CLIMATE CHANGE: ADAPTATION TO ENVIRONMENTAL AND SOCIO-ECONOMIC CHALLENGES

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1. INTRODUCTION

The planet Earth and the World are equally at risk of extinction. Global warming poses a threat to the Earth's ability and capacity to provide for the living. As a result, the World is heading for food insecurity due to effects of global warming which leads to climatic irregularities such as temperature increase, rainfall variations, droughts, floods and extended crop growing seasons (Wikipedia 2010b). The developing countries are the prospective victims of climate change. For example, African countries are particularly vulnerable due to their dependence on rain-fed farming, poor farming infrastructure, and low level of financial capital. The International Food Policy Research Institute (IFPRI)'s future projections predict 25 million more children malnutrition in the Sub-Saharan region in 2050 (Sepaela 2010:6).

The World appears to be the main culprit in the cause of all these global environmental ills. It is again the World that will most suffer the consequences such as extreme climate events, food insecurity, and socio-economic challenges. It is again the World that needs to correct or alter the situation through reduction (mitigation) of greenhouse gas emissions or to adapt within climate change conditions. Agriculture is extremely vulnerable to the effects of climate change because farming is weather-dependent. Extension therefore becomes one of the major role players in any efforts meant to ease the climate change impact. This paper has therefore been initiated to make a contribution towards addressing climate change from agricultural perspective.

1.1 Purpose

This paper seeks to highlight the current temperature increases and their effects on food production systems. The paper also seeks to identify adaptation options to the negative impacts of climate change on agricultural food production systems on the one hand and the socio-economic implications to the farmers, on the other. To achieve this objective, the review therefore focuses prominently on the impacts of temperature increase and change in rainfall pattern on agriculture. It also looks into the approaches that may enhance adaptation of farming systems within climate change conditions.

1.2 Data Source

The paper conducted literature review on climate change putting a particular focus on the subjects such as global warming, the impacts of climate change on farming land, the effects of climate change on weed control, and the benefits that farmers may draw from the effects of climate change on agricultural food production systems. The review also examined the socio-economic implications of climate change on farming conditions. It also conducted literature review on climate change adaptation mechanisms.

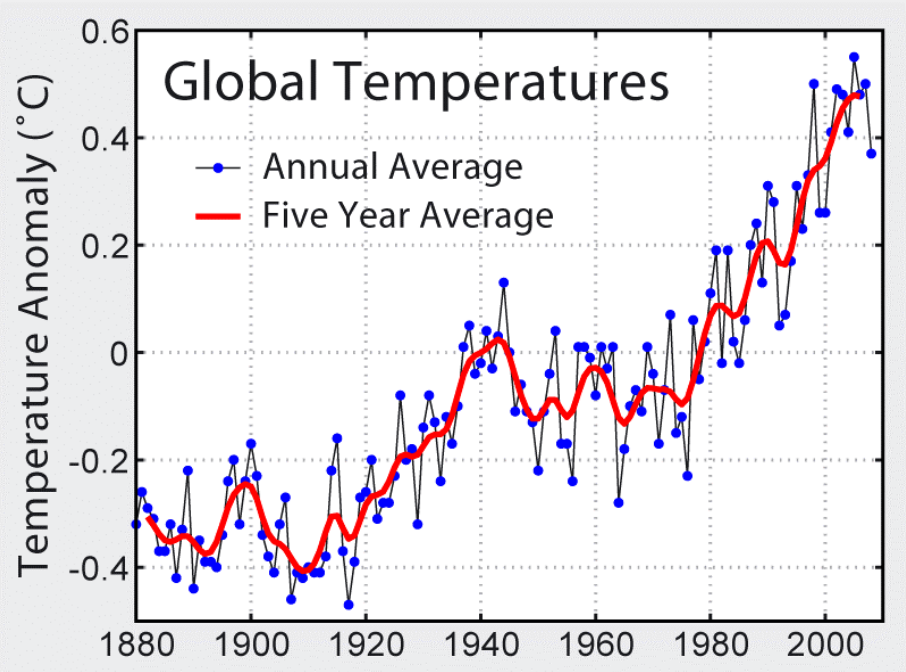
2. DISCUSSION

As point of departure, the discussion begins with global warming as the major climate change factor that impacts on the farming land, crop and livestock production systems and rates, and production costs. The discussion also relates the climate change factors that may increase farming production costs with the prospects of future capacity to adapt the agricultural food production system within the severe climatic changes. The discussion is therefore focused on such climate change aspects from which some socio-economic dimensions are established. The discussion is organised in the following structure: The first section defines climate change and further reviews literature on global temperature variation over time. The second section of

the discussion reviews the effects of climate change on agricultural food production systems. The third part of the discussion reviews the financial implications of climate change on farming sector. Section four of the review formulates the adaptation strategies to cushion the negative impacts of climate change on farming processes. The last section of the discussion examines the socio-economic implications of climate change on farmers.

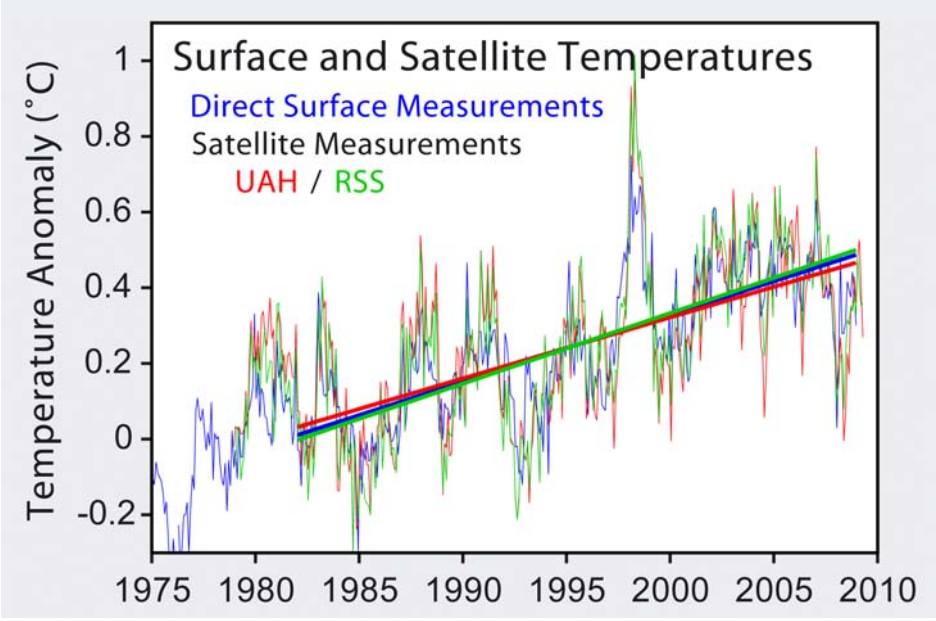
2.1 Climate Change

Climate change represents a change in long term average weather patterns clumped together. These weather patterns may become warmer or cooler. The concern is therefore about global warming which refers to an average increase in the Earth's temperature. The increased temperatures are accompanied by irregular increased or decreased rainfall or snowfall. The temperature changes have been observed for a number of years to measure the rate in which it progresses over a period of time. Figures 1 and 2 present the findings of the observations on the global temperature changes.



Source: Wikipedia (2010b)

Figure 1: Global mean surface temperatures difference.



Source: Wikipedia (2010b)

Figure 2: Comparison of ground-based (blue) and satellite-based (red, green) records of temperature variations.

2.2 The Effects of Climate Change

The impacts of climate change are advanced by among others, global temperature increase and change in rainfall amount and pattern (United States Environmental Protection Agency 2010). These high temperatures increase the Earth's environmental temperatures to the level that life and food security is threatened. The poor or developing countries will be hit hard because most of their crop production processes are rain-fed. In southern Africa and South Asia, for example, more than 30% and 10% of the crop production will respectively be lost in 2030 (Wikipadia 2010a:2). In other words, by 2030 food security in southern part of Africa will be at stake. South Africa is therefore not exception.

Climate change may physically affect agricultural crops in these countries in the following different four ways (Kurukulasuri & Rosenthal 2003:7-9):

2.2.1 Carbon dioxide may benefit the crops in that it increases water use efficiency and rate of photosynthesis. This means that from the carbon dioxide, farmers may save irrigation water, and the crops may be able to produce more food from their forage material.

2.2.2 Changes in temperature and precipitation may lead to lengthened crop growing seasons on the one hand and extreme rainfall events which change soil moisture and content, on the other. As temperature and precipitation increase, soil moisture, atmospheric humidity and the length of growing seasons increase. As a result the environment becomes more favourable for growth of insects and diseases.

2.2.3 Droughts and floods are some of the climate change extreme events that pose a threat to agriculture. Droughts may cause moisture stress in the crops.

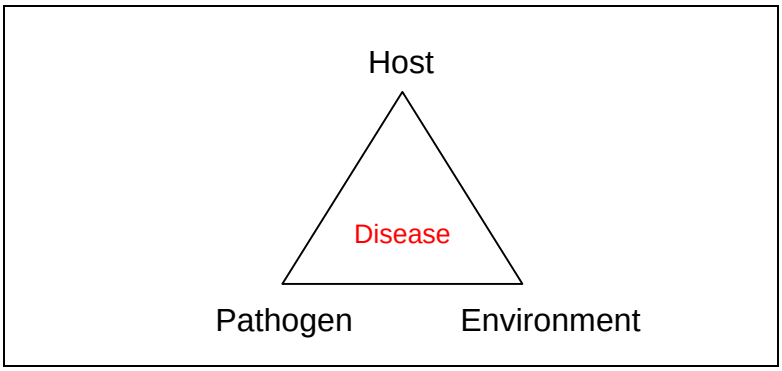
2.2.4 And floods may increase the rate of soil erosion and degradation wherein soil fertility becomes adversely affected.

2.3 Climate Change and Financial Implications on Farming

High temperatures may increase soil water evaporation rate as well as crop water demand. The farmers will therefore need to increase water supply and multiply their irrigation frequencies. As a result, the farmers will suffer increased irrigation water expenses. These expenses would therefore be incurred from various farming system dimensions such as the increased amount of irrigation water, the new irrigation technology consistent with the conditions, and the water management infrastructure (storage dams, pumps etc).

Climate change also makes chemical weed control difficult and expensive. A change in wind speed and soil moisture stress may negatively affect weed control because high speed winds affect the application and efficiency of herbicides. And drought on the other hand promotes development of thicker cuticles or increased leaf pubescence which reduce penetration of herbicide into the leaves of the weeds (Lewis H. Ziska). Petzoldt and Seaman (2010:7) here agree that increased temperature and moisture may change the efficacy of fungicide and bactericide. Ziska further argues that pesticides work effectively in rapid growing and metabolizing plants that are free from environmental stress.

Environmental consistency and stability appears to be very important for effective and efficient farming systems. Curtis Petzoldt and Abby Seaman present a three leg triangle (Figure 3) which shows the relationship between pathogen (pests), host, and environment towards causing a disease. The argument here is that if any of the three factors is altered, the progression of a disease can occur. This may therefore mean that the risks of disease infestations to farming sector increase.



Source: Petzoldt and Seaman

Figure 3: The three leg triangle illustration.

The production cost may also increase in livestock production sector particularly milk production industry wherein high atmospheric temperature increases the loss of sodium and potassium through high rate of respiration. As a result, the animals' feed conversion rate decreases. This therefore means that to maintain their milk production, milk producers need to increase the amount of their dairy feed additives. Table 1 illustrates the relationship between the changes in temperature, dairy feed requirement and the projected milk production from the findings of the study conducted in 2005 in United States of America among New York dairy herds.

Table 1: Analytic illustration on temperature, food intake and milk production.

Run	Temp °F	% difference in temp.	Energy required for daily maintenance	Increase in energy required	Milk production from metabolised energy	Decrease in milk production
1	60	22%	16.38	11.50%	85.3	7.50%
2	90		18.27		77.8	

Source: Larry E. Chase

2.4 Adaptation Mechanisms

Adaptation refers to adjustments in production systems and management practices to cushion the adverse impact of climate change on farmers. Adaptation may be adopted at levels of socio-economic and political sectors or structures. i.e. at farm, industry or government level. However, for the purpose of this review, the discussion is prominently focused on farm level of adaptation. According to Smit and Wall (2003), there are two distinct responses to climate change. That is to mitigate greenhouse gas emissions and to adapt. This therefore means that we must either reduce carbon emission or adapt.

From the analysis of Mitchel et al's work, David W. Wolfe found that grain crops such as wheat and oats tend to lower yield when summer temperatures increase. As a result, farmers are advised to adapt to this challenge by opting for, among others, varieties that need longer growing seasons. It must be borne in mind that the adaptation strategies may have costs and other form of challenges on the one hand, and opportunities attached thereto, on the other. Table 2 gives a simplified illustration of a series of adaptation mechanisms farmers should opt for in order to counter the effects of climate change.

Organic farming may be another climate change counter measure which does not use farming inputs such as synthetic fertilizers, herbicides and pesticides to avoid pollution of air, soil and water. However, this farming practice optimizes soil fertility and crop productivity on the one hand, and enhances crop diversity, on the other (Müller-Lindenlauf 2009:4). Farm management practices such as disaster and risk management, sustainable production, water management and efficient water storage may also enhance adaptation to climate change (FAO 2009).

Table 2: Adaptation mechanisms in relation to their implementation cost levels.

Adaptation strategy	Costs	New challenge or opportunity
Change planting and harvesting dates	0 - low	Different market window with lower prices
Change crop varieties	0 - Moderate	Cost on new planting equipment Adjusted cultural practices Uncertain market response to new quality
Change crop species	Low - High	Risk of no guarantees on market New profits
Increased water, fertilizer, herbicide, and pesticide use	Low - Moderate	More fertilizer, more weeds, more costs on herbicides
New irrigation system	Moderate - High	
Increase organic soil content	Low	Improved soil fertility Reduced carbon emission

Source: David W. Wolfe

2.5 Socio-Economic Implications

The following are the implications of climate change on farming sector:

2.5.1 Climate change is a challenge to farming sector. However, there are some good aspects accompanied its impact. For example, some forage crops become advantaged when temperature increases in that they become much more resistant to fungal infections in warmer conditions (Coakley et al 1999 as cited by Petzoldt & Seaman). As a result, therefore, the farming sector may make economic gains from such crops.

2.5.2 As the demand for farming inputs such as herbicides, pesticides and dairy feed additives increases, the agricultural chemical input producers may optimize their sales. As a result, such economic sectors may increase their contribution to the Gross Domestic Product (GDP). Thus growth of the economy from which farmers themselves as citizens do benefit.

2.5.3 For the regions like Sub-Saharan Africa and South Asia wherein agricultural sector accounts for a large part of their GDP, export earnings and employment, the effects of climate change may be suffered most. These countries may suffer high rate of job losses and unemployment.

2.5.4 The vast majority of the people in developing countries live in rural settlements where their livelihoods are largely dependant on agriculture. This therefore means that climate change may negatively affect their level of household income and food security.

3. RESULTS

The following have been identified from the review and summarized as follows:

3.1 Farming temperatures are continuously increasing.
3.2 Farming lands face severe soil erosion.
3.3 A decline in crop production is projected.
3.4 Food shortage is imminent particularly in Asia and Sub-Saharan countries.
3.5 Pesticides efficacy decreases when temperature increases.
3.6 Farming costs may drastically increase.
3.7 Agricultural input sector grows due to the increase in input demands.
3.8 Forage crops become resistant to fungi in increased temperature.
3.9 It is people who cause climate change, and it is people who must mitigate or adapt.
3.10 Farmers in developing countries may have a limited ability to adapt due to among others, future technology deficiency.

4. CONCLUSIONS AND EXTENSION IMPLICATION

4.1 Adaptation of agricultural food production systems depends on future changes in technology. Extension therefore needs to embark on intensive research on adaptation options.

4.2 Extension therefore needs to create awareness on the need for adaptation within climate change.

4.3 Extension needs to communicate adaptation lessons and success stories within farming sector.

4.4 Vern Grubinger emphasizes (that:

> "the sooner Extension and other service providers become familiar with the issue (*climate change*) and with the range of possible responses, the sooner we will be able to integrate climate change into our programming, as one of the many factors that farmers should consider when making management decisions"

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