frameworks, the one by [11] as shown in Figure 1 outlines how the drivers of global warming bring about changes in climate. It also shows these changes in weather do change the assets used in food production, which in turn change food production activities and the resulting components of food security, food consumption patterns and human health. In this framework, the adaptive responses of food systems to climate change influence change in system assets and is, in turn, influenced by changes in food system activities. The framework on climate change and food security [11] was adopted and modified for use in this study as shown in Figure 1.

Climate is already changing and affecting food system assets, food system activities and food security. The critical issue here is on how food systems respond to climate change, sustain food system assets and activities and maintain food security. In this study, adaptive responses of food systems are seen to be influenced by how the producers (farmers) perceive climate change and variability. As shown in Figure 1, farmers' perception of climate change and weather variability is expected to influence adaptive responses to food system activities in terms of investment decisions made on input use which, in turn, will impact on the components of food security and the overall food security of the farming households.

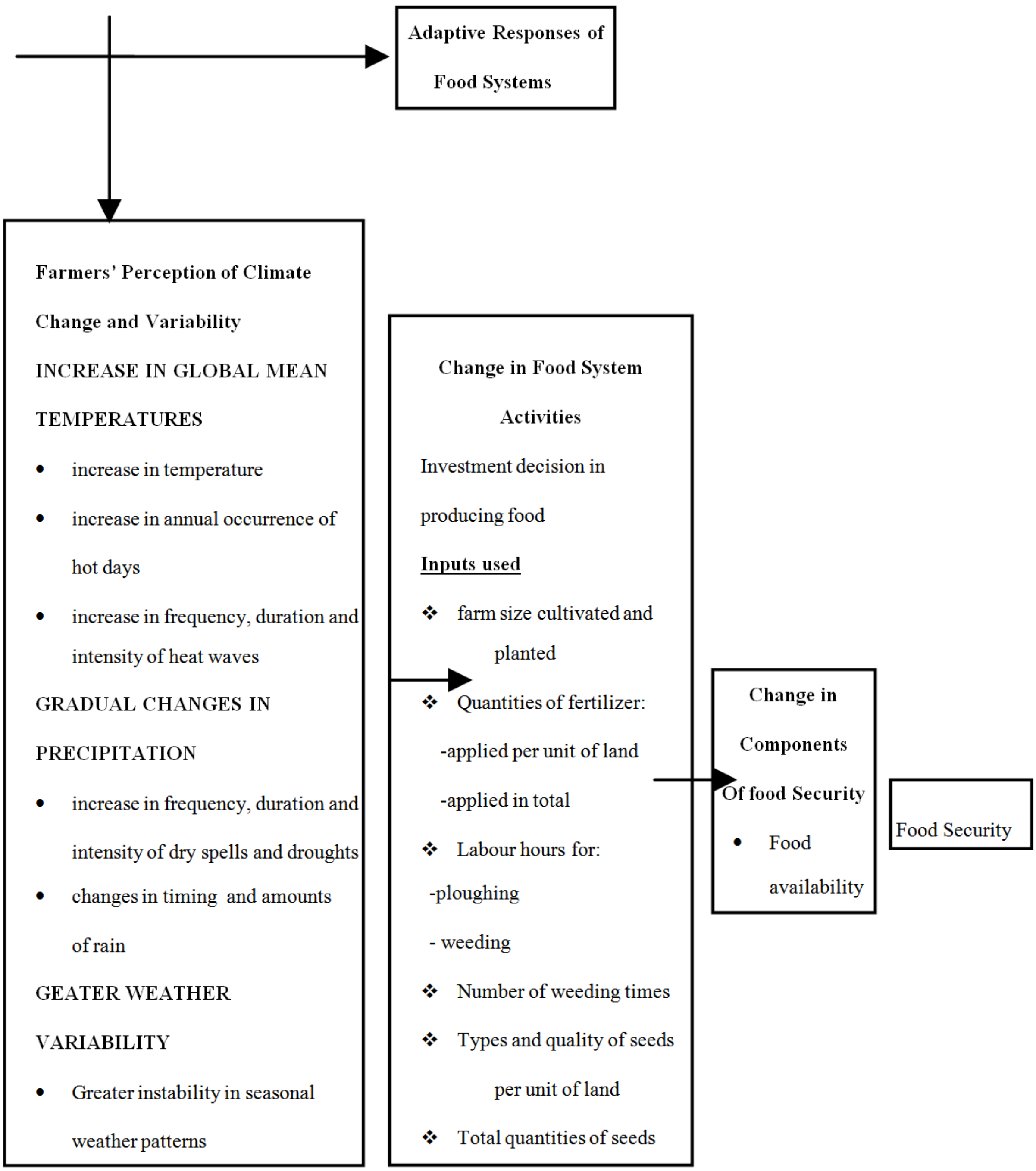

Figure 1. Modified FAO/NRCB (2008) Climate Change and Food Security Framework

2. Method and Material

2.1. Study Area

The kingdom of Swaziland is a small landlocked mountainous country in southern Africa. It lies between 25°43' and 27°27' south and 32°8' and 30°44' east and covers an area of 17364 km2 (The Swaziland Environmental Action Plan [12].

The study area, lies between the Lowveld and the Highveld regions and further classified into lower and upper Middleveld with gentle sloping hills and wide valleys. The Middleveld has a wide range of agro-ecological conditions, ideal representativeness of highlands and mid and lowland areas where mixed farming and maize production is practiced. The region normally receives an annual rainfall of 750 - 1000 millimetres. Its average annual temperature ranges 24 – 260 C.

2.2. Methodology

In this study, [11] framework on climate change and food security was adopted and modified to assess the influence of farmers' perception on adaptive responses of food systems, food system activities and components of food security. The variables considered under climate change encompassed changes in temperature, changes in precipitation and weather variability.

Farmers' perception of climate change and weather variability was established using the modified climate change and food security framework. The framework was used to establish how farmers perceived climate change and weather variability and how their perception influenced adaptive responses of food systems and food system activities.

The study used both primary and secondary sources and the main approach that was used for data collection for this study was exploratory. Using questionnaire methodological triangulation was employed to collect data through face-to-face interviews (with household heads), focus group discussions (with community elders) and observation to harness diverse ideas about the same issue and assist in 'cross-checking' the results and consequently help to increase the validity and reliability of the findings [13].

2.2.1. Selection of Study Area and Subjects

The study employed multi-stage sampling. The first stage involved purposive sampling of the Middleveld. This region was selected due to its wide range of agro-ecological conditions, ideal representativeness of highlands and mid and lowland areas where mixed farming and serious maize production is practiced.

The second stage involved the selection of constituencies (Tinkhundla) falling within the Middleveld region. Spatial sampling was used to sample three constituencies to avoid sampling areas with the same soil, rainfall patterns, climate and geology. A grid reference system in line with GIS software (arc map) was used to sample spatially on a map scale of 1:250 000. Three constituencies Ndzingeni, Mthongwaneni and Sandleni were selected.

The third stage involved the selection of communities from each sampled constituency. A grid reference system in line with GIS (arc map) was again used to spatially sample three communities from each constituency. Communities that lied closer to the point of intersection were selected. Spatial sampling is ideal where spatial variations in the distribution of phenomena over an area are studied such as rainfall, soils and distance [14]. Spatial sampling is therefore ideal for this study since livelihoods such as crop farming and livestock farming are influenced by the factors mentioned above thus it is crucial to employ spatial sampling to avoid sampling areas with the same physiographic characteristics. 270 households with 90 from each constituency were selected.

2.2.2 Data Analysis and Presentation

Analysis of the household food security access was done using the household food insecurity access scale (HFIAS). This had questions pertaining to problems of food access in the past four weeks rated no=1, rarely=2, sometimes=3, and often=4.

The lived poverty index (LPI) measures entities which each household had gone without in the past, for example, enough food, cash income and electricity. The index was rated 1-5 with options of never=1, just once or twice=2, several times=3, many times=4 and always=5. The options were totalled and divided by five to get the average which was a number between 1 and 5. The higher the number, the more the household was living in poverty. The LPI was only used to analyse two variables (food and cash income). This was done to avoid distortion from the other variables such as water, electricity and fuel since they are available in most rural households thus including them was giving a low average which was misleading thus resulting to misleading conclusions on this aspect.

For food availability, the frequency of going without food as a result of food prices was used. The scale used was from 1 to 5 where never=1, about once a month=2, about once a week=3, more than once a week but less than every day of the week=4 and every day=5. The scores were summed up to a number between 1 and 5.

Data collected through use of questionnaires was coded and analysed through the aid of computer software packages: Microsoft Excel 2007 and Statistical Package for Social Sciences (SPSS) version 20. The chi square was used to test if climate change has any significant effect on crop yield. This was further corroborated by correlation analysis. Correlation analysis was also used to ascertain if there was any significant difference in the record of climate factors over the period of 20 years. The climate parameters, that is, temperature and rainfall from the department of meteorological service was used to explain the rate of crop yield using Multiple Regression Analysis (ANOVA) to find out if climate change does have a significant effect on food crop production or not. In testing the hypothesis, Chi-square was used and the significant level was set to 0.05.

Frequencies and cross tabulations were done to find relationships amongst the variables. Data collected from the focus group discussions was also coded and analysed by finding and recording consensus to different views given. The results of the study were presented according to the modified climate change and food security framework by addressing the different aspects of the framework. Data was presented using graphical techniques such as bar graphs, pie charts and frequency tables, depending on the nature of the data. A form of narration was also used to supplement the presented data.

3. Results and Discussion

3.1. Rainfall Variability

Analysis was conducted at constituency level and the rainfall data indicated a decline in the amount of rainfall received since the year 2000 to 2011 in all three constituencies and there was also noted variability in the rainfall received. Mthongwaneni, for instance, recorded the highest (1802.5mm) rainfall in 2000. In the year 2011, the rainfall received was 786.9 millimeters which indicated that there was notable decline in the amount of rainfall received since 2000. In Sandleni constituency, the same trend was observed in 2000 where the highest (1235.7mm) amount of rainfall was received. However, in 2011 the area recorded 1059 millimeters showing a slight decline. Ndzingeni recorded the highest (4288.9mm) rainfall in 1998 and 3684.4 millimeters in 2000; however, in the year 2011, the amount of rainfall received in the same constituency was 3112.8 millimeters indicating a remarkable decline and variability in the rainfall received (Figure 2).

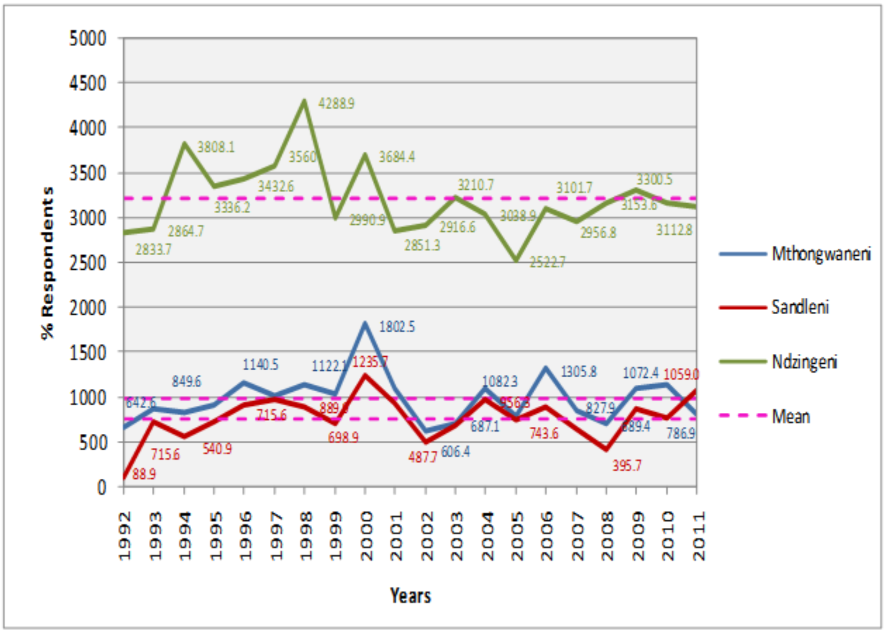

Figure 2. Total annual rainfall received in Mthongwaneni, Sandleni and Ndzingeni constituency from 1992 to 2011 (Source: Swaziland Meteorological Department)

The same analysis was carried out for the selected constituencies to see the variability. The highest rainfall (378.9mm) was recorded in November followed by January (191.6mm) with February, May and June recording zero millimeters. Mtfongwaneni, on the other hand, recorded 268.8 millimeters in January followed by December (205.2mm) with July, August and September recording little or no rainfall. In Sandleni constituency, January recorded maximum rainfall (167.9mm) followed by December (165.2mm) with May, June, July, August and September recording little or no rainfall (Figure 3). This shows that there is a change in the timing of rains which makes it hard to predict the amount of rainfall. These indicate that there is variability in rainfall even within months.

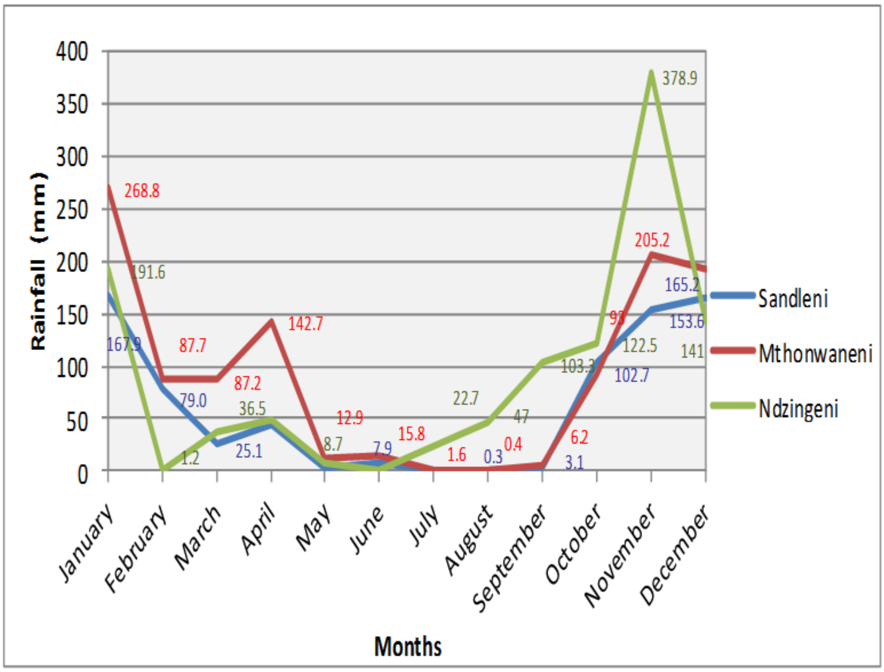

Figure 3. Monthly total rainfall for Mthongwaneni, Sandleni and Ndzingeni constituencies for the year 2011 (Source: Swaziland Meteorological Department)

The results presented above indicate that there was noted decline and variability in rainfall received in the Middleveld region and within the selected constituencies. The monthly rainfall also indicates variability even within the months and within the farming season (October to March). Rainfall variability is a great challenge to farmers. It makes rainfall highly unpredictable and tends to confuse farmers. This then makes it essential to assess how farmers perceive climate change and variability especially in terms of rainfall since agriculture is highly sensitive to rainfall variability [15] and that rainfall is a critical factor on which farmers base their decisions on what to grow and when to grow it [7] hence perception becomes important.

3.2. Temperature Variability

At constituency level, an increase in maximum temperature from 1997 to 2011 has also been observed from the data. Mthongwaneni, for instance recorded 24.3°C in 1997 and the temperature has been increasing since 1997 to 2011 where 25.8°C was recorded. The same pattern was observed for Ndzingeni where 22.6°C was recorded in 1997 and 23.1°C in 2011. Sandleni recorded 22.6°C in 2000 and 23.4°C in 2011(Figure 4).

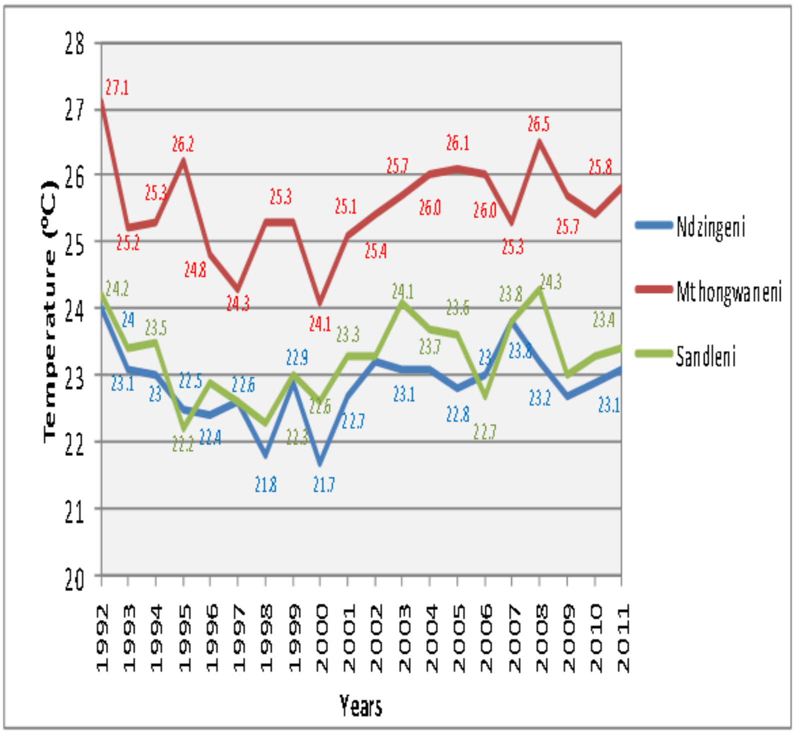

Figure 4. Annual average maximum temperature for Ndzingeni, Mthongwaneni, & Sandleni constituency from 1992 to 2011 (Source: Swaziland Meteorological Department)

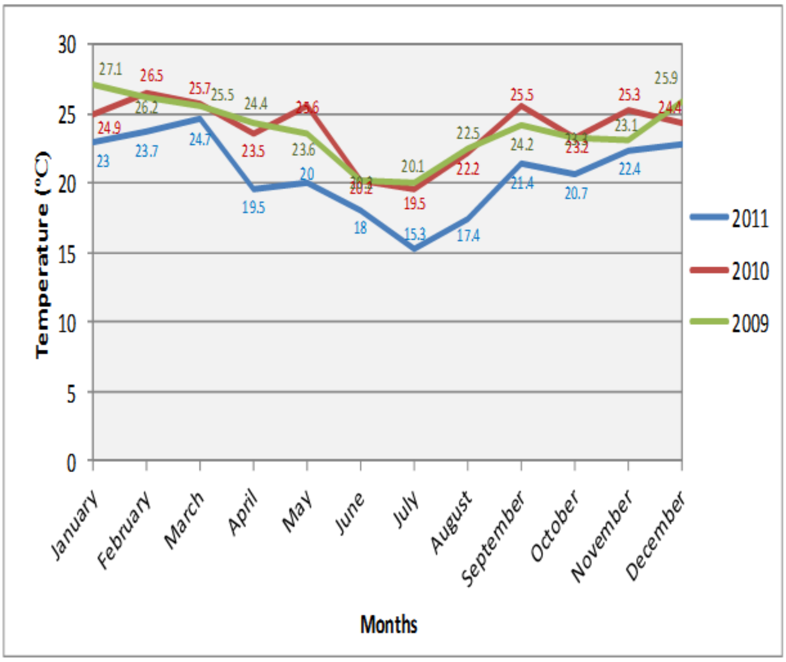

Figure 5. Average monthly maximum temperature for the Middleveld region from 2009-2011 (Source: Swaziland Meteorological Department)

Monthly temperatures for three successive years (2009-2011) were also used to further confirm that there has been temperature variability between months in different years. For instance, a significant difference in maximum temperature was experienced in April where 24.4°C was recorded in 2009, 23.5°C was recorded in 2010 and

19.5°C was recorded for the same month in 2011. The same pattern is observed for a majority of the months, especially May, July, September and October (Figure 5).

3.3 Farmers Perception on Climate Change and Variability

One of the specific objectives of the study was to determine how Swazi farmers perceive climate change and variability in terms of precipitation and temperature.

3.3.1. Changes in Frequency, Duration and Intensity of Dry Spells

A majority of farmers (90%) noted an increase in frequency of dry spells. Very few said it had either stayed the same (2.6%) or declined (1.5%). The majority of respondents (93.3%) noted an increase in the intensity of dry spells with only a few (4.4%) who indicated that no changes had occurred. A minority (1.9%) noted a decline in the intensity of dry spells. A majority of farmers (91.9%) noted also that there has been an increase in the duration of dry spells in the past twenty years. Only a few (7.0%) did not observe any change while very few (0.7%) noted a decline in the duration of dry spells (Figure 6).

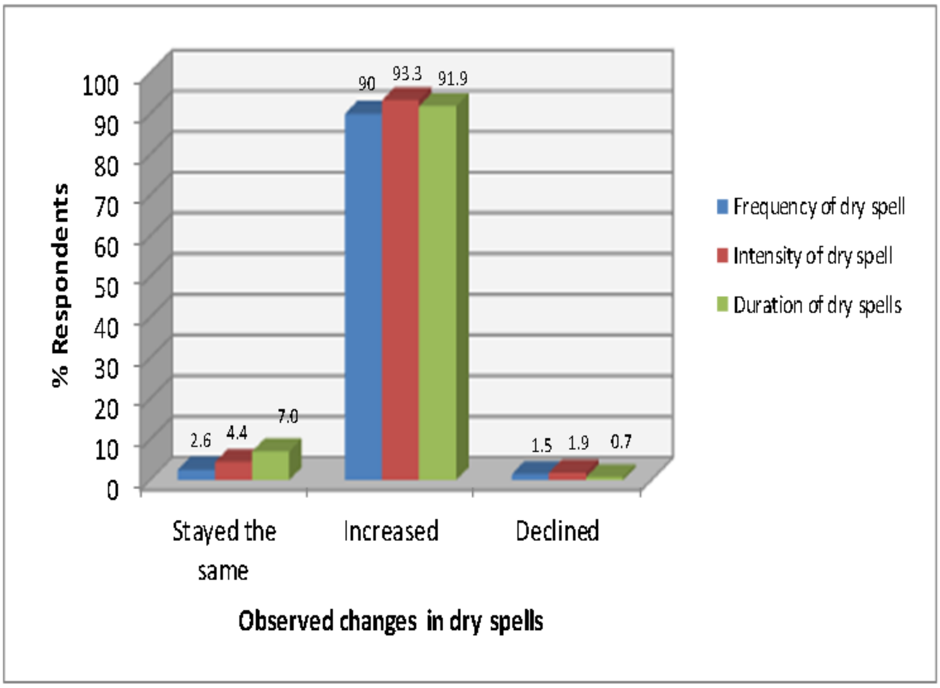

Figure 6. Gradual changes in frequency, duration and intensity of dry spells

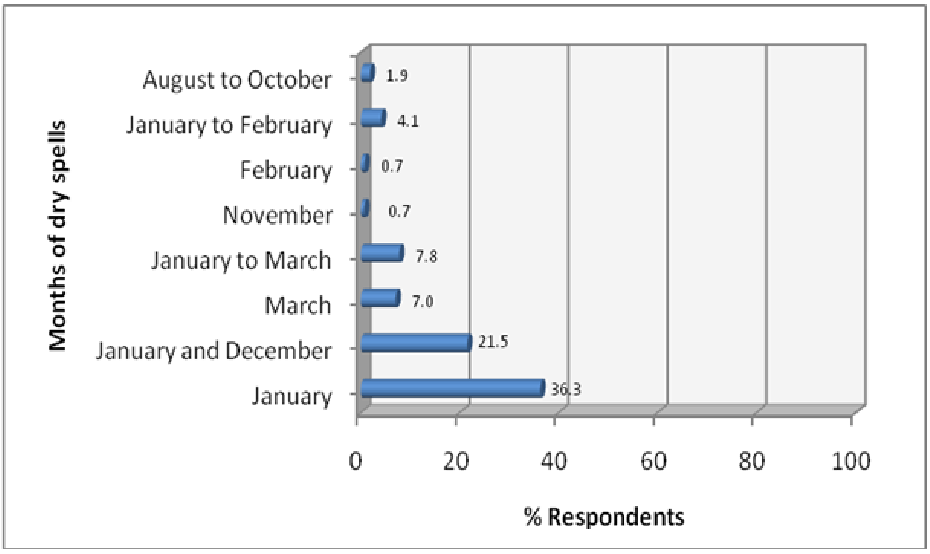

Figure 7. Months dry spells experienced

The study further sought information on months dry spells are experienced. It was noted that majority (36.3%) indicated that dry spells last for the whole of January while others, which is also a majority of the respondents (21.5%) noted that the dry spells start in December until January. Only a few (7.0%) noted March and others (7.8%) indicated January to March as the most vulnerable months. It is worth noting that there are a few (1.9%) also who noted August to October as months of dry spells while these moths are well known to be rainy months that normally mark the start of the farming season (Figure 7).

3.3.2. Long-term Changes in Mean Rainfall, Frequency, Intensity and Duration of Drought

A majority of farmers (94.8%) indicated that they have noted changes in mean rainfall over the past years. Very few (5.2%) did not notice any change in rainfall. Farmers in the Middleveld of Swaziland indicated that they have noted changes in the frequency, intensity and duration of drought in the past years. The majority (88.1%) of the farmers noted the frequency of drought had increased with only a few who said it had either remained the same (7%) or declined (3.7%). A larger percentage (93.3%) of farmers also noted that the intensity of drought had increased. Very few noted that it had either stayed the same (3.3%) or declined (3%). Majority (91.1%) of farmers under study noted that the duration of drought had increased with only (6.3%) indicating that the duration of drought has stayed the same with only a few (2.2%) who noted a decline in the duration of drought in the past years (Figure 8).

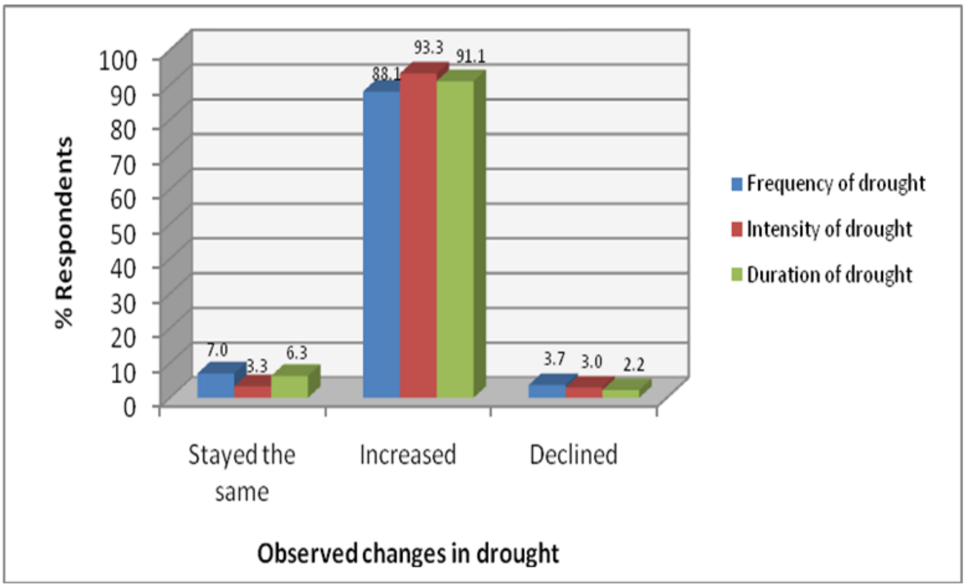

Figure 8. Gradual changes in frequency, intensity and duration of drought

Results from Focus Group Discussion (FGD) (Box 1) also confirm farmers' perception on climate change. The community elders concurred that rainfall patterns had changed and become unpredictable. There is also more variability in the rainfall pattern and variability has also affected and messed up their farming calendar and made farming risky.

Box 1. Elder's response regarding the change in timing and amount of rain received

- When we grew, we knew that by October we start farming and rains used to start early September and sometimes late August. We have never seen this...farming starts late November and sometimes December... others even start to grow maize in January.
- Rains have become seriously unpredictable now. They just come when you least expect them and suddenly disappear when our maize is at a critical stage. We are now confused...we don't know when to start planting
- Now no one knows when rain will come. It comes as a surprise and rains heavily and suddenly stops. We run around for tractors and take time to find them since we have to queue until the soil dries due to intense heat.
- Because of this uncertainty, we now fear to plough and plant all our fields, planting is expensive and you need to be sure that it will rain so that you don't waste money instead of buying food because really farming has become too risky.
- When rains arrive very late or we get a tractor late, we don't plough because we have noticed that December and January there is too little rains and sometimes nothing comes.

The results of the study indicated that famers have noted that climate is indeed changing, and this was a correct observation made by a majority of farmers in the study area. This observation is crucial and forms the base for any adaptation responses or strategies to climate change as [4] suggest that the nature of farmers' responses to climate change will depend on their recognition that climate is changing. Among the essential things that were noted by the majority of famers were that there is an increase in the frequency, intensity and duration of dry spells and droughts. The findings also indicate that the majority of famers noted that there is a decline in the amount of rainfall received compared to the past. The timing or onset of rains has also changed and this has resulted to a shift in the farming season. This is similar to what was also observed by [17] in their findings that variability in climate disturbs the farming calendar since it results to either an early or delayed onset of rains.

Based on the findings made by this study, it transpired that other farmers observed that the frequency, duration and intensity of dry spells have either decreased or stayed the same which was contrary to what the majority of farmers had observed. The same was observed in terms of the amount of rainfall received. Contrary to the observation by the majority of farmers, some farmers indicated that the amount of rainfall received has increased while others indicated that it has stayed the same. While these farmers are a minority, they are significantly important to consider as they give us an idea that different farmers perceive climate change differently which is in line with findings by [17] in a study conducted in Ogbomosho Agricultural zone of Oyo State in Nigeria on farmers' perception of the impact of climate change on food crop production which also revealed that different farmers perceive climate change differently.

3.3.3. Farmers Perception of Weather Variability (Temperature)

A majority of the farmers accounting for 80% indicated that they have noted great variability in seasonal weather pattern. Only a few (20.0%) indicated that they have not noted any changes. Respondents were asked to explain the instability they have noted in seasonal weather pattern using specific weather variables. The results indicated that the majority (49.6%) indicated that temperatures have become extreme while a reasonable number (25.2%) indicated that they cannot tell specifically but can note the change. Few farmers (15.9%) indicated that there is a reduction in rainfall amount while 14.8 percent noted that it is now hard to locate the start and end of seasons. Only a minority of the respondents noted that rains have become unreliable and inconsistent (Figure 9).

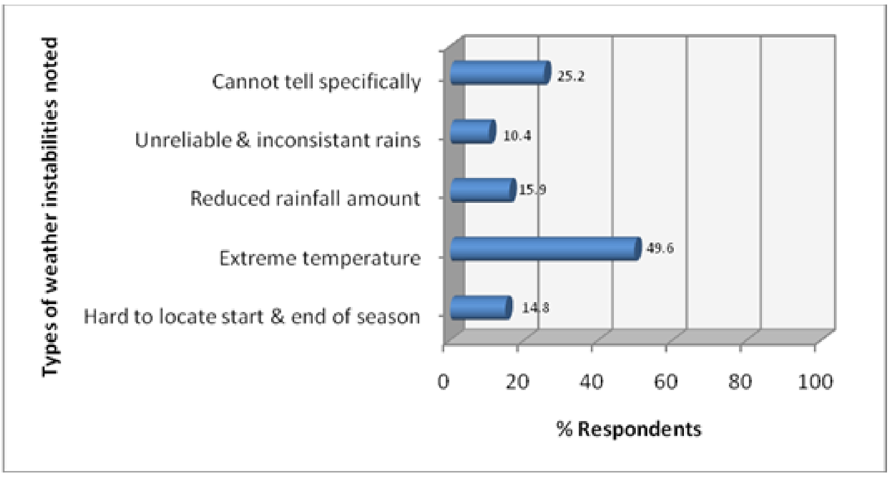

Figure 9. Instability in relation to specific weather variables

3.4. Changes in Farming Calendar

Analysis was also carried out to determine if respondents have noted any changes in start and end of farming season. Majority of farmers (82.6%) noted changes in the start and end of the growing season with very few (17.4%) who did not notice any change. Respondents were further asked to indicate the shift in relation to specific months. The results (Figure 10) indicate that the majority (44.8%) noted that the farming season now starts in December to April. A reasonable number (27%) indicated that it starts in November to April. Very few farmers (13.7%) indicated that the season starts in October with a minority (12.2%) who indicated that they did not notice any change.

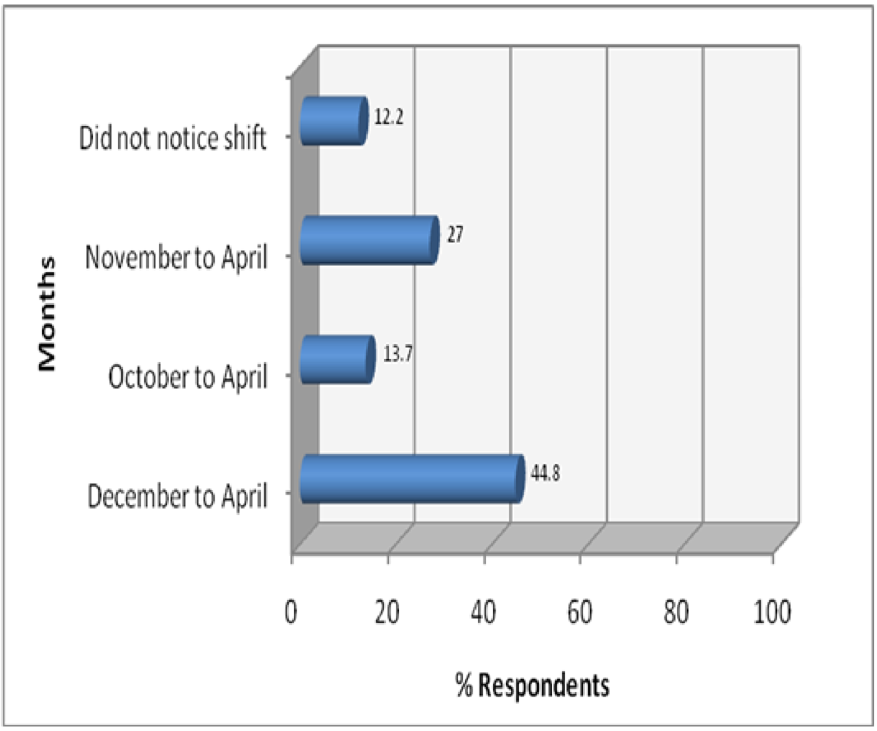

Figure 10. Start and end of farming season

It was further probed to determine if the farming seasons set on too early or too late. A majority of farmers (98.0%) indicated that the season is now late while very few (2.0%) indicated that the season sets on earlier than before. The study also wanted to determine what farmers have noted in terms of the length of the farming season. A majority of the respondents (80.4%) observed that the season has become shorter than before. Only a few (15.6%) stated that it has become longer than it used to be in the past twenty years.

3.5. Factors Affecting Farmers' Perception

3.5.1. Education Level in Relation to Perception

It was crucial for the study to further analyses some factors affecting farmers' perception as cited in other studies by some scholars. One of these was education level which was analyzed to determine whether the level of education of famers influence their perception in the selected study area. The results show that 32.2% of farmers with no formal education perceived rainfall as low in the 2011/2012 farming season. Very few farmers (10%) perceived rainfall as plenty. The same was true of farmers with primary education only. A majority of them perceived rainfall as either low (33.3%) or average (36.7%). Majority of farmers with skill training (28.9%) and tertiary education (25.6%) perceived the amount of rainfall to be plenty in the 2011/2012 farming season (Figure 11).

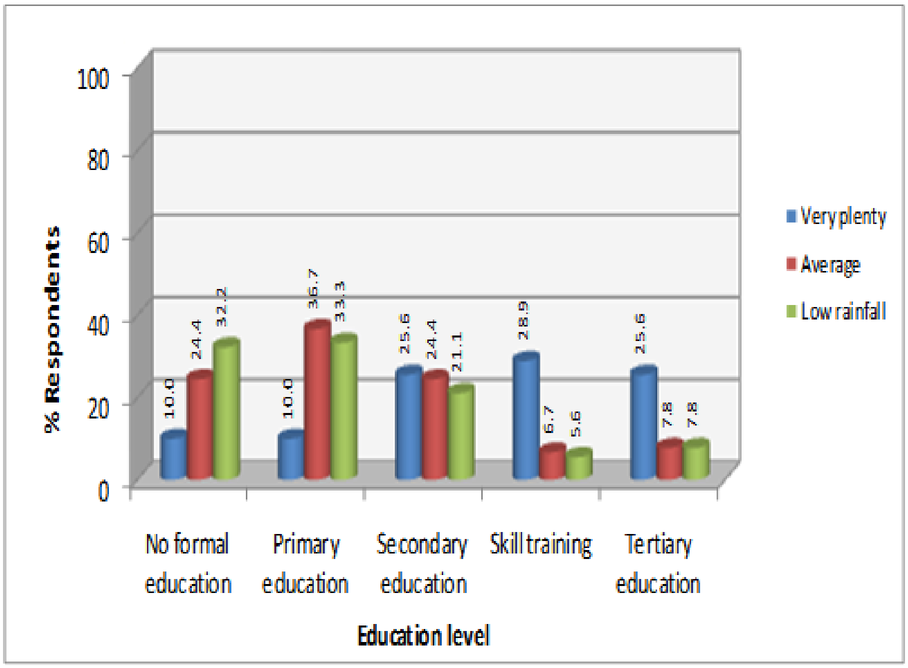

Figure 11. Perception of rainfall by education level

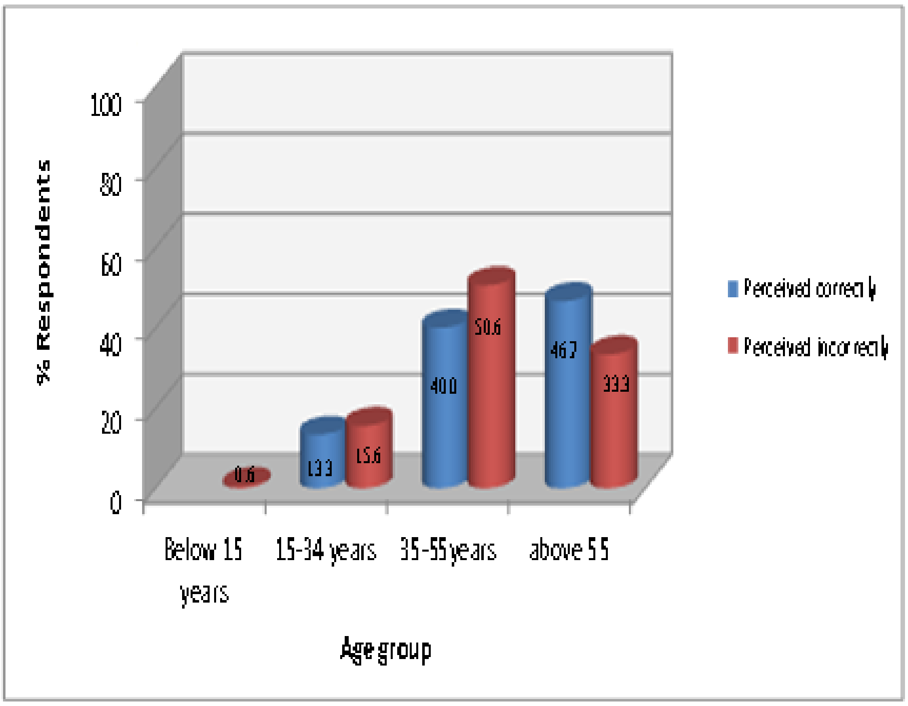

Figure 12. Perception of rainfall by age

3.5.2. Age in Relation to Perception

Perception by age was also analyzed to determine if age influences farmers' perception in the selected study area. Results indicate that 46.7% of farmers who perceived correctly are above the age of 55 years. Few farmers (33.3%) above the age of 55 years perceived incorrectly. In the other age groups, farmers who perceived incorrectly make up the majority (Figure 12).

3.6. The Impact of Farmers' Perception on Rainfall on Investment Decision

3.6.1. Impact on Types of inputs Used

Analysis was also carried out to determine the types of agricultural inputs used in each household in the 2009/2010 and 2011/2012 farming seasons. Results indicate that labor (100%), seeds (100%) and land (100%) were used by all farmers in the interviewed households. It was also discovered that a majority of household (78.1%) in 2010 and (83.8%) in 2011 used fertilizer. Pesticides were used by few farmers in both years. It is worth noting that 4.2 percent of farmers did not engage in crop cultivation in 2011/2012 while in the previous year (2009/2010) they were doing crop cultivation (Figure 13).

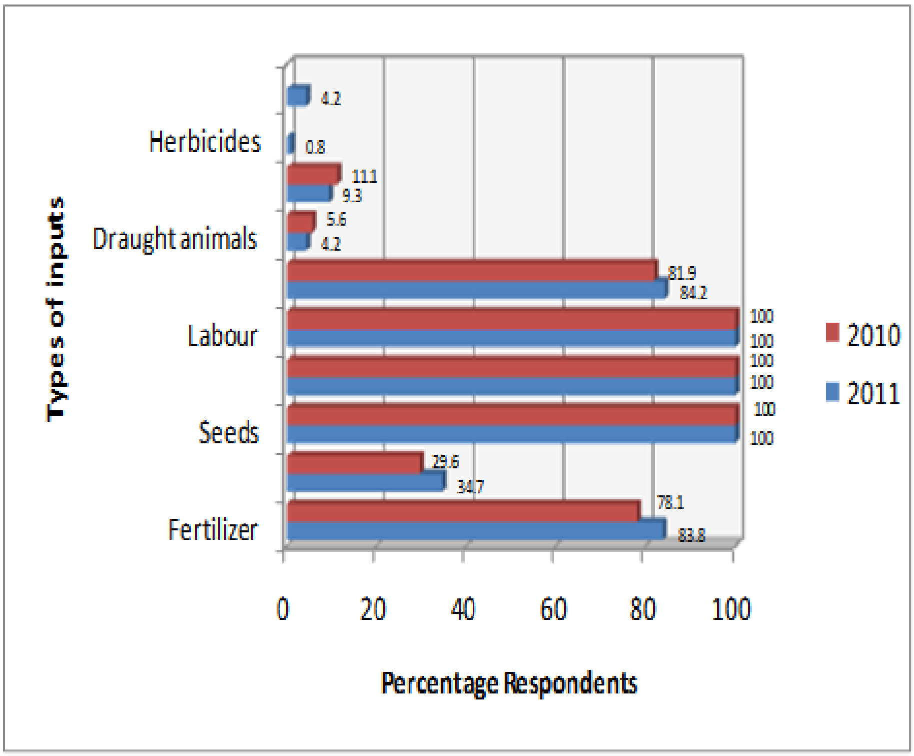

Figure 13. Types of inputs used in 2010 and 2011 farming season

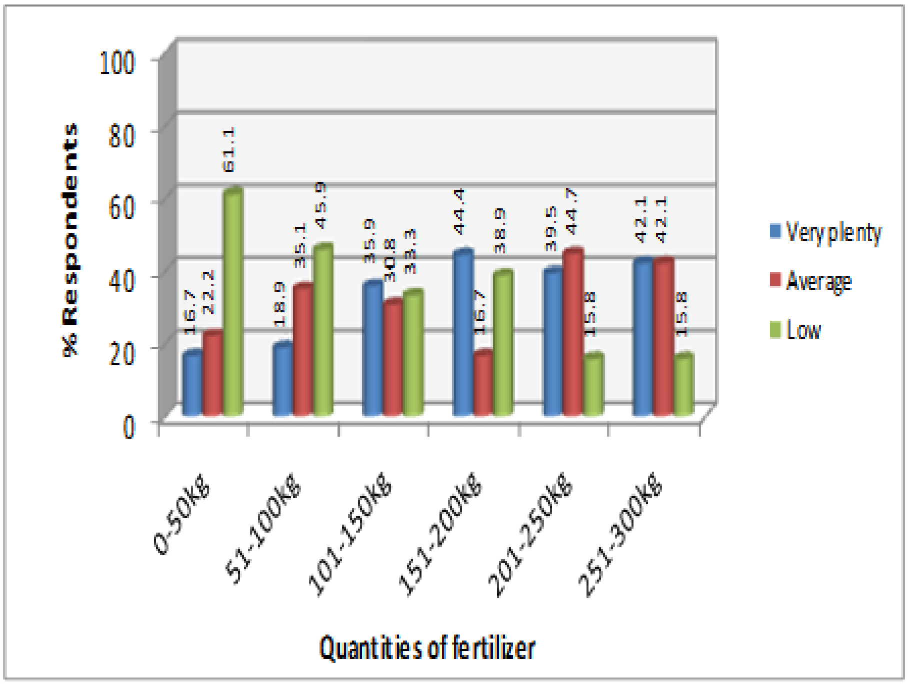

Figure 14. Amount of fertilizer applied in relation to perceived rainfall in 2011

Analysis of the amount of fertilizer used per hectare of land was also done in relation to perceived rainfall in 2011. The results indicated that majority of farmers (42.1%) who applied 251-300kg of fertilizer were those who perceived rainfall to be very plenty in the 2011/2012 farming season and those who perceived it to be average in the same year. The results also indicated that the majority (61.1%) of those who applied 1-50kg was those who perceived rainfall to be low. The same is true with those who applied 51-100kg of fertilizer. Those who perceived rainfall to be low also form the majority (45.9%) of those who applied 51-100kg of fertilizer. Very few (16.7%) of those who perceived rainfall to be plenty were found to apply 1-50kg of fertilizer per hectare. It was also discovered that only 15.8 percent applied 251-300kg of fertilizer per hectare which is the minority (Figure 14). The differences between the three types of perceptions for the 2011/2012 farming seasons was further tested statistically using the chi-square to see if there was a significant difference. The calculated Chi-square was 29.44 and the critical value at significance level 0.05 was 18.31. Based on these results, the null hypothesis (H_0) had to be rejected in favour of the alternative (H_1) since the calculated value of chi square was greater than the critical value at significant level 0.05. This means that there is a relationship between farmers' perception of climate and weather (in this case, rainfall) with quantities of fertilizer used per unit of land.

The results from interviewed heads of households on fertilizer used in relation to how rainfall was perceived were also supported by the results from the FGDs with the elders in the study communities (Box 2). According to the elders (Box 2), farmers reduce quantities of fertilizer used when they think the rain may not be enough. They will not use fertilizer for planting, but rather wait. If it rains, then they apply only the top dressing fertilizer. The elders are of the opinion that if they apply fertilizer and it does not rain, then it will burn the crops. They also acknowledged that there have been years when they thought rainfall would not be enough, but it rained well and only those who had invested well had a good crop, and those who were afraid to take the risk felt badly.

Box 2. Elders perception about fertilizer application and rainfall

- We reduce fertilizer amount when we think rains will not be enough, putting a lot will be a waste since now you cannot trust this rain…fertilizer is expensive just to waste.
- Sometimes we don't even put it, we just plant without it until we see that it rains then we put it (top dress) when maize has grown…look that field, I did not put it, even last year.
- In this community, it has become a common practice not to apply fertilizer because the sun now is too hot…and when the rain go away for a long time the maize die. The fertilizer burn up the maize so we prefer planting without even though we see that now we don't get maize, we survive on food aid and buying
- In other years, it rains in this area and those who have applied enough fertilizer get good yield and even sell maize and we feel bad when we did not apply it due to fear that it might not rain…the climate change has just come to cause hunger and poverty especially to us who never went to school and don't even understand what it is…

Analysis was also done on input used by education level in the year 2011 and 2010 to determine if the level of education has an influence on the input types used. Results indicate that the farmers use the different types of inputs regardless of their education level. However it is worth noting that in terms of fertilizer, the farmers with skills.

The results on inputs used indicate that farmers in the study area use different types of inputs regardless of perception. However, the levels of utilization of these inputs differ. Only the three inputs (land, seeds and labor) which are the core inputs were utilized by all farmers. It was also gathered that amounts of fertilizer applied varied significantly with perception. Farmers, who perceived rainfall to be low invested insignificant amount of fertilizer per hectare, while those who perceived it to be plenty tended to apply more. This was further tested statistically for significance. The results on the chi-square test on the significance of the differences observed indicate that there is a relationship between farmers' perception of climate and weather (in this case, rainfall) with quantities of fertilizer used per unit of land). When farmers perceive a good rainfall year, they also tend to invest more inputs (fertilizer) in their production. This was further confirmed in a FGD with farmers. To these farmers, this was one of their adaptation strategies to climate change due to fear of loss. These findings are similar to those made by [17] who also observed that some farmers apply fewer inputs as an adaptation mechanism or strategy to climate change. These findings confirm and support the argument by [6] who argues that farmers may not apply fertilizer when they think there will be no rain and are "too wary" to incur losses and fail to exploit opportunities in wetter years.

3.7. Household Food Security and Rainfall Perception

3.7.1. Food Availability and Access

The measure of food availability in relation to perceived rainfall was conducted by establishing if households have ever gone without food within a period of twelve months. Results indicated that majority of farmers (50%) who never went without enough food were those who had correctly perceived rainfall to be plenty. Farmers who perceived rainfall to be low are a minority (36.7%) of farmers who never went without enough food. It is interesting to note that farmers who perceived rainfall to be low are the majority of those who always go without enough food (4.4%) or at least go several times (30%) without enough food (Figure 15).

The months of adequate household provision (MAHP) was then used to establish months in which a given household did not have enough food to meet the family needs. A majority of households indicated that the most terrible months in which they went without enough food the previous year were January (33.0%), February (20.7%), October (14.4%), September (13.3%) and November (13.0%) to mention but a few. It is worth noting that most households have a challenge of food supply in January and February when schools are opening and most of the money they could be using to purchase food is directed to payment of schools fees. Another important thing to note is that in September, October and November most households lack sufficient food. These months mark the start of the planting seasons in most areas in the selected study area. This indicates that a majority of households fail to produce enough food that can sustain then until the next farming season (Figure 16).

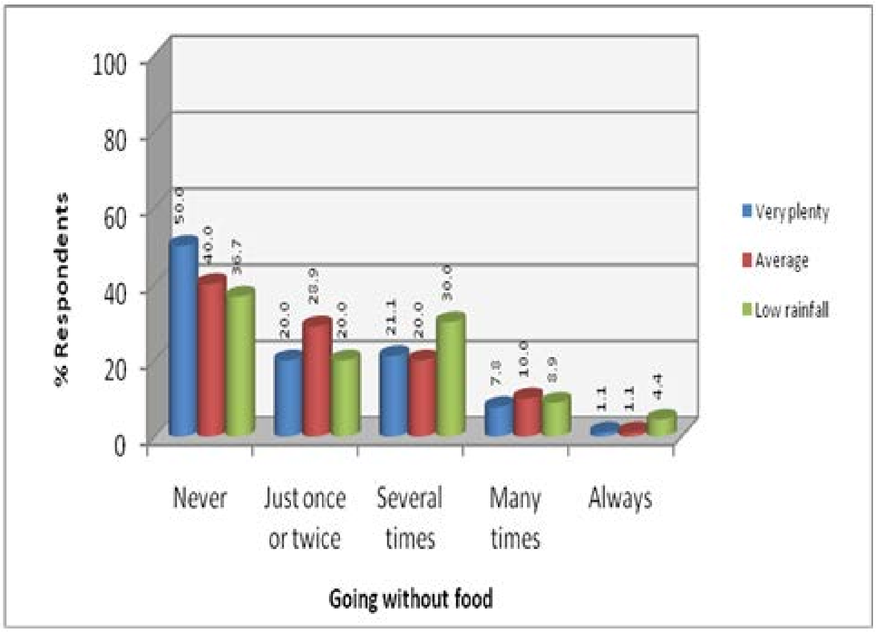

Figure 15. How often households gone without enough food a year

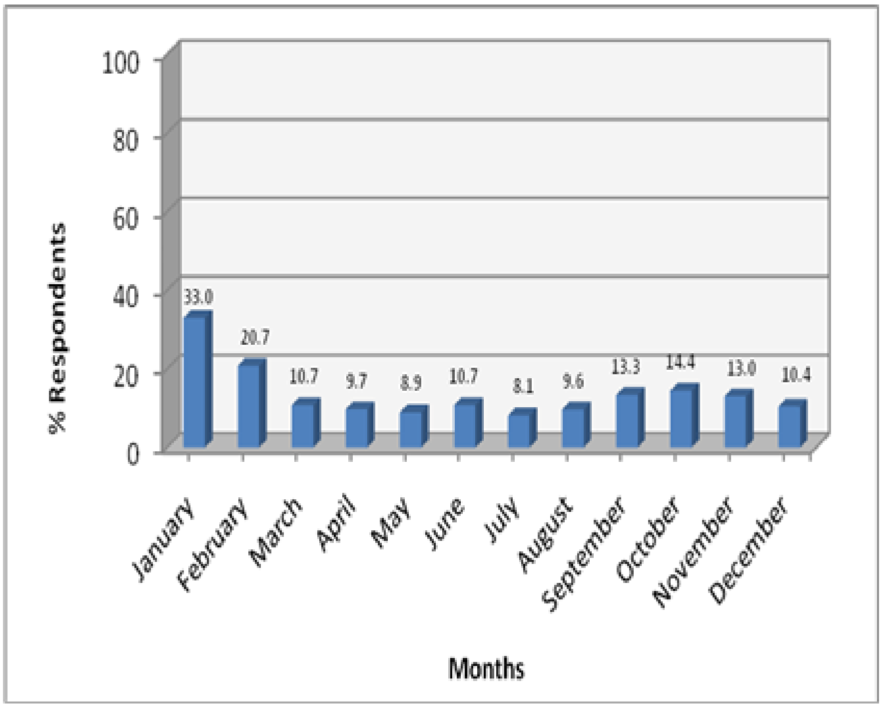

Figure 16. Months of inadequate household food provision

It was also important to find out from respondents how important food aid in their households was. A majority of farmers (37.8%) indicated that food aid is very important. A reasonable number (23.6%) also indicated that it is important while only a few farmers (12.5%) indicated that it is not. Only 8.0 percent stated that food aid is not important at all (Figure 17).

3.7.2. Food Security Status

An analysis was also undertaken using the household food insecurity access prevalence indicator in order to establish the level of household food security. Results indicate that majority of household (34.4%) are moderately food insecure. Households that were moderately food insecure were 15.9 percent of the households under study. On the other hand, a reasonable number of households (25.2%) were found to be food secure and 24.4 percent were found to be mildly food secure (Table 1).

Table 1. Household food insecurity access prevalence indicator

Status	Frequency (f)	Percentage (%)
Food secure	68	25.2
Mildly food secure	66	24.2
Moderately food insecure	93	34.4
Severely food insecure	43	15.9
Total	270	100.00

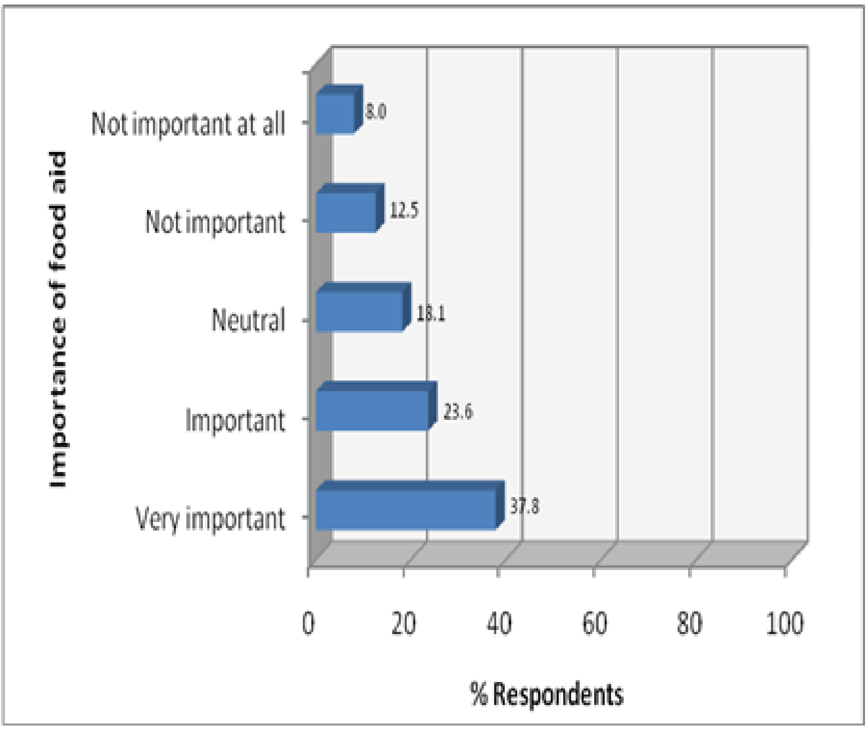

Figure 17. Importance of food aid in household

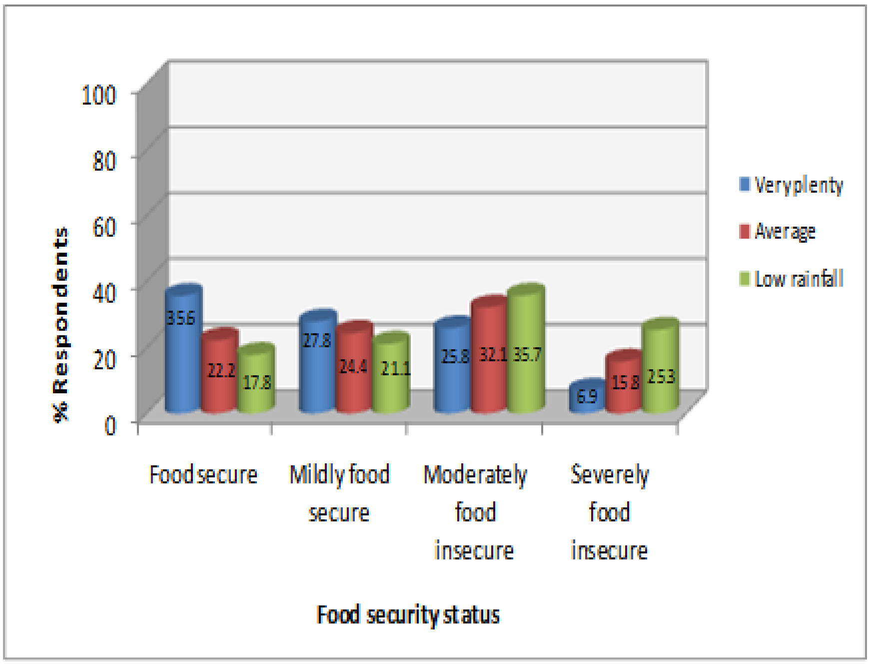

Figure 18. Food security status in relation to perception

3.7.3. Food Security Status in Relation to Perception

The same analysis was carried out in relation to perceived rainfall. The researcher wanted to know if there was a relationship between perception of rainfall and food security status at household level. Results indicate that the majority of households (35.6%) which are food secure perceived rainfall to be plenty. The same was true with the proportion of households who were found to be mildly food secure. Majority of the mildly food secure households (27.8%) perceived rainfall to be plenty. It is interesting to note that a majority of the moderately food insecure households (35.7%) were those who perceived rainfall to be low. This is also true with those who are severely food insecure. A large number of these households (25.3%) are those who perceived rainfall to be low. This indicates that a majority of those who perceived rains to be enough and average are food secure or at least moderately food insecure. Very few (6.9%) of these who perceived rainfall to be plenty were found to be severely food insecure (Figure 18). This was tested for significance using the chi-square test. The test, however, indicated that the relationship is not significant as the calculated chi-square value (11.706) was less than the critical value (12.59) at significance level 0.05. The root cause of food insecurity in Africa and other developing countries is the inability of people to gain access to food due to failure of the agricultural sector [18], thus scholars argue that the key to addressing food insecurity in Africa lies in increasing the agricultural profitability of smallholder farmers and creating rural off-farm employment opportunities.

4. Conclusion

Based on the findings, the study concluded that farmers perceived correctly climate change and weather variability. However, some perceived wrongly the amount of rainfall to be expected at the onset of the farming season. Farmers who perceived incorrectly the amount of rainfall in the beginning of the farming season made inadequate input investment (in this case on fertilizer) and they harvested lower yields and were more food insecure. Contrary, farmers who perceived correctly the amount of rainfall tended to make adequate input investment and harvested more yield and were less food insecure. Other farmers were too wary of climate change and missed opportunities in good years and felt bad when other farmers got better yields. The study concluded that farmers' perception of climate change and weather variability, in particular rainfall, influence investment decision and the resulting crop yield and food insecurity. It is essential that farmers perceive rainfall correctly, especially the onset of the rains so that they can invest adequately. Education and age were found to influence how farmers perceived rainfall conditions. Farmers who were relatively older and those with higher education tended to perceive rainfall more correctly than those very young ones and those without or with low education levels.

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