

UNIVERSITY OF GHANA, LEGON



**IMPLICATION OF CHANGING CLIMATIC CONDITIONS ON THE
LIVELIHOODS OF SMALLHOLDER PINEAPPLE FARMERS IN AKUAPIM
SOUTH MUNICIPALITY**

BY

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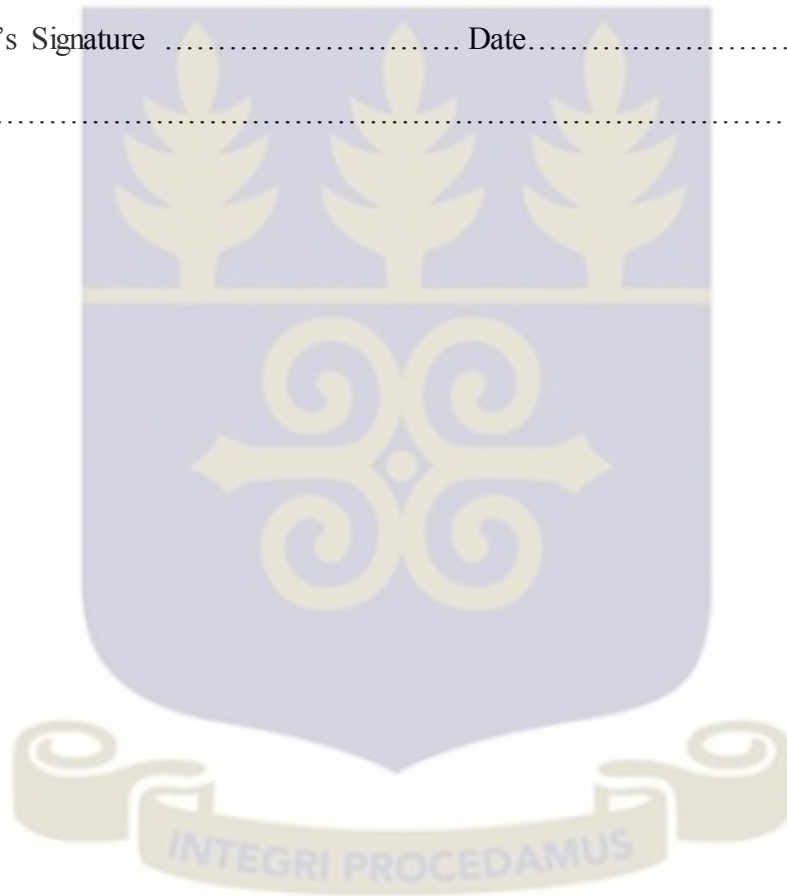
DECLARATION

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I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

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CERTIFICATION

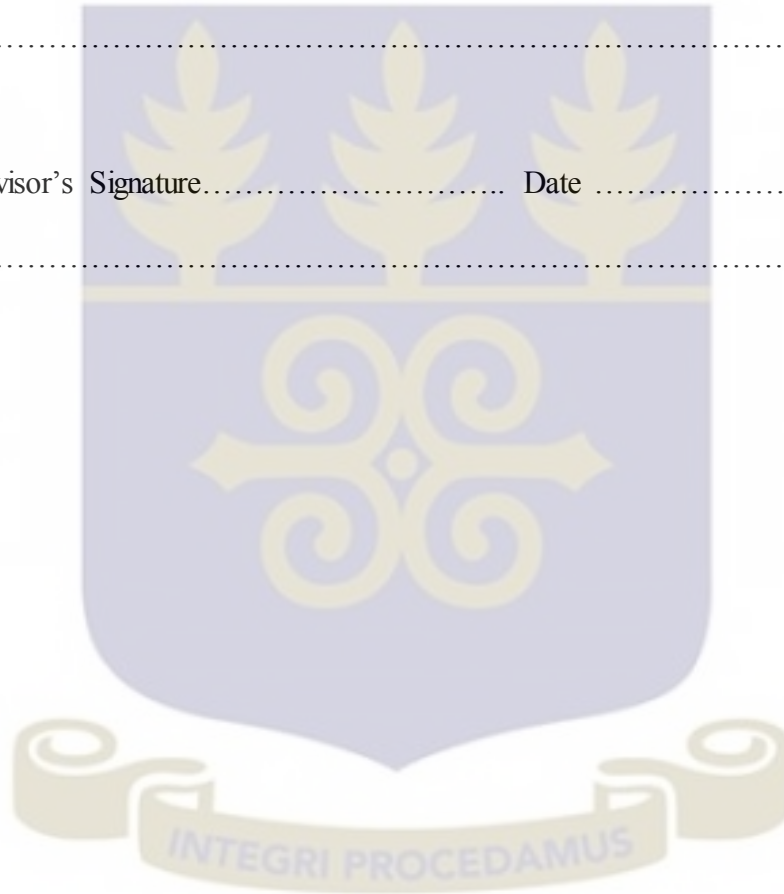
We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision, laid down by the University of Ghana-Legon.

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Co-Supervisor's Signature..... Date

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DEDICATION

I dedicate this work to my mothers, Mrs. Gladys Asante and Mrs. Rose Afranie and to all my other mothers for making this possible. God bless you.



ACKNOWLEDGEMENT

This thesis would not have been possible without the support and guidance of my supervisors, Dr. Irene Egyir and Dr. Albert Ahenkan. I wish to thank them for giving me the opportunity to work on this project, and most of all words of wisdom and guidance which were invaluable to the successful completion of this project. I similarly wish to extend a thank you to the staff of the Climate Change and Sustainable Development program particularly Prof. Yaa Ntimoa-Baidu and Dr. Kwadwo Owusu for making this project possible.

My Thesis is based on fieldwork in Akuapim South Municipality and this work would not have been possible without the help and support of many people. In particular, I owe a great deal of gratitude to Prof. Audrey Gadzekpo, for letting me be part of her project on “Climate Adaptation Learning”, for guiding me and shaping my work. I am also indebted to the staff of Ministry of Food and Agriculture-Nsawam Municipal Office without whom this research would not have been possible. I appreciate the generous smallholder pineapple farmers of the Akuapim South Municipality, who allowed me access to their homes, wisdom, and understanding of climate change and agriculture. Their willingness to spend long hours with me, and being patient with me made this thesis possible.

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ABSTRACT

Changing climatic trends pose problems for agriculture dependent livelihoods in Sub-Saharan Africa. In Ghana, Smallholder pineapple farmers in the Akuapim South Municipality are often considered vulnerable to the changing climatic conditions as a result of their farms being located in marginal soils, their insecure land tenure and their participation in unpredictable world export markets. Analysing how smallholder pineapple farmers in the municipality perceive climate variability and extremes, the associated risk on their yields, the factors that enable or constrain their adaptive capacity, and their adaptation response may prove insightful for creating effective education and training tools and climate adaptation policies. In the study, data was obtained from primary (household survey) and secondary sources (Ghana Metrological Agency and The Ministry of Food and Agriculture). The results of the linear specification model showed that rainfall and temperature range very much influence pineapple yield within the municipality. The study also showed that most respondents' account of the changes in the long-term climatic trends was similar to that of the regional climate records. The discrete choice model used to find the determinants of climate adaptation strategies in the municipality, confirmed that marital status, education and perception of changes in temperature are the important determinants of adaptation. Finally, the study established that adaptation and coping responses used by farmers included both on and off-farm approaches. The thesis results suggest that adaptation efforts intended to reduce the impacts of changing climatic trends on smallholder pineapple farmers should be holistic and address the day-to-day problems and risks associated with their livelihoods.

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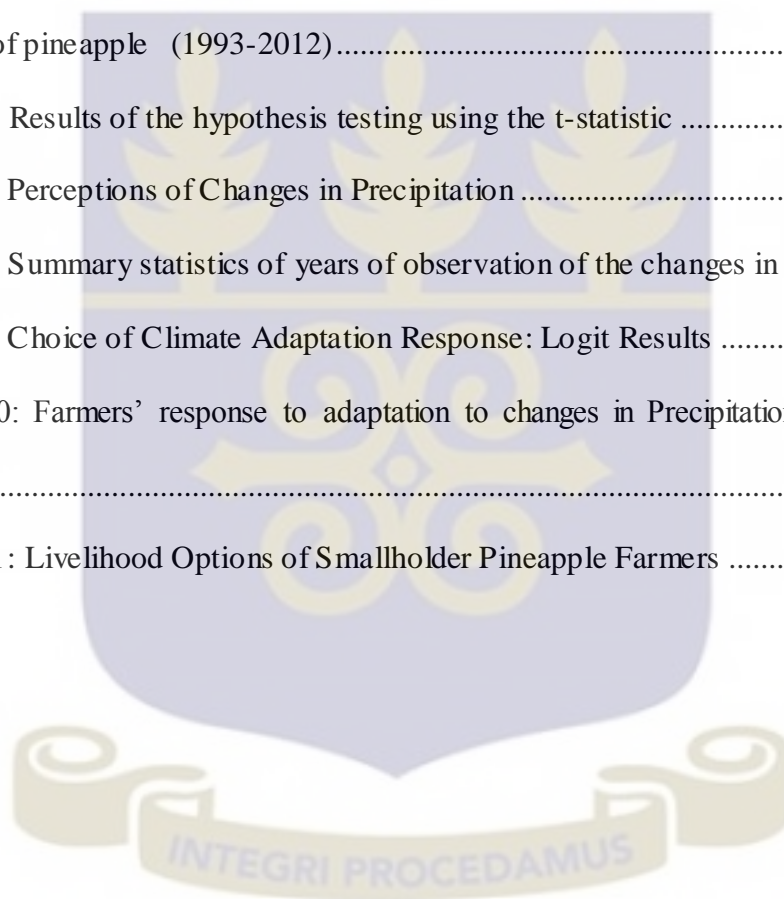
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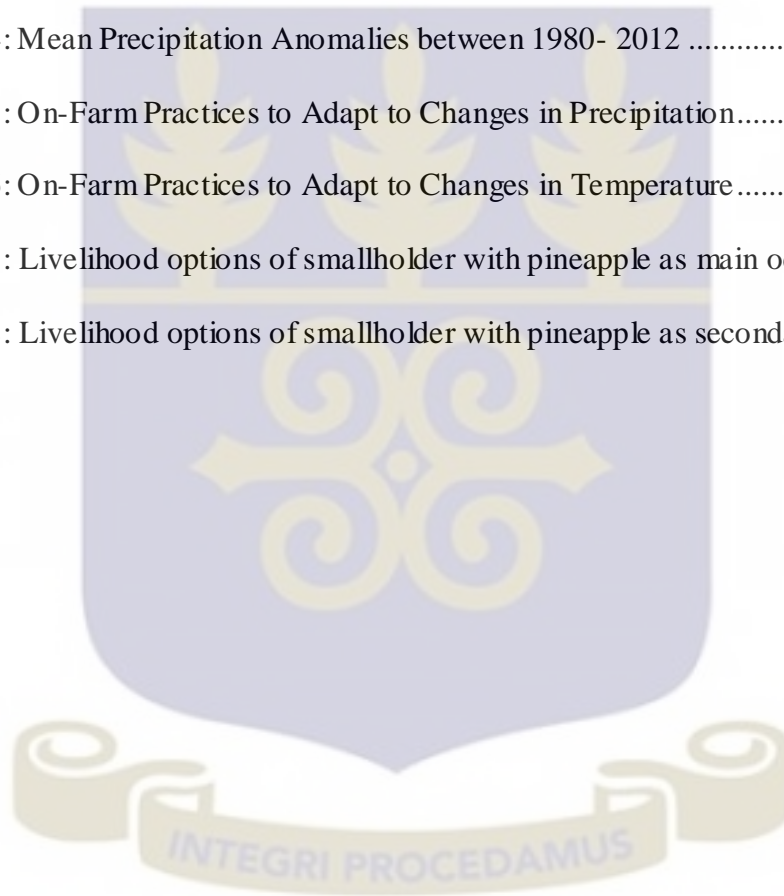
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ACRONYMS

FASDEP II	Food and Agricultural Sector Development Policy
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GPRS I	Ghana Poverty Reduction Strategy
GPRS II	Growth and Poverty Reduction Strategy
GSGDA	Ghana Shared Growth and Development Agenda
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
MDG	Millennium Development Goals
METASIP	Medium Term Agricultural Development Plan
MOFA	Ministry of Food and Agriculture of Ghana
NTAE	Non-Traditional Agricultural Export
SPSS	Statistical Package for Social Science



CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Livelihood security has progressively become embedded in the socioeconomic and political layers of many economies. In Africa, just like other developing regions of the world, livelihood security has become an important issue for agriculture development and regional food security (Baro & Deubel, 2006; Cousins & Claassens, 2006; Downing & Lüdeke, 2002; Haile, 2005). Defined as adequate and sustainable access to income and resources to meet basic needs which include adequate access to food, potable water, health facilities, educational opportunities, housing and social integration (Frankenberger & McCaston, 1998). Household Livelihood Security, is now one of the key agricultural developmental policy drivers in many societies across Africa today (Conroy & Litvinoff, 2013; Dercon & Gollin, 2014).

Highlighting the multiple benefits and importance of agriculture to the inhabitants of Sub-Saharan Africa Region, most growth and poverty reduction strategies have focused on improving livelihoods through agriculture development (Birner & Resnick, 2010; Diao et al., 2007; World Bank, 2002). According to Staatz and Dembele (2008), agriculture is the primary source of livelihood for about 62 percent of the population of Sub-Saharan Africans (excluding South Africa) and generates nearly 27 percent of GDP. Indeed, while several studies recognize the potential of smallholder agricultural production as a practical poverty reduction strategy (Diao et al., 2007; Singh et al., 2014), productivity of smallholders remains low and further compounded by poor and inadequate access to functioning input-output markets and support services (Adeleke

Salami et al., 2010; Barghouti et al., 2004; Nyoro & Ariga, 2004; Sabates-Wheeler et al., 2009).

In Ghana, strong evidence points to the fact that smallholder agriculture, which employs the use of simple technologies and cultivation practices has yielded little effort in meeting the needs of a growing economy (MOFA, 2012). Considering the importance of agriculture and the policy focus on agricultural development, various policy documents including the Ghana Shared Growth and Development Agenda (GSGDA) and the Food and Agricultural Sector Development Policy (FASDEP II) have all clearly stipulated the role of smallholder commercialization in improving the livelihoods of farmers (MOFA, 2012).

So, following the emergence of the structural adjustment and trade liberalization policies in the early eighties, Ghana has undertaken various initiatives in an attempt to expand and diversify its market share. Much of these local initiatives have taken place through the increased intensification and commercialisation of smallholder horticultural crop production, especially along major market centres and shipping ports (McCullough et al., 2008; Porter, 2002). According to Chamberlin (2007), this process forms part of a broad based, pro-poor agricultural growth in Ghana and one area identified in this effort is smallholder pineapple production (Asuming-Brempong et al., 2012).

In view of the fact that smallholder pineapple production has the potential to contribute enormously to socio-economic development, efforts have been made to improve upon productivity. In the Akuapim South Municipality, pineapple production is among the horticultural crops adopted by several farmers because of its higher market value and increased yields (Achaw, 2010; Asuming-Brempong et al., 2012; Takane,

2004). Although numerous positive factors are associated with smallholder pineapple production in Ghana, especially in the fight against poverty and underdevelopment (Brooks et al., 2009; Rhode; Tollens, 2002), there are still challenges to the attainment of the United Nations “Millennium Development Goals” to eradicate extreme poverty and hunger, and reduce child mortality by 2015 (Washington et al., 2006).

In recent times, the issue of changing climatic factors has been recognised as a serious environmental and livelihood threat (Cooper et al., 2008; Lambin & Ehrlich, 1997; Sold et al., 2013). Reported projections indicate that the estimated impact of changing climatic factors on livelihoods will be enormous, especially in areas where many smallholders rely on rain-fed agriculture (Boko et al., 2007). In a continent where agricultural production is so closely linked to annual and inter-decadal climate variability coupled with low levels of human and physical capital, and poor infrastructure, the level and trend of changing climatic conditions are likely to have a significant impact on crop production levels (Cooper et al., 2008; International Food Policy Research Institute (IFPRI), 2009; Washington et al., 2006). Changes in temperature and precipitation will also affect crop photosynthesis, crop phenological stages (planting to flowering), as well as water and nutrient availability (de Azevedo et al., 2007; Long, 1991). Therefore with such changes in climatic trends, Ghana’s agriculture may likely suffer as a result of this phenomenon.

1.2 Problem Statement

Ghana’s Medium Term Agricultural Development Plan (METASIP) asserts that an understanding of the impact of changing climatic conditions on agricultural production

is necessary in order to meet the demands of the ever growing human population (MOFA, 2012). Thus, the vulnerability to the impacts of future change in climate regimes remains a critical issue in the interaction of society with global environmental change (Adger, 1996). However, there exist various gaps in our knowledge of the effect of changing climatic factors on yield of farmers especially that of commercial smallholders.

In Akuapim South, the competitive advantage enjoyed by the municipality including the fact that the area is endowed with improved agronomic practices, relatively good infrastructure including proximity to major market centres and ports, and most importantly the support from government to actively engage in pineapples production, has aided the municipality to become a major pineapple growing area (Achaw, 2010). According to Achaw, in 1995, two-thirds (60%) of the nation's total pineapple export came from the municipality, accruing to the country about US\$5 million in foreign earnings.

Yet over the period, yields and livelihoods have declined considerable. To a large extent, literature on challenges to smallholder pineapple cultivation has concentrated on quantifying the share of non-climatic related factors on yields. Some of these challenges include effects such as price changes, credit, regulation changes, inadequate governmental infrastructure support amongst others and how they have affected yields and productivity of smallholder farmers (Boansi et al., 2014; Danielou & Ravry, 2005). However, little consideration has been given to the impact of changing climatic trends on livelihood security including access to food for smallholder farmers.

Although various assertions including some substantial studies have been conducted to gauge the effect of climate change on the yield of subsistence smallholder

farmers, however, it remains to be known what the impact of the changes in climatic factors are on the yield of farmers engaged in high value fruit crops like pineapple (Altieri & Koothakan, 2008; Jones & Thornton, 2003; Morton, 2007). This research work has been prompted by the need to get a deeper understanding of the major impact changing climatic factors are having on smallholder pineapple farmers.

1.3 Objectives of the Study

The objective of this research work was to;

1. Assess the impact of changes in the major climatic factors on pineapple yield over the last two decades.
2. Compare farmers' responses of perception of changing climatic factors to the climate records in Akuapim South Municipality.
3. Identify the factors that influence smallholder pineapple farmers' adoption of climate change strategies
4. Identify the range of livelihood strategies used by smallholder pineapple farmers to cope/adapt to the major climatic factors.

1.4 Research Questions

Arising from the above objectives the following research questions were posed;

1. What has been the impact of changes in the major climatic factors on the yield of pineapple farmers over the last two decades?

2. How does the perception of farmers on changing climatic factor compare with that of scientific data?
3. What are the factors that influence smallholder pineapple farmers' adoption of coping/adaptation strategies?
4. What are the ranges of livelihood activities undertaken by the farmers to adapt to the changing climatic trends?

1.5 Research Hypotheses

The hypotheses verified in the course of the research states that;

H_0 : There is no significant difference in changing climatic trends on pineapple yield in Akuapim South Municipality.

H_A : There is significant difference in changing climatic trends on pineapple yield in Akuapim South Municipality.

H_0 : There is no significant difference in the coping strategies farmers use to adapt to climate change.

H_A : There is significant difference in the coping strategies farmers use to adapt to climate change.

1.6 Justification of the Study

Smallholder pineapple production contribute enormously to growth, employment and poverty reduction strategies of the Ghanaian economy (Achaw, 2010). It is hoped that through this study a better insight can be given to enrich the stock of literature regarding climate impact on smallholder pineapple production. The expectation is that, the findings from this research will reveal the extent to which the living standards of the people have been impacted by changing climatic factors and serve as basis for further work.

The study is also crucial since the Ghana Poverty Reduction Strategy (GPRS I), Growth and Poverty Reduction Strategy (GPRS II) and the Ghana Shared Growth and Development Agenda (GSGDA) see the fruit sub-sector as a priority sector. Therefore, enhancing livelihoods and ensuring sustainable development in the fruit sub-sector has a role in this achievement. Furthermore, these policy documents see the development of the fruit sub-sector as a major tool for achieving the MDGs 1, 5 and 7 therefore, based on the crucial role information plays in the formulation and implementation of agricultural policies, results from the study could provide useful information to assist government in setting priorities and formulating policies concerning improvement and sustainability of smallholder pineapple farming.

It is also believed that through this study, extension agents will be better informed to assist farmers in dealing with implication of changing climatic trends on their production. Thus, the study would create greater understanding of current pineapple production practices and constraints and how it is changing under a variable climate. The

study would also document the local adaptation practices and farming system which will help understand situations on the ground.

Lastly, this research is carried out partly in fulfilment of a master's degree.

1.7 Limitations of the study

This study seeks to find out the influence of major changing climatic factors on smallholder pineapple farmers in Akuapim South Municipality. Generally, in using a case study approach, the research is limited by the extent to which generalization can be made from the findings based on the sample to describe the entire population. However, if proper procedures are used to obtain samples, the outcome of the study will reflect the true characteristics of the population.

This research is also limited by other factors. The first relates to the data collection. Poor record keeping, memory lapses, and unwillingness to share information on some key changes in variables such as their perception of changes, livelihood assets among others were common problems encountered during the data collection. These problems tend to affect the quality and accuracy of data. However, the results were not affected in any way since the findings are interpreted in the context of these setbacks.

The other handicaps for the study were resource and time constraints. Finance and material resources available for the study were inadequate. Time was also another limiting factor in this study. The study was conducted within limited academic time frame. This also did not allow for a large sample of individuals for the study that would permit wider generalization of findings and inferences from the sample about the population.

1.8 Organisation of this Report

The report for the study is divided into five chapters. Chapter one gives a general introduction to the research. Here, issues such as background to the study, problem statement, research questions and objectives are discussed. Other issues discussed in this chapter include the significance of the study and the organization of the study.

Chapter two also gives the theoretical basis for the study. In other words, it involves the review of existing relevant literature on the topic in line with the study objectives. The review will be based mainly on the opinions, views and publications of experts that have a bearing on the topic.

Chapter three contains the profile of the study area (Akuapim South Municipality). In addition, chapter three will contain the description of the research approach and design, study area, sampling procedures, sample size, research instruments, field work and administration of data, pre-test and data analysis

Chapter four of the study contains the analysis and evaluation of the research findings. The data collected forms the reference point to the discussion and analysis of the findings based on the literature reviewed.

Lastly, chapter five summarises the major findings, policy implications and recommendations for government agricultural policy planning and future research studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter highlights the definitions and explanations of relevant issues related to the study. That is, the chapter talks about the background of changing climatic factors and livelihood of farmers, climatic factors affecting the growth and production of pineapple, impact of major changing climatic factors on pineapple yields as well as its quality. In addition to the above, it includes the major climatic factors that are changing with respect to their livelihoods. Furthermore, it throws more lights on adaptive measures of farmers to the changing climatic factors. This aims at presenting the theoretical underpinnings of the study and put the issue of changing climatic factors and livelihood into proper context.

2.2 Definition of Terms and Concepts

The following terms have been adopted and used as working definitions for the study:

i. Changing Climatic Trends/ Factors

This is any significant climate change or variation of natural or anthropogenic origin observed over a long period of time (Niasse et al., 2004). It is referred to as the long-term change in the state of the climate, which is identified by changes in the means and/or changes in the variability, or changes in the frequencies or intensities of extreme events (Nelson & Lambrou, 2010). In this study climate change and climate variability

is not distinguished and the used term in this study is changing climatic trends or factors.

ii. Vulnerability

The degree to which a system is susceptible; or unable to cope with adverse effects of climate change including climate variability and extremes. It is a function of the magnitude of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (M. Parry et al., 2001).

iii. Adaptation

All adjustments in behaviour or economic structure that reduce the vulnerability of society to changes in the climate system (Smith et al., 1996).

iv. Adaptive Capacity

Ability of a system to adjust to climate change (including variability and extremes) to moderate potential damages, take advantage of opportunities, or cope with the consequences (McCarthy, 2001). Adaptation is concerned with addressing the consequences of climate change (Schipper, 2006). Adaptation refers to activities aimed at reducing or preventing the impacts of climate change on human and natural systems.

v. Coping

The wide-ranging set of mechanisms used or actions taken (by ecosystems or people) in reaction to threats or impacts. Coping includes pre-emptive measures, as well as more reactive adjustments and adaptations (Turner et al., 2003).

vi. Coping capacity

The potential of a system to reduce impacts from stresses, not necessarily the actual coping actions taken in response to a stress. Actual coping can be markedly less than the

capacity for coping, depending on system goals and priorities, institutional and informational obstacles, and timely access to coping resources, all of which vary across the human and ecological components of the system (Turner et al., 2003).

vii. Resilience

The ability of a system to absorb stresses without changes in its fundamental structure and function that would drive the system into a different state or extinction (Kasperson et al., 2003).

viii. Perturbation

A disturbance to a system resulting from a sudden shock with a magnitude outside the normal range of variability. Perturbations may arise from human driving forces, ecological (natural) events, or combinations of the two. Perturbations may arise from within or outside of the exposure unit (Turner et al., 2003).

ix. Sensitivity

The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli (McCarthy, 2001).

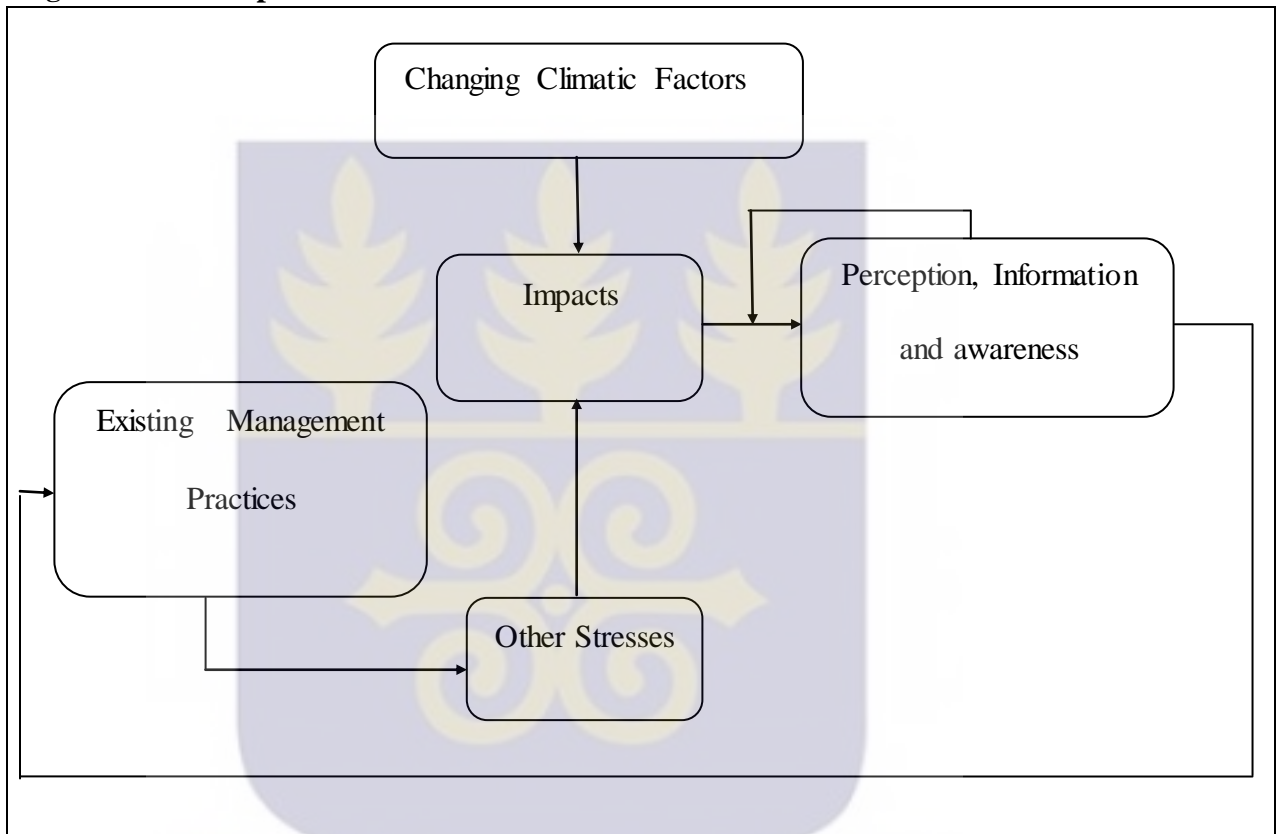
x. Exposure

The contact between a system or system component and a perturbation or stress. Exposure is a function of both the magnitude and scope of the perturbation, and of the system with which it comes into contact (e.g., its location) (Turner et al., 2003).

2.3 Conceptual Framework

A conceptual framework for climate change vulnerability and adaptation designed for this study is presented in Figure 2.1

Figure 2.1: Conceptual framework of the Climatic Interaction



Adapted from Klein Tank et al. (2006)

The conceptual framework, adopted from Klein Tank et al. (2006), illustrates the associations and show how changing climatic factors affect smallholder pineapple farmers.

Changing climatic factors represents a fundamental challenge to smallholder agriculture and in this case pineapple farmers. This is because changing climatic factors and associate impact are unavoidable (IPCC, 2007). It requires a need to adapt based on

the recognition of the reality that changing climatic trends are affecting farmers at unprecedented levels now than was in the past.

Therefore adaptation actions will have to be based on the implicit and the explicit understanding of the vulnerability .i.e. how climate is likely to change, the probable impact of the change and the potential for adaption by first considering the existing management practices and the other kinds of stresses present. In short, the vulnerability of smallholder pineapple operations to changing climatic factors requires an understanding of how climate is likely changing (e.g. temperature, frequent droughts), the sensitivity of the system to adjust to the change (e.g. the relation between crop yield and temperature and persistent drought) and the potential of the system to adjust to the change (e.g. Irrigation and drought resistant varieties).

2.4 Smallholder Commercialization for Agricultural Development

According to Jayne (1994), the complexity of agricultural development has changed considerably. Many developing countries are seeking new ways of expanding their export baskets as well as ensuring a wider economic transformation. Thus, in almost all developing countries, smallholder agriculture has evolved rapidly from just producing for food security reasons to having enough to sell and provide for the wellbeing of farming households (Pingali & Rosegrant, 1995). Smallholder agriculture, being a key development issue in recent years, appears to have gained in much of the discussion and action, in ways of improving the livelihoods of farmers whose contributions are vital to developmental growth. According to von Braun (2005) the importance of smallholder

commercialization has been seen as vital to development strategy of ensuring pro-poor growth.

Whilst the issue of smallholder commercialization has increasingly become important, one of the common forms in which smallholder commercialization occurs in these countries is through production of high value crops like pineapple. Although some studies has raised questions of the ability of the smallholder commercialization to engage smallholders in meaningful agricultural ventures and raising their incomes, doubting the very soul of such development as nothing more than increasing farmers' risk. Accordingly, many have argued that commercialized nature of smallholder production hampers the food security needs especially where food crop productions competes with commercialized ones for farm household resources especially in resource poor Africa (De Janvry et al., 1991). Other argument about the risk involve also stem from the fact that smallholder farmers face numerous risks to their production and hence consequently leads to increased poverty during market failures and challenges to production. An example is the case of shift in demand of pineapple variety on smallholder pineapple production in Ghana (Takane, 2004).

Despite these arguments, studies on smallholder commercialization have elicited significant research of interest to Africa's development. In one such study, von Braun (2005) noted that smallholder commercialization is an indispensable pathway towards economic growth and development for most developing countries who rely on the agricultural sector for growth. In another study, Pingali (1997) argues that subsistence agriculture that characterise many developing countries' agriculture may not be a viable activity to ensure sustainable household food security and welfare gains in this current

century. Consequently, markets and profit maximization will have to become the driving objective for farm household's to survive in the current age of increased globalization (Pingali & Rosegrant, 1995). Therefore, in the light of the above review, it is generally conceivable that the basic motivation of smallholder commercialization is higher returns to farmers through the increased access to markets to from the use of resources for its production.

Likewise, as a means to ensure growth in Sub-Saharan Africa, smallholder commercialization remains the most important growth income for governments and farmers alike especially through exports. Incidentally, Chauvin (2012) suggested that smallholder commercialization is the major source of export revenue for a large number of Sub-Saharan African countries including Ghana and the livelihood basis for millions of rural households who grow those crops (Chauvin, 2012). It has also been suggested that smallholder farmers engaged in the smallholder commercialization stand a better chance to rise out of poverty on the back of export and increase domestic markets than their counterparts in subsistence production. Statistical and empirical records have consistently corroborated this assertion as true (Asuming-Brempong et al., 2012; Pingali, 1997; Pingali & Rosegrant, 1995).

Many scholars have suggested that in the presence of certain trends, smallholder commercialization will stand to benefit and will encourage shift toward high value crop production across a wide range of developing countries. According to Pingali and Rosegrant (1995) the existence of low-cost, well-integrated and efficient rural markets is a key to agricultural commercialization. Pingali (1997), also argued that household asset holdings, both in terms of capital and as a buffer to mitigate any production and market

related shocks, are relevant in a smallholder commercialization process. Chauvin (2012), also argue for the need of resource-saving and yield-enhancing technological innovations as vital to the commercialization process. Additionally von Braun (2005) stated that urbanization and higher income from economic growth in any nation increases the demand for smallholder commercialized products. These studies amongst others highlight the importance of creating enabling environment for smallholder commercialization to flourish in Africa.

2.4.1 Women in smallholder commercialisation

In terms of commercialization of agriculture, women are increasingly disadvantaged because of persistent gender disparities in access to productive resources (E. Fischer & Qaim, 2012) although women make essential contributions to agriculture and rural livelihoods. Their access to productive resources, such as land and capital, is often constrained. Various studies shown that literature on women and agriculture discuss their subsistence production and decries women lack of access to productive resources (Davison, 1988; Mies et al., 1987). Others including Were in Spring (2000), indicated that women have surprising amount of control over critical resources and that decision making has been frequently been undermined in literature. According to the author, gender divisions of labour is not rigid as assumed and that the male dominated ideology is mainly an idea rather than the reality.

Also Suda (1996), in Spring (2000) remarked that whilst women are often underpaid as workers in commercialization, they are often involved in various non-farm activities like trading in the informal sector. Furthermore, Spring (2000) indicated that women's entry into commercial agriculture produce lasting changes at household level

which leads to increased food security and household wellbeing, education and many more livelihood benefits.

Thus, with the establishments of these theoretical and empirical literature bases for smallholder commercialization in Africa's development, we turn to focus on pineapple production and factors affecting smallholder Pineapple Production in Ghana.

2.5 Pineapple Production

2.5.1 Global outlook

Pineapple is one of the major tropical fruits in demand globally, with world production in 2004 of about 16.1 million metric tonnes. Of this total, Asia produces 51% (8.2 million mt), with America and Africa contributing 32% and 16% of world production, respectively (da Silva Souza & Reinhardt).

Table 2.1 :World Pineapple Production 2005-2010 (Metric Tons) - Asia

Country	2005	2006	2007	2008	2009	2010
Thailand	2 183 280	2 705 180	2 815 280	2 278 160	1 894 860	1 924 660
Philippines	788 220	1 833 910	2 016 460	2 209 340	2 198 500	2 169 230
China	1 288 774	1 382 289	1 381 901	1 385 693	1 477 329	1 519 072
India	278 900	1 262 600	1 362 000	1 245 000	1 341 000	1 420 000
Indonesia	25 082	1 427 780	1 395 570	1 433 130	1 558 200	1 390 380
Vietnam	470 000	572 732	519 300	482 600	460 000	77 200
Malaysia	40 000	299 318	316 210	384 673	400 070	416 070
Bangladesh	234 865	253 825	238 360	210 283	229 068	234 493

Source: The Statistical Division (FAOSTAT) of the Food and Agriculture Organization of the United Nations (2011)

Table 2.2: World Pineapple Production 2005-2010 (Metric Tons) – Americas and Australia

Country	2005	2006	2007	2008	2009	2010
Brazil	2 292 470	2 560 630	2 676 420	2 568 550	2 206 490	2 120 030
Panama	45 628	49 805	71 002	75 907	87 849	90 600
Mexico	51 672	633 747	671 131	685 805	749 396	701 746
Costa Rica	605 240	1 805 000	1 547 530	1 667 530	1 682 040	1 976 760
Colombia	78 007	96 995	34 574	36 044	427 766	398 010
Venezuela	49 182	356 879	363 075	358 796	360 000	371 400
U.S.A.	192 323	170 551	172 000	180 000	200 000	170 000
Peru	203 930	234 281	212 059	243 492	274 393	310 556
Honduras	144 953	147 000	132 131	134 100	115 059	124 719
Ecuador	103 478	105 000	110 000	100 000	110 000	113 900
Guatemala	97 096	194 423	200 404	200 444	201 447	207 800
Australia	104 022	153 015	164 732	162 000	157 679	153 000

Source: The Statistical Division (FAOSTAT) of the Food and Agriculture Organization of the United Nations (2011)



Table 2.3: World Pineapple Production 2005-2010 (Metric Tons) – Africa

Country	2005	2006	2007	2008	2009	2010
Nigeria	90 000	895 000	900 000	810 832	898 376	1052 000
Kenya	600 000	17 860	429 065	339 850	257 623	272 231
Congo*	95 210	196 260	197 320	193 390	199 466	200 548
Ivory Coast	95 204	176 698	159 668	86 147	66 730	65 000
S. Africa	180 618	166 335	160 088	144 791	122 993	92 892
Benin	21 182	80 055	129 287	134 966	222 223	220 800
Ghana	60 000	66 000	68 000	70 000	74 715	73 700

Source: The Statistical Division (FAOSTAT) of the Food and Agriculture Organization of the United Nations (2011)

2.5.2 Ecological requirements

Pineapple is fairly drought resistant but for high yields a well distributed annual rainfall of at least 1000mm and a maximum of 1500mm are required. Furthermore, a uniform relative humidity with mean values ranging from 70% to 80% is also required to ensure its growth. A regular supply of soil moisture is essential. Medium altitudes of 1350-1750m above sea level are the best. Below 1350m the fruit has little fibre, leading to a mushy fruit. As a tropical plant pineapple grows best and produces better quality fruit at temperatures ranging from 22 to 32°C and with daily amplitude of 8 to 14°C. In temperatures above 32°C the plant grows less well and if associated with high solar radiation can burn the fruit during the maturation phase. Temperatures below 20°C also result in diminished growth and favour the occurrence of premature flowering, which increases management problems and the loss of fruits (Bartholomew et al., 2003).

Pineapple is very sensitive to saturation of the soil with water, which affects its growth and production. Consequently, good drainage and concomitant good aeration are basic requirements because they favour root development and reduce the risk of plant loss from fungal pathogens. The water table should be not less than 80 – 90 cm from the soil surface. It is considered that an effective soil depth of between 80 and 100 cm will be adequate for growing pineapple because the roots tend to be concentrated in the top 15 to 20 cm of soil. However, within the effective soil depth, soil texture changes and/or abrupt increases in soil density inhibit root growth and prevent the roots growing deeper of an intermediate texture (15-35% clay and more than 15% sand), without obstacles to the free drainage of excess water, are recommended most for this crop. Soils with a sandy texture (up to 15% clay and more than 70% sand), which generally have no drainage problems, are also recommended, but almost always, the incorporation of organic residues and manures is needed to increase their water-holding capacity and the retention of nutrients. Clayey soils (more than 35% clay) that have good drainage, like many Oxisols, may also be recommended for pineapple plantations. On the other hand, silt soils (less than 35% clay and 15% sand) should be avoided. The large silt content causes undesirable soil structure characteristics, which affect aeration and drainage, and may negatively influence plant establishment and development (Pinon, 1978; Py et al., 1987) .

Land that is flat or has a slope not exceeding 5% is preferred because, in addition to facilitating mechanized cultural practices, the soil is less susceptible to erosion. Erosion can be a serious problem because the pineapple has a shallow root system and for a large part of the crop cycle there is little or no vegetative covering on the soil. Preventing soil erosion (Sedaghat, 2010).

2.5.3 Smallholder pineapple production and commercialisation in Ghana

According to Agyare (2010), pineapple is by far one of the most important crop within the horticultural subsector of the Ghanaian economy, employing over 15,000 individuals out of which 40% are women and generates rural incomes of over 6 million USD. According to the author, small holders account for 30 percent of production, over a land area of about 3,237 hectares of land predominantly concentrated around Greater Accra, Eastern, Central and Volta regions of the Ghana and typically, producing varieties like sugarloaf, smooth cayenne and MD2.

Pineapple production is viewed largely as a lucrative agricultural venture in Ghana, and between 1994-2004, pineapple production has experience growth by over 172% (Gatune et al., 2013). The potential of pineapple industry to unlock economic growth and agricultural development in Ghana has given rise to many market-led rural development (Reardon & Timmer, 2007). For instance, the growth of the pineapple industry spearheaded major increases in the level of smallholder commercialization in Ghana, which has previously been non-existent and importantly provided the tools for achieving the Millennium Development Goal that calls for reducing in extreme poverty and hunger by 50% (Cervantes-Godoy & Dewbre, 2010; Shilpi & Umali-Deining, 2008)

Publications by Afari-Sefa (2007), indicated that pineapple production has gained increased popularity among smallholders' farmers in Ghana. This he attributed to as a result of high market value and yields of the pineapple crop. More so, he indicated that the crop has the advantage of fitting the needs of smallholder farmers who are constraint by resource and have no marketable surplus. From all indications, his study concluded

that pineapple had grown to become an important source of income for smallholders, whose land holdings have become small due to population pressure. Additionally, overseas market demand has contributed significantly to farmers interest and foreign exchange receipts of the country albeit several technical and production constraints (Donkoh & Agboka, 1995; McCulloch & Ota, 2002).

2.5.4 Pineapple production in Akuapim South Municipality

Akuapim South Municipality is an important pineapple-growing area in Ghana with over three hundred 300 smallholder farmers cultivating average acreages of between 2 to 5 hectares (MOFA). The main varieties of pineapple grown is the MD2, smooth cayenne and sugarloaf (Kapongola, 2014). According Attua (2010) pineapple production in the municipality has been concentrated particularly along the Nsawam-Aburi corridor. The author also indicated that the land is increasingly been degradation however, the increasing market demands continue to push farmers to expand cultivation of the crop, even to marginal lands.

Over the last decades, the export market and large processing companies as well as increasing number of small-scale processing enterprises has provided new opportunities for smallholders to sell their produce through contract farming and inclusive business models (Barrett et al., 2012; Takane, 2004).

Unfortunately, the industry is getting stagnated despite the huge potential. This has been attributed to the following: the lack of capital, the continual use of traditional methods of cultivation, changes in demand on the international market and lack of market linkages between the producers in the municipality and market agents (commercial farms and processors)(Barrett et al., 2012; Suzuki et al., 2011).

2.5.5 Factors affecting pineapple production

Different indicators have been developed by different authors in measuring factors affecting pineapple production. Using regression analysis Sali et al. (2005), regressed production against a number of factors they believed to affect yield performance of smallholder pineapple farmers in Kampung Meranek. In that study they used an econometric approach to regress the production (i.e. yield output) against a number of factors which included labour, pineapple cultivation practise, land, knowledge and farm record keeping.

Similarly, using the Cobb- Douglas production function, Naik (2008) studied the production and marketing of pineapple in the Shimoga District of India and examined the productivity of important resources used in the cultivation of pineapple. The Cobb- Douglas production function was used to estimate the resource productivity of pineapple cultivation. He classified the variable inputs into five major groups which included human labour, fertilizers, weedicides, growth regulators and planting materials with the dependable variable being yield of pineapple per hectare. The results of the regression analysis of pineapple production by sample cultivators did show a range of marginal value product to marginal factor cost for various resources. The regression co-efficient for fertilizer and planting material were positive, which indicated that they will have a positive impact on the pineapple yield with further application of these two resources in the production process.

Conley et al. (2003), also tried to study pineapple output as a result of the combination of two most important inputs in pineapple production. They regressed output

over fertilizer and labour. They indicated that there was agronomic evidence that pineapple yields are very responsive to fertilizer. Their empirical measure of input intensity was based on fertilizer usage since it was better measured than labour. The logit model was employed to describe changes in inputs. They concluded that farmers were more likely to change input levels upon the receipt of bad news about the profitability of their previous level of input use.

Adinya et al. (2011) conducted a study on the estimation of efficiency constraints using Cobb-Douglass production function in snail production by small farmers in Cross River State, Nigeria. In their research they analysed the data obtained using the Ordinary Least Square (OLS) multiple regression technique to determine the relationship between snail output and the input variables. They also tried to use the linear, double-log and semi-log function forms to determine which of the forms would best fit the relationship between snail output and the independent variables. The value of their co-efficient of determination (R^2) indicated that the Cobb- Douglass production function was the best compared with the Linear and Semi-log production functions. The Cobb-Douglass function had the highest R^2 value of 0.60 and meeting other econometric criteria.

The regression analysis also did show that farm size, labour, farm management practices, operating costs and farming experience had positive influence on output of snail production and were significant at one percent level of significance.

2.6 The Issue of Changing Climatic Factors

Recent research on the influence of changing climatic factors have noted with concern the impacts of changing climatic factors on agriculture and natural resources

including other important support structures in many developing countries including Ghana (Speranza, 2010). A consensus that has emerged has highlighted that developing countries especially those in Sub-Saharan Africa are more vulnerable to changing climatic factors than developed countries, first, because of the predominance of rain-fed agriculture in their economies. Secondly, the scarcity of funding for adaptation measures, and thirdly, their warmer baseline climates and their heightened exposure to extreme events as a result of their position on the globe (G. Fischer et al., 2005; Nnamchi & Ozor, 2009). In short Africa and for that matter Ghana is at risk of changing climate.

2.6.1 Changing climatic trends and agriculture

According to the IPCC (2007), the threats of climate change to human society and natural ecosystems have been elevated to a top priority following much reviewed publications and the observed impacts in many areas. Whilst there is no shortage of published literature on climate change and agriculture, reviewed publications indicate that changing climatic factors are projected to impact broadly across all spheres of the agricultural sectors, increasing pressure on all livelihoods and food supplies, especially smallholders. Supporting this assertion studies carried out by Sali et al. (2005), indicated that changing climatic trends are modifying the distribution of food crops most especially in the tropics. Again Rosenzweig and Hillel (1995), indicated that increased temperatures will also affect physiological processes in certain food crops which will result in both positive and negative effects on crop production.

Naik (2008), explain some of the changes that are taking place in the agricultural context in Africa and for that matter Ghana. Further Studies by Cooper et al. (2008),

indicated that water stress and competition for water resources will affect agricultural production since most of developing countries agriculture depends on the availability of rain water for production. And therefore using various models she showed that persistent shortage of water are likely to increase conflicts among water dependent activities like farming and livestock rearing leading to modification of livelihood strategies.

While categories of impact of changing climatic factors has been notice throughout the agricultural sector, with various reports indicate that implications of climate change will affect food security and components of livelihood outcomes: Studies by Birkmann and von Teichman (2010), indicates that addressing the potential complexities of climate change interactions and their possible impacts requires mainstreaming of cross-sectorial responses.

2.6.2 Impact of climate change on rain-fed agriculture and livelihood of farmers

A study by Cooper et al. (2008) concluded that there is high impact of changing climatic trend on rain-fed agriculture. According to World Bank (2008), while climate forms one of the main factors of agricultural production, the effects of changing climate conditions on rain-fed agricultural production has raised much concerns at national and international level. Additionally, Belloumi (2014), revealed that the climate extremes such as occurrence of drought and floods are as important for agricultural outputs as average values. Thus changing climatic trends are not just a change in the average value of climate but the distribution of outcomes

Ringler et al. (2010), suggests that developing countries will be most affected by the changes in climatic factors, and this is bound to have a significant impact on crop

yields and production, leading to yield declines for the most important crops largely developing countries' vulnerability to changing climatic trends stems from its high dependence on rain-fed agriculture and poverty which hampers any effective adaptation. Globally, 80 per cent of the agricultural land area is rain-fed, which generates 65 to 70 per cent of staple foods, however, a large proportion 70 per cent of the population inhabiting in these areas are poor due to low and variable productivity.

Assessments of regional impacts of changing climate factors on agriculture Müller et al. (2010) widely agree that the most vulnerable to small changes in temperature and precipitation is countries in Africa. One of the most pertinent issues in regards to human development is reduced agricultural productivity. A majority of the world's population officially living in poverty (under US\$ 1 per day) depends directly on agriculture for their survival. Climate change scenarios indicate substantial losses in the production of food staples linked to drought and rainfall variation, especially in areas of sub-Saharan Africa, where projected revenue losses due to loss of arable land amount to 26 percent by 2060 (Parry et al., 2004; M. Parry et al., 2005).

2.6.3 Impact of climate extremes on agriculture production

Climate extremes are as important for agricultural outputs as average climate values. Climate extremes with catastrophic consequences as well as volatilities are already increasing as well as changes in distribution (Sivakumar et al., 2005). From an economic perspective, a climate extremes are events that causes a perturbation to the functioning of the economic system, with significant negative impact on assets, production factors, output, employment, or consumption (Przyluski & Hallegatte, 2010).

It makes the agriculture sector highly vulnerable because agriculture is directly exposed to climate extremes and their unwelcome consequences. Cavallo et al. (2013), asserts that only extremely large disasters have a negative effect on output both in the short and long term.

Climate extremes are generally meteorological, hydrological, geological or biological. Examples of meteorological and hydrological disasters are storms, floods and droughts. The impacts of climate extremes on pineapple production sub-sector can be direct or indirect as well as positive or negative. For instance, storms increase the supply of water for agriculture as they usher in rain. Floods also improve soil fertility as they deliver nutrients from the uplands to the lowlands. In other words climate extremes in a way have the ability to increase agricultural production in the affected areas and help improve the food security situation. In contrast, there are direct and negative impacts of climate extremes on the agriculture sector as well. Storms, floods and droughts have the potential to reduce farm productivity; damage farm inputs, facilities and/or infrastructure, and limit farm planting options. Furthermore, individually, storms and floods can damage farm supply routes and cause death or injury to farm workers (Godilano, 2004).

Drought impacts crop growth and development at different levels including soil moisture uptake, root growth, shoot growth, various plant processes such as photosynthesis, respiration, plant water uptake and final yield. Droughts often stimulate sequences of actions and reactions leading to long-term land degradation. A 50% fall in agricultural GDP would translate into a 10% decrease in GDP for an economy in which agriculture accounted for 20% of total activity in the pre-drought year. In Northeast Brazil, when the agricultural GDP decreased between 17.5 and 29.7%, the fluctuations

were explained almost entirely by the occurrence of droughts. For example, the estimated GDP per capita in the Northeast was \$1,494 in 1993, compared with \$3,010 in the rest of the country (Sivakumar et al., 2005).

Impacts during the non-growing season include loss of top soil; loss of soil nutrients; soil compaction; soil erosion; permanent damage to perennial crops, trees, livestock, buildings, and machinery; and permanent cessation of farming in floodplains. Impacts during the growing season include waterlogging of crops; lodging of standing crops; loss of soil nutrients; loss of pasture use; soil erosion; greater susceptibility to diseases and insects; interruptions to farm operations; permanent damage to perennial crops, trees, livestock, buildings and machinery etc. Flood plains are the areas of highest productivity. Some of the most flourishing ancient civilizations were in the flood plains as proximity to rivers enabled them to enhance agricultural productivity.

2.6.4 Climate adaptation by smallholder farmers

Bindi and Olesen (2011), asserts that there are two main types of adaptation namely; autonomous and planned adaptation. Autonomous adaptation is the reaction of a farmer to changing precipitation patterns such that the farmer changes crops or uses different harvest and planting/sowing dates. Planned adaptation measures are conscious policy options or response strategies, often multi-sectoral in nature, aimed at altering the adaptive capacity of the agricultural system or facilitating specific adaptations (Easterling, 1997). Farm level analyses have shown that large reductions in adverse impacts from climate change are possible when adaptation is fully implemented (Mendelsohn & Dinar 1999). Short-term adjustments are seen as autonomous in the sense

that no other sectors (e.g. policy, research etc.) are needed in their development and implementation.

Long-term adaptations are major structural changes to overcome adversity such as changes in land-use to maximize yield under new conditions; application of new technologies; new land management techniques; and water-use efficiency related techniques. Reilly and Schimmelpfennig (1999), define the following as the major classes of adaptation: seasonal changes and sowing dates; different variety or species; water supply and irrigation system; other inputs (fertilizer, tillage methods, grain drying, other field operations); new crop varieties; forest fire management, promotion of agroforestry, adaptive management with suitable species and silvicultural practices (FAO, 2005).

Although resource-dependent communities have adapted to change throughout history yet projected climate change poses multiple additional risks to food dependent communities that might limit the effectiveness of past adaptive strategies. Since farmers' livelihood and socio-economic status is determined by the net income of production sales, change in the climate in either rainfall or temperature from the normal condition, would lead to a reduction in yield and net income of the farmers. To mitigate the action in the net income of small holder farmers FAO (2005) concluded that adaptation strategies will require to be context and location specific and to consider impacts both short-term (e.g. increased frequency of severe events) and long-term (e.g. reduced productivity of aquatic ecosystems). According to Mendelsohn and Dinar (1999), all three levels of adaptation (community, national and regional) will clearly require and benefit from stronger capacity building, through awareness raising on climate change impacts.

Adaptation options also encompass diversification of livelihoods and promotion of aquaculture crop insurance in the face of potentially reduced or more variable yields.

2.6.5 Rain-fed agriculture and changing climatic trends in Ghana

According to Ministry of Food and Agriculture (2011), agriculture in Ghana is predominantly rain-fed. It is ranked high among rain-fed agricultural countries in Africa, Ghana's agricultural production generally have been tied to the amount of rainfall it receives yearly. Further studies also reveal that the total area under irrigation in Ghana is estimated to be about 29,804 hectares, representing about 0.2% of the total land area; while the area under inland waters is approximately 1.1 million hectares representing 8% of the land area (Asuming-Brempong et al., 2013).

Rain-fed dependent agriculture is practiced among many smallholder farmers in Ghana and it represents two-thirds of the total cropped area of Ghana. The importance of rain-fed agriculture is obvious from the fact that rain-fed agriculture supports 40 per cent of the national food basket. And therefore any impact as a result of changing climatic trends will lead to significant fall in food production. As in many parts of Africa, Ghana is subject to a variety of risks arising from changes in climatic trends. Climate extremes such as floods and droughts, frequently affect livelihoods and infrastructural development across the divides of the country. According to the Global Facility for Disaster Reduction and Recovery (GFDRR) report (2012), Ghana is ranked high among African countries most exposed to climate related risks such as floods, droughts and coastal erosion.

With high likelihood that changing climatic trends will lead to decreasing rainfall in Ghana, studies of rainfall in parts of Ghana has shown variability in rainfall patterns. Whilst it is unclear how rainfall in Ghana will evolve, it is expected that it will

experience tremendous changes. Many studies have also shown that Ghana is likely to witness agricultural productivity losses in accordance with observed pattern and scenarios of projected changes in climate. Climate change projections made up to 2100 for Ghana indicate an overall increase in temperature by 2-40 with no substantial change in precipitation quantity (Danielou & Ravry, 2005). Already the signs of climate change have been observed in various parts of Ghana through losses to agricultural yield, coastal inundation, loss of biodiversity which have danger of submergence of the coastal zones. Additionally, records of changes in agriculture and water resources as a result of frequent floods and droughts gives an indication of the various changes taking place in the economy (Danielou & Ravry, 2005).

2.7 Perception, Scientific Data and Adaptation to Climate Change

Literature on adaptation to climate changes makes it sufficiently clear that perception is a necessary prerequisite for adaptation (see D. J. Maddison, 2007). This section tries to understand the ability of farmers to detect climate change, before ascertaining how they adapted to whatever change they believe has(is) occurring in climate. It also tries to determine from literature the characteristics of those farmers who, despite claiming to have witnessed climate change, have not yet responded to it. Finally, and importantly what literature says about farmers perceptions of climate change and how it correspond to the evidence of changes provided by scientific data.

2.7.1 Smallholder farmers' perceptions of climate change and response

Exploration of existing literature suggests that the human dimension of global climate change has become an increasingly important issue. In terms of smallholder agriculture, the adoption and successful reaction to climate change depends on the tendency of farmers to perceive such change.

Studies by various authors including D. J. Maddison (2007), indicates that adaptation to climate change is a two-step process that involves, perceiving that climate is changing and then responding to the change. Using data from the “Climate, Water and the Agriculture” project D. J. Maddison (2007), established that smallholder farmers already perceive that the climate has become hotter and also that it rains less, and shorter in duration. Further analysis in the same study, also showed that more experienced farmers were better at distinguishing climate change and annual variability than the less experience ones.

Additionally, Mertz et al. (2009), using focus group and household surveys in the savannah zone of central Senegal revealed that households have a high awareness of climate change and variability. The study went forth to identify that winds and occasional excessive rainfall as the most destructive climate factors. However, the studies carried out by Mertz et al. (2009) also showed that without posing the questions of change in livelihoods in a climatic context, households assign economic, political and social reasons for such changes in livelihoods. They therefore concluded that climate narratives are likely to influence responses when questions mention climate.

Similarly, studies by Fosu-Mensah et al. (2012) using the logit regression analysis showed that farmers in Sekyeredumasi District of Ghana perceived changes in

temperature and rainfall. In the study of 180 households, about 92 % perceived increases in temperature whilst 87% perceived decreases in precipitation over the years. Perception of climate change by farmers seem to suggest that farmers' perception of changes in climate is a basic precondition for adaptation. However this is not the case in many instances. The study of Fosu-Mensah et al. (2012), established that less than half of farmers i.e. 44% of the farmers made adjustments to farming as a result of increasing temperature against 40% as a result of decrease in precipitation.

Also, studies by D. J. Maddison (2007), also explore the rate of response. According to the author, it was possible to distinguish between individuals who perceived climate change but did not adapt in any way. He stated that this does not mean that such farmers were acting unreasonably given their circumstances, but that such individuals may be experiencing barriers to adaptation, which may likely cause changes as noticed in the studies above by Fosu-Mensah et al. (2012). Such barriers which may influence the probability that someone who notices any aspect of climate change will adapt to it includes farmer experience and farmer education, age, gender, proximity to market, land tenure amongst others. Concluding on the subject, the author expressed that just because a farmer makes an adaptation to climate change does not mean that the adaptive measure taken is appropriate

The assertion by D. J. Maddison (2007) was corroborated by Grothmann and Patt (2005). They argued that people act either to avoid impacts to things they value or to benefit from opportunities associated with climate change. According to Grothmann and Patt (2005), past work on adaptive capacity has focused on people's resources, and other factors that could determine whether they have an objective ability to act. They made

reference to the fact that outside of climate change, however, a plethora of literature dealing with human decision-making and action suggests that motivation and perceived abilities are also important determinants of human action. They established that several socio-cognitive variables influence people's motivation, and hence the decisions they make, arguing that models of adaptive capacity ought to include these variables.

2.7.2 Smallholder farmers' perception of climate changes and scientific data

A vast number of studies have tried to determine to a large extent the level of convergence or divergence of smallholder farmers' perception and scientific records. These comparisons are carried out to justify the perception of smallholders, whether they are able to accurately predict or otherwise in agreement with the scientific records collected on climate. Arguing on this point, D. J. Maddison (2007) indicated that there were some points of convergence as well as divergence in his study of some countries across Africa. For instance in Ghana, records showed that the temperatures were getting warmer, which correlated to what the farmers were saying, however in South Africa, whereas many farmers indicated that they have perceived high changes in the temperature, records show that no such changes have occurred.

Similarly, Ovuka and Lindqvist (2000) studied meteorological data and farmers' perception of rainfall in the Central Highlands of Kenya. They used rainfall data from five meteorological stations during the period from 1947 to 1996 and carried out analyses on an annual and a monthly basis. Additionally, discussions were held with 60 farmers about rainfall and its variation. The results from their analyses showed that the production seasons for maize, the main annual crop, and periods during which maize plants are

sensitive to drought showed decreasing trends in rainfall amounts for the study period. Also, results from the interviews indicate that most of the farmers think rainfall has decreased over the last 40 years. They concluded by explaining the differences noticed in farmers perception and metrological data, that farmers' perceptions of rainfall are related to periods when the main food and annual crop require water and not to the periods metrological data is often analyse, which is annual and rain periods.

The assertion shared by the earlier authors, Ovuka and Lindqvist (2000) in the preceding paragraph was rehashed by Manandhar et al. (2011), in the study of the perceptions of, and the adaptations to climate change by farmers in the western development region of Nepal. Using information from both primary and secondary data sources, climate data were analyzed through trend analysis. The results from that study showed that most farmers perceive climate change acutely and respond to it, based on their own indigenous knowledge and experiences, which goes to support the point made by Ovuka and Lindqvist (2000), that farmers' perceptions of rainfall are related to periods when the main food and annual crop require water and not to the periods metrological data is often analyse. However Manandhar et al. (2011) concluded that farmers' capacity to observe and understand climate could provide the basis for a locally based monitoring system to supplement the network of metrological data, which does not capture remote information.

2.8 Smallholder Farmers and Coping Strategies to Climate Change and Variability

Studies indicate that most important impact of climate change and variability will be felt among smallholder farmers (Bryan et al., 2009; Cooper et al., 2008; Morton,

2007). According to Altieri and Koohafkan (2008), coping with chronically variable yields of food crops is critical for the survival of farm households in marginal environments where agro-climatic conditions are challenging. From their work, they argued that managing risk exposure is an important preoccupation of agricultural households and their only insurance mechanism are to depend on their knowledge, locally available resources and inventiveness in such situations.

Similarly, Morton (2007) stated that farmers whose livelihoods are located in marginal environments, or in areas of high variability of rainfall or high risks of natural hazards are often characterised by livelihood strategies that have been evolved to manage the impacts. From that study, it was evident that understanding the different forms of impact suffered by farmers and the approaches farmers use and what guides their decisions is important to ensure better strategies to combat climate change.

2.8.1 Factors that Influence coping strategies of farmers

According to Bryan et al. (2009), a better understanding of factors that influence coping strategies of farmers is important to inform what guides actions they take to avert the impact of climate change. From their study findings, Bryan et al. (2009) used a probit model to examine factors that influence farmers decision. They established that factors such as wealth, access to extension, credit, climate information, government support and access to fertile land, influence how farmers cope to changes in climate.

Similarly, Fuhrer and Gregory (2014), used the multinomial logit model to show that different socio-economic and environmental factors affect the mechanisms farmers use to cope with extreme climate events. They established that education, gender, farm income, livestock ownership and access to extension positively influence coping

strategies of farmers. They advised that measures should be put in place to encourage income generation and asset holding, especially livestock, both of which will enable consumption smoothing during, and immediately after, harsh climatic events.

Additionally, Cooper et al. (2008) called for greatly enhanced investment in agriculture by a broad range of stakeholders. According to the authors production uncertainty associated with, between and within season rainfall variability remains a fundamental constraint to many smallholders and therefore the ability of farmers to cope better with the constraints and opportunities of current climate variability must first be enhanced for them to be able to adapt to climate change.

2.8.2 Livelihood options for climate change

According to Howden et al. (2007), the challenges associated with climate change are already evident, and therefore the likelihood of further impact calls for an urgent need to addressing adaptation more coherently. For many smallholder farmers in Sub-Saharan Africa this is an imperative, since livelihoods in the region is primarily agro-based. In their study, they established that implementation of livelihood options by farmers are likely to have substantial benefits especially, under moderate climate change for some cropping systems. However, they also established that there are limits to the effectiveness of these livelihood options (especially, if not planned) under more severe climate changes. Hence they called for more systemic changes in resource allocation by farmers, such as targeted diversification of production systems and livelihoods.

Contributing on the same subject Cooper et al. (2008) stated that there are a wide range of options that are available to farmers to help them deal with the challenges associated with climate change. They showed that whilst smallholders are the primary

‘investors’ and risk-takers in rain-fed production, there are also a wide range of associated support agents upon whose strategies, decisions and operations they often depend to adapt to challenges associated in farming. Their work showed that over time, and especially in the more arid environments where rainfall variability impacts most strongly on livelihoods, farmers have developed coping strategies to buffer against the uncertainties induced by year-to-year variation in water supply coupled with the socio-economic drivers which impact on their lives. However their work also pointed to the fact that such coping strategies used by farmers are ‘risk spreading’ in nature and are designed to mitigate the negative impacts of poor seasons but do not exploit the positive opportunities of average and better than average seasons.

The outcome of the study by Bryan et al. (2009), stated that coping strategies used by farmers are of two levels one which is at household levels and the other at the public level. They showed that most common livelihood options used by farmers included the use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation, further buttressing the studies done by the earlier authors. However they stop short to state that these changes in livelihood options were influenced by access to credit and was the reason why despite having perceived changes in temperature and rainfall, a large percentage of farmers did not make any adjustments to their farming practices.

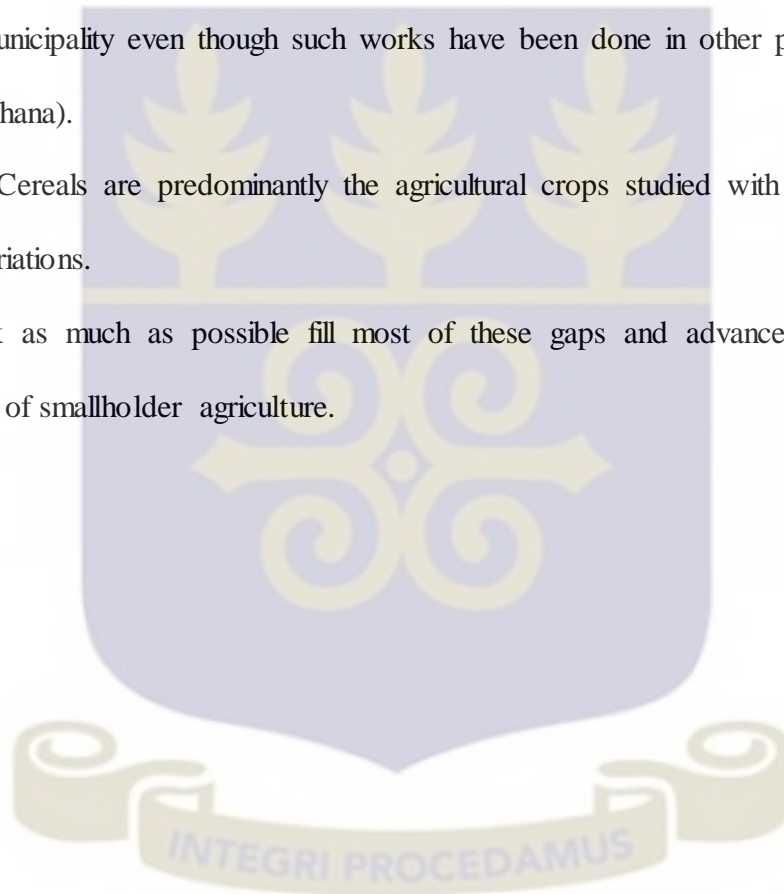
2.9 Conclusion

From the review of studies conducted the following lessons can be drawn; an optimum amount of temperature and rainfall are conditions necessary for pineapple

production. Furthermore, changes in climatic factors have a propensity of reducing agricultural production and Sub-Saharan African countries are more vulnerable to changing climatic factors because of the predominance of rain-fed agriculture in their economies. The gaps observed were as follows;

- Enough studies have not been carried out in the area of climate variability (change in climatic parameters) and pineapple yield in Akuapim South Municipality even though such works have been done in other parts of the country (Ghana).
- Cereals are predominantly the agricultural crops studied with respect to climatic variations.

This work as much as possible fill most of these gaps and advance knowledge in the directions of smallholder agriculture.



CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter the methodology used in this study is discussed. The chapter seeks to give an overview of the spatial and socio-economic context within which data were collected for the study in terms of its geo-physical and socio economic characteristics as well as social services. Furthermore, the chapter provides a step by step approach for undertaking the study.

3.4.1 Research Design

The research employs a case study as an appropriate design and Akuapim South Municipality is chosen for that purpose. According to Yin (1992), three basic principles underline a case study. First, the “how” and “why” questions. However, he indicated that the “what” question is used when the case is for exploratory purposes. Secondly, case study requires no control over behavioural events and thirdly, the case study focuses on contemporary events.

In view of the above principles, the case study was used for this research since the research fulfils all of them. The study explores the implication of changing climatic factors on the livelihoods of smallholder pineapple farmers and identifies specific issues peculiar to the municipality. Again, the use of case study provides much detailed information about the phenomenon (Neale et al., 2006). Therefore the use of this design provides detail information on the implication of changing climatic factors on the livelihoods of smallholder pineapple farmers.

However, one of the limitations of case study is the difficulty in generalising from one case to another (Neale et al., 2006). Critics say that case studies provide no ground for establishing generality of findings (Soy, 1997). However, findings from this study will be supported with literature to make it viable and reliable for generalisation. This is the basis for the literature review in the previous chapter. Another criticism is that case studies lack rigour (Neale et al., 2006), that is, they are unscientific and bias in findings. However, this study will rely on scientific processes for data collection and analysis.

3.2 The Study Area

Location and Size

Akuapim South Municipal is one of the 26 municipal and districts assemblies within the Eastern Region. Aburi is now, the municipal capital, formerly it was Nsawam which is located within a gap along the main highway between Accra and Kumasi and is just 35km from the national capital. It occupies about 403 square kilometres of land. The Municipality shares boundaries to the south with Ga West Municipal and Tema Metropolitan Assembly, both of which are part of the Greater Accra Region. To the north-west its neighbours are Suhum-Krabo-Coaltar, Akuapim North and West Akim Municipal respectively (Akuapim South Municipal Assembly, 2013; GSS, 2010; MOFA, 2012).

Vegetation and Climate

The municipality lies within the Semi - Deciduous Rain Forest and the Coastal Savannah Zones of Ghana. The vegetation is predominantly dry semi – deciduous forest

and savannah woodland with re – growth. The natural bio-geophysical environment appears rather vulnerable to farming and other forms of environmental stress. Timber resources are negligible. Tree types that are most wide spread in the municipality include Palm, Mango, Silk Cotton, Neem and Cassia (GSS, 2010).

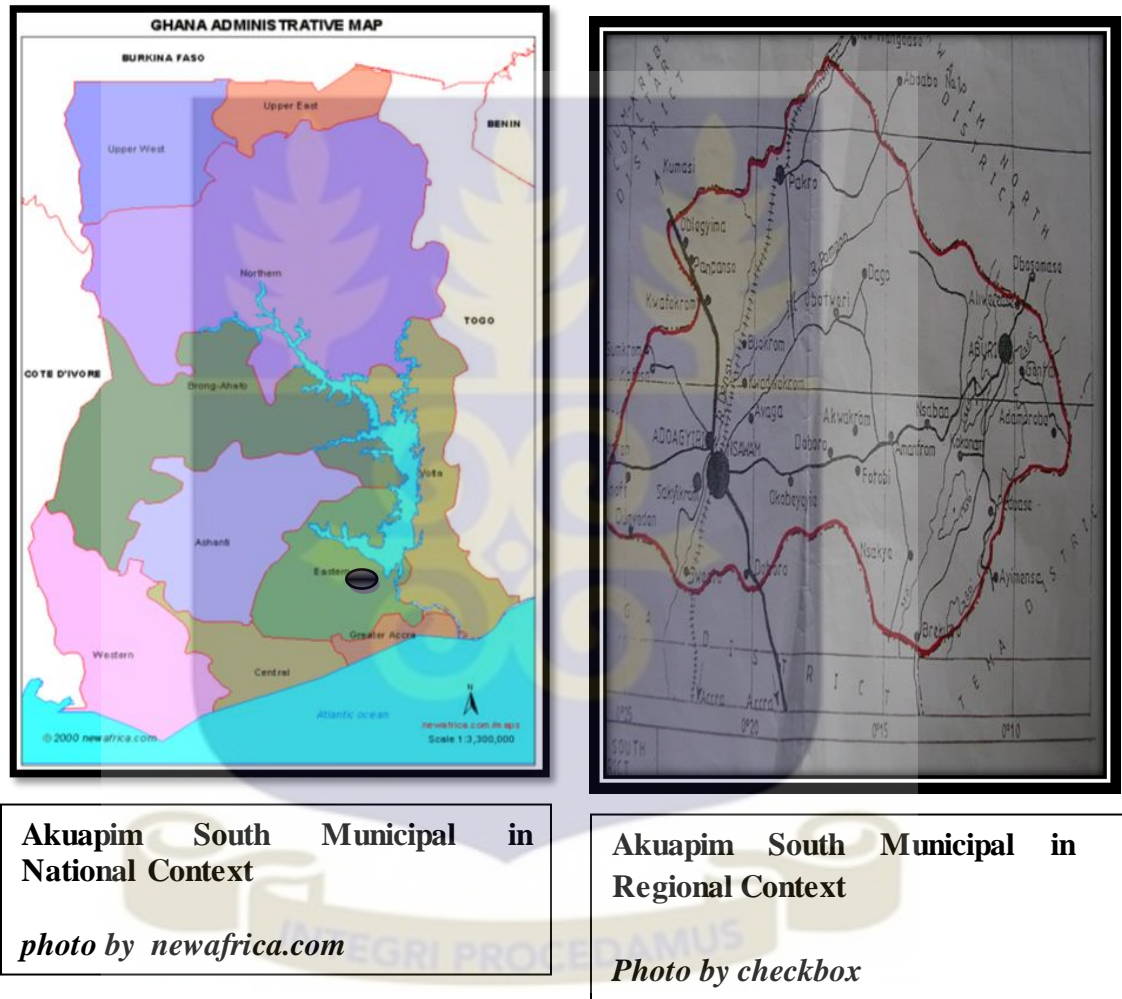


Figure 3.1: Context Map of Akuapim South Municipal

The area is also characterised by a double maxima rainy season, which reaches its peak period in May – July, and the minor season occurs in the period of September – November. The dry season starts in November – December and ends in March. The

annual rainfall is between 670mm and 1130mm; temperatures are warm throughout the year with maximum monthly mean of 37.2°C and a minimum of 21.0°C. Relative humidity is generally high ranging from the highest of 98% in June to 31% in January/November. The dry season sets in November through December - January and ends in March (GSS, 2010; MOFA, 2012).

Relief and Drainage

The municipal's relief characteristics is generally undulating with steep slopes in some parts. The Municipality is interspersed with five highlands, which are rocky in nature. The topography of the municipal is generally undulating. It is a mountainous terrain, rugged and characterized by configuration of several summit and steep slopes of hard sandstones and quartzite ridges many rocks out-crops and scarps. Akuapem South Municipality is endowed with a number of water bodies. These water bodies are in the form of rivers, dams and dugouts. This leaves the Municipality with a lot of potential with regards to developing them for irrigational purposes, thereby reducing the dependence on rainfall for agriculture. The major rivers in the municipality are Densu, Ponpon, Dobro and Nsakyi. Some communities which currently practice some form of dry season agriculture are Okubeyeyie, Akraman, Nsakyie, Bowkrom, Pakro, Panpanso, Aburi and Dobro (Akuapem South Municipal – Ministry of Food & Agriculture).

Soil

Soil types are generally sandy loam but clays are found in the valley bottoms. Major crops grown in the municipality include pineapple, pawpaw, maize, cassava, oil palm, plantain, and yam while major vegetables are okro, pepper, garden eggs onion, cabbage and tomatoes. Soil fertility is fairly good in the Akuapem South Municipality,

however due to continuous cropping its fertility is declining over the years. A crop like pineapple which is widely cultivated in the municipality is a high consumer and reduces soil fertility. Furthermore the effects of bush fire in the area are a threat to decreasing soil fertility (MOFA, 2012).

Soil fertility is improved by the use of inorganic and organic manure by farmers. Blue sky which is a company in the municipality converts the peels of pineapple into organic manure. This could be expanded to enable them produce this fertilizer in larger quantities for the use of farmers in the municipality (MOFA, 2012).

Land Tenure System

Land in the Municipality is mostly held by Chiefs in trust for the community, thus they hold the custodial interest in the land. However, heads of families and their family members hold freehold interest in land in the community. Non-members of the land owning community can have access to land mostly under share cropping schemes for farming purposes. This is done in such a way that 2/3 of yield after harvest is owned by the tenant and 1/3 is given to the owner of the land. Leasing of land is increasing gaining in predominance in the region, where a person pays for land for a particular period; in which case he/she owns the entire yield after harvest. The land tenure system in the region does not discriminate against women. Women in the region can own land for use in agricultural or other purposes as they wish (Akuapem South Municipal – Ministry of Food & Agriculture; GSS, 2010).

Farming System

About eighty percent of farmers practice mixed cropping. This is usually on plots cultivated with food crops for home consumption. Some sizeable, (averaging 60%) proportion is however sold out for income.

Mono cropping is practiced by about 9.3% of farmers with 2.7% engaged in mixed farming. The dominant crop cultivated by farmers practicing mono cropping is pineapple, pawpaw and orange fruit growers (Akuapem South Municipal – Ministry of Food & Agriculture; MOFA, 2012).

3.3 Target Population

The population of Akuapem South municipality as of 2009, was estimated to be 145,442 with the population expected to grow at 1.6 percent per annum (MOFA, 2012). However smallholder pineapple farmers formed the target population of the study and is used to determine the sample size (Osuala, 2007). It is believed that this group have been living with the impact of changing climatic variability and extremes and are capable of providing the relevant information needed for the study. The Population of pineapple farmers as at 2012 was 2,991.

3.4 Sample Size Determination

According to Miller and Brewer (2003) it is possible to compute the ideal sample size for a scientific study when the total population is known together with some parameters. The mathematical sampling model given by Miller and Brewer (2003) was used to determine the sample size. For the purpose of this research, a sample frame of

2991 was used, a confidence level of 90 percent and a margin of error of 10 percent. A sample population of 120 was obtained as the sample population for the study.

Formula

$$n = \frac{N}{1 + N(\alpha)^2} \quad (3.1)$$

Where: n = Sample size

N = Total population of the farmers

α = is the confidence interval (90 percent was adopted for the study)

3.5 Sources of Data

In order to analyse the possibility of changing climatic variability and extremities on smallholder pineapple farmers in Akuapim South Municipality. Data was collected from both secondary and primary sources. Secondary data sources included annual rainfall and temperature data for two decades (1993-2012), data on crop yield which covers the same period was also used. Other secondary sources including published and unpublished texts, journals, and dissertation were also used.

The study collected primary data using questionnaires. This was administered to respondents in the field during the field survey. The collection of primary data was done in consultation with the insights from the Municipal Agricultural Unit – Nsawam.

3.6 Sampling Technique

A multi-stage sampling technique was used for data collection in this study. These included the purposive sampling and quota sampling. Purposive sampling technique was used to identify the smallholder pineapple farmers within 13 communities within the municipality. Then a quota sampling technique was applied to gather data such that more questionnaires were administered on males than females. In other words, female pineapple farmers had unequal chances to be selected for questionnaire administration, therefore a quota of 40 questionnaires and 80 questionnaires respectively for female and male farmers was used to ensure that female farmers were fairly represented. Based on the research questions, the primary unit of analysis for this study are the smallholder pineapple farmers.

3.8 Data Collection Instrument

The research instrument selected to collect data for the study was an interview schedule. Closed ended, partially closed ended, and open ended questions items were used to prepare the instrument. Using this instrument, each interview schedule was divided into four parts based on the objectives of the study.

Part one covered information on the socio-demographic characteristics of the respondents. Part two covered the different kinds of farming systems used by the respondents. According to literature, farming system used by farmers substantially affects their coping effort. Part three covered respondents' perception of changing climatic factors and how they are adapting. And finally, part four covers their livelihood assets

and welfare. The choice of the number of interview schedules administered was computed using a statistical formula above in section 3.4.

3.9 Method of Data Analysis

The data obtained during the survey were analysed using the Statistical Package for Social Science (SPSS) Version 21 and the Eview statistical software. The method for achieving the results has been highlighted below.

3.9.1 Socio-economic background of respondents:

Descriptive statistics such as tables, frequencies and percentages were used to describe the socio-economic background of respondents i.e. smallholder pineapple farmers.

3.9.2 Assessing the impact of major changing climatic factors on yield

Following previous researchers, the crop yield response model is estimated in a linear framework (Dixon et al., 1994; Gallagher, 1986; Garcia et al., 1987; Garrity, 1984; Huff & Neill, 1982). Various algebraic forms of the yield response regression have been estimated in prior yield response studies. Huff and Neill (1982), used linear specifications for precipitation and temperature and a quadratic trend variable. Offutt, Garcia, and Pinar Garcia et al. (1987), also used a linear specification for mean temperature, precipitation, and a trend variable. While there is no preferred form for entering weather variables into yield response models, the linear framework is most common.

Present day researchers have used the linear specification model in estimating the impact of climate change in agriculture (Dasgupta, 2013; Van Passel et al., 2012). In order

to investigate the impact of climate change on pineapple yields, a modified version of the Mendelsohn and Dinar (1999), model is used;

$$\ln Y_t = \delta_0 + \delta_1 T_t + \delta_2 T_t^2 + \delta_3 R_t + \delta_4 R_t^2 + \delta_5 \text{Var} T_t + \mu_t \quad (3.2)$$

Specifically the functional form for the study is specified as;

$$\ln Y_{i,t} = \delta_0 + \delta_1 \text{TEMP}_t + \delta_2 \text{TEMP}_t^2 + \delta_3 \text{RAIN}_t + \delta_4 \text{RAIN}_t^2 + \delta_5 \text{Var} \text{TEMP}_t + \mu_t$$

(3.3)

Where:

$Y_{i,t}$ = yield of pineapple

TEMP_t = Average Annual Temperature

TEMP_t^2 = Average Annual Temperature-squared/Extreme Temperature

RAIN_t = Average Annual Rainfall

RAIN_t^2 = Average Annual Rainfall-squared/Extreme Rainfall

$\text{Var} \text{TEMP}_t$ = Variations in Annual Temperature/Deviations in Annual Temperature

Table 3. 1: Apriori Expectation of Pineapple Yield Response Model

Variables	Description	Measurement	A-priori expectation
TEMP_t	Average Annual Temperature	Degrees Celsius	+

$TEMP_t^2$	Average Annual Temperature-squared/Extreme Temperature	Degrees Celsius	-
$RAIN_t$	Average Annual Rainfall	Millimetres	+
$RAIN_t^2$	Average Annual Temperature-squared/Extreme Temperature	Millimetres	-
$VarTEMP_t$	Variations in Annual Temperature/Deviations in Annual Temperature	Degrees Celsius	+/-

Testing of hypothesis

The student t-statistic was employed to test both the null hypothesis and the alternative hypothesis stated to ascertain whether or not the estimated parameters are significantly different from zero.

The t-statistic is calculated using the formula stated below:

$$t_{cal @ 0.05} = \frac{\bar{X}_{2i} - \bar{X}_{1i}}{SE_i} \quad (3.4)$$

\bar{X}_{2i} and \bar{X}_{1i} are the means for the current and previous decades compared for i^{th} climate variable respectively. The SE_i is the standard error for the i^{th} climate variable.

Justification of variables

According to Chen and Chang (2005) temperature and rainfall are the major climatic variables that affect crop yield. Similarly Lobell et al. (2007) argued that the associated impacts of changes in temperature and altered pattern of rainfall affect yields

and increase risks in agricultural productivity. Studies by Cushman (2005) revealed that cultivated pineapple crop has an adaptation system of photosynthetic carbon fixation that allows it to be highly productive in limited water availability conditions. In spite of these adaptation to dry conditions, the greatest yields and the best quality fruits are obtained when the crop is well supplied with water (Bartholomew et al., 2003). Hence in this study we hypothesise that an increase in rainfall is likely to increase the yield of pineapple, however extreme variability in rainfall is likely to decrease yields and increase the incidence of rot.

Also, Studies by da Silva Souza and Reinhardt also show that pineapple grows best and produces better quality fruit at temperatures ranging from 22 to 32°C. However extreme temperatures as a result of climate variability causes a diminished growth and the occurrence of premature flowering, which increases management problems and the loss of fruits. Following this, the study also hypothesises that an increase in temperature is likely to increase the yield of pineapple, however extreme variability in temperature is likely to decrease yields. The temperature variation was included in the model to measure the influence of temperature ranges on pineapple yield which was hypothesised to affect yields.

Hypothesis:

Ho: The independent variables have no significant effect on yield of pineapple

H_A: the independent variables have either positive or negative significant effect on yield of pineapple

Decision rule: Reject the null hypothesis if the t -cal is greater than the t -table, otherwise; do not reject at 95% confidence interval with $n-k$ degree of freedom, $(20-6)=14$

3.9.3 Comparing farmers' perception of changing climate

In this analysis, the study intends to reconcile the different accounts of changing climatic factors in Akuapim South Municipality using a multiple epistemological framework that seeks to integrate works from social and physical sciences. It follows similar works done by Burnham (2014) and Maharjan and Joshi (2013) in triangulating the connection between the perceived changes to different attributes of climate by the local farmers and the results obtained from the analysis of the recorded temperature and rainfall data.

Since the intention is to determine the secular trend in climate and make the connection between perceived changes in climate by the local farmers and the climate records, a time series of actual climate data, comprising mean yearly average temperature and rainfall were obtained. This data obtained from the Ghana Metrological Services Department for the years 1980–2012, was used to establish the climatic trend. This series was used because it describes the variations in the values of the variables (rainfall and temperature) through time. This data was then compared to the perception of the local farmers on the changes in climatic trends. From the farmers' perspective a time frame was developed based on the major climatic events that the local people could easily recollect.

According to Piya et al. (2012), the perception of local pineapple farmers about the climate variability and extremes can be entirely different from what science says

about climate change. Therefore this method of triangulation was used to deepen our understanding of interactions taking place in the study area.

3.9.4 Identifying factors that influence climate adaptation:

In assessing the factors that influence smallholder pineapple farmers' adoption of climate change strategies, binary Logit model was used due to the fact that the dependent variable is discrete (Greene, 2003). A logit model analyses the relationship between a binary dependent variable and a set of independent variables. The logit model as employed by numerous studies to study farmers adaptation to climate change (Apata et al., 2009; Fosu-Mensah et al., 2012; Seo & Mendelsohn, 2008).

The logit model uses a logistic cumulative distribution function as compared to the Probit which uses normal distribution function and the linear probability model estimate probabilities. The logit function is presented as follows:

$$p = \frac{e^{\beta'x}}{1+e^{\beta'x}} \quad (3.5)$$

$$1 - p = \frac{e^{\beta'x}}{1+e^{\beta'x}} = \frac{1}{1+e^{\beta'x}} \quad (3.6)$$

Where, p is the probability of being vulnerable or not vulnerable given x_i , $e =$ Denotes the base natural logarithms, $x_i =$ represents i^{th} independent and β represents the vector of parameters to be estimated. The logit model could be written in terms of odds and log of odds ratios to enable comprehension of the interpretation of the coefficients (Hosmer & Lemeshow, 1989). Al-Karablieh et al. (2009), informed that this odds ratio is a linear function of the independent variables. From equation (3.5) and (3.6) the odds ratio for a

logit model is given as $\frac{p}{1-p}$. This measures that $Y = 1$ relative to the probability that it is zero. Since the estimated coefficients only exhibit the direction of effects of independent variables on the dependent variables and show neither the magnitude nor probabilities, marginal effects are instead used to interpret the effects of independent variables on the probabilities. The marginal effects which are the relative effect of each independent variable x_1 on the probability of an outcome is calculated by differentiating equation (3.5) with respect to x_1 . This will result in equation (3.7).

Maximum likelihood estimation

Since the logit model is non-linear, maximum likelihood estimation method was employed to obtain the logit parameters. The maximum likelihood function exhibited normality, consistency and asymptotic functions if the model is correctly specified;

Specification of the model

As developed by (Kalyebara, 1999) and cited in (Mudzonga, 2011), the general form of the logit model to be estimated is as follows;

$$Prob(Y_i = 1) = F(\beta'X) \quad (3.7)$$

$$Prob(Y_i = 0) = 1 - F(\beta'X) \quad (3.8)$$

Where, Y_i is the observed response for i^{th} observation of the response variable, Y

$Y_i = 1$, adopt

$Y_i = 0$, do not adopt

X - Is a set of independent variables that determine the farmer's probability to adopt climate change strategies; the specified logit model for the study is;

$$Adopt = f(\beta'X) = f(Gen, Age, Age^2, Edu, Edu^2, H/h, Farmx, Pas, Mas,$$

$$FS, Temp, Rain, Land)$$

$$Adopt = \beta_0 + \beta_1 Gen + \beta_2 Age + \beta_3 Age^2 + \beta_4 Edu + \beta_5 Edu^2 + \beta_6 H/h + \beta_7 Farmx +$$

$$\beta_8 Pas + \beta_9 Mas + \beta_{10} Fs + \beta_{11} Temp + \beta_{12} Rain + \beta_{13} Land$$

(3.9)

Marginal effects estimation

The results of a logit model only show the impact of explanatory variables as just increasing or decreasing the likelihood of household to adopt a climate change. However, in order to measure the magnitude of the impact of the explanatory variables on whether, a household is likely to adopt or not adopt climate change strategies. The marginal effects are calculated.

The marginal effects are computed using the following equations:

$$\frac{dp_i}{dx_i} \left[\frac{e^{\beta'x_i}}{[1 + e^{\beta'x_i}]^2} \right] \beta_i \tag{3.10}$$

$$= F(\beta'X)[1 - F(\beta'X)]\beta_i \tag{3.11}$$

Table 3. 2: Description of Variables and Apriori Expectation from Model

Variables	Description	Measurement	Apriori expectati on
Y_i	Dependent variable	1 = Adopt 0 =do not adopt	
Gen	Gender	1 = Male 0 = Female	+
Age	Age of respondent	Years	+/-
Age^2	Age squared of respondent	Years	+
Edu	Highest level of education	0 = No formal education 1 = Primary 2 = other (specify)	+
Edu^2	Education squared	0 = No formal education 1 = Primary 2 = Other (specify)	+/-
H/h	Household size	Number	+/-
Fs	Farmland size	Hectares	+

<i>Pas</i>	Member of Pineapple association	1 = Yes 0 = No	+
<i>Mas</i>	Marital status	0 = Married 1 = Never married 2 = Separated 3 = Widowed	+/-
<i>Farmx</i>	Farm experience	Years	+
<i>Temp</i>	Perception about temperature intensity	1= Increased 2 = Decreased 3 = No change 4 = Don't know	+
<i>Rain</i>	Perception about amount of rainfall	1 = Increased 2 = Decreased 3 = No change 4 = Don't know	+
<i>Land</i>	Land acquisition	1 = Own 0 = other (specify)	+

Justification of variables

Gender

Gender is included as explanatory variable to examine the effect of gender on the choice of adopting climate adaptation strategies. Studies have found that men and women adapt to climate differently. Men's decisions to adapt are more strongly influenced by their access to information, while women's decisions are constrained by social barriers (T. T. Deressa et al., 2009).

Age

The age can be used to capture farming experience. While studies have shown a relationship between number of years of experience in agriculture and the adoption of climate adaptation strategies, the experience in farming increases the probability of

uptake of adaptation measures to climate change (Nhemachena & Hassan, 2007). This study hypothesizes that age and experience increases the probability of adapting to climate change.

Marital Status

The marital status of respondents examines whether married individuals are more inclined to adopting climate adaptation strategies than those who are not. Elementary principle of human welfare suggest that the marital status of an individual plays a vital role in enforcing perception about the climate variability and hence adaptation (Kuntashula et al., 2014). This study hypothesized that the marital status may constrain or promote the choice of climate adaptation.

Household Size

Household size represents the number of persons in a household. Household size is meant to capture the possible interactions among members of the household that facilitate or increase the need for adopting strategies to protect or (and) increase livelihood against climate variability and extremes. It is hypothesized that larger households would have a greater need for adopting strategies to adapt to climate variability. Thus, the need for adapting to climate variability will be higher based on larger household size. Bryan et al. (2009) and T. T. Deressa et al. (2009) all observe that household size has a positive effect on the need for adopting climate adaptation strategies.

Education

Education of respondents is measured by the highest level of schooling. Education variable examines whether educated individuals are more inclined to adopting climate adaptation strategies than less educated ones. It also plays a vital role in enforcing perception about the climate variability and therefore enhancing adaptation (Striessnig et al., 2013). It has been hypothesized that the higher the level of one's education the less likely he/she use strategies to adopt. Therefore it is expected that education will impact positively on the adoption and use of climate adaptation strategies.

Member of Pineapple association

It is important to appreciate that social networks play a vital role in helping individuals to adapt or not adapt to climate variability and extremes (Kuntashula et al., 2014). Accordingly it was hypothesized that individuals with better social networks have greater opportunities than individuals with no social networking opportunities. This is reflected in whether a household is involved in any association or group.

Farm size

Farm size is associated with greater wealth and it is hypothesized to increase adaptation to climate change. Studies on climate adaptation indicate that farm size has an effect on the adoption of climate adaptation (Nhemachena & Hassan, 2007).

Farm Experience

Study shows that farm experience of the household, has positive association to farmers' choice of adaptation (Nhemachena & Hassan, 2007). The notion is held that an experienced farmer has better knowledge of the climatic history of the area better than unexperienced ones. Such farmers are more likely to adapt better to the changing environment compared to farmers with less farming experience in their areas, as they can better judge the environment even by using indigenous knowledge systems.

Land Acquisition

It is expected that farmers who have ownership of the land would take up adaptation measures that help them reduce losses or take advantage of the opportunities associated with these changes than those who don't.

Perception about Temperature and Rainfall

It is expected that farmers' perception of risks as a result climate variables (temperature and rainfall) would positively correlate to attitudinal change to climate adaptation (Nhemachena et al., 2014). Accordingly, it is hypothesised that farmers who perceive a higher likelihood of an adverse impact of climate are more likely to take steps to curb the risks.

3.9.5 Identifying the range of livelihood options

In this section, descriptive statistics such as tables, frequencies and percentages are employed to describe the range of responses smallholder pineapple farmers use to adapt to changes in climatic conditions. In using this approach, the study aims to explore the ways local smallholder pineapple farmers cope with the trends of changing climatic factors.

3.10 Conclusion

This chapter discussed the methodology for the study. A case study design was adopted for the study. Primary data were collected through survey of smallholder pineapple farmers in Akuapim South using a multi-stage sampling design. The study employed questionnaire instrument for data collection. The study adopted both descriptive and inferential approach for the analysis of the implication of changing climatic factors on smallholder pineapple farmers. Since rainfall and temperature has wide effect on smallholder production, the study employs the use of the linear specification model, to estimate the effects of rainfall and temperature on smallholder pineapple production. Also, the logit model was employed to estimate farmer's choice of adopting changing climatic trends. Finally, descriptive statistics were used to describe the range and kind of adaptation efforts used by farmers.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the results of the study carried out on the field. Among the sub-topics discussed in the chapter are: socio-economic characteristics of respondents, the impact of changing climate parameters on yield of pineapple, trends in smallholder pineapple farmers' perception to actual climate records, determinants of choice of adaptation and the range of livelihood responses that farmers use to adopt to changes in climate.

4.2 Socio-Economic Profile of Respondents.

Table 4.1: Towns Survey in the Akuapim South.

Names	frequency	Percentage
Otiakrom	16	13.3
Nsakyee	12	10.0
Amanfro-Attakrom	11	9.2
Pokrom	7	5.8
Pepawani	19	15.8
Kwamekrom	6	5.0
Awoyekrom	6	5.0
Kwame Ntow	5	8.4
Otopayaw	7	5.8
Aburi	11	9.2
Oboadaka	5	4.2
Atrebim	6	5.0
Agyarku	4	3.3

Source: Author's computation from field work, 2014

The areas surveyed for the study, regarding smallholder pineapple farmers' perceptions of the long-term changes in climatic trends are presented in table 4.1 above.

The areas covered include 13 settlements within the Akuapim South Municipality.

From the results, the highest number of smallholder pineapple farmers surveyed came from Pepawani which formed (15.8 %) of respondents. This was followed by Otiakrom, (13.3 %) and Nsakyee, (10 %.) The rest of the breakdown has been detailed in Table 4.1 above.

Results of the survey reveal that out of one hundred and twenty (120) pineapple farmers selected for investigation, male farmers constitute (62.5 %) whilst the female farmers made up the remaining (37.5 %) of the sampled population, as shown in Table 4.2. This finding agreed with that of Suzuki (2014) who indicated that smallholder pineapple farming in Ghana is male dominated sector. This findings also supports the findings of E. Fischer and Qaim (2012) who asserted that women are increasingly disadvantaged because of persistent gender disparities in accessing productive resources when it comes to commercialisation of smallholder agriculture. This finding affirms that gender is one of the things that shape the control of resources within society (Lambrou & Piana, 2006).

The large majority i.e. (60 %) (Table 4.2) of the smallholders who made up the respondents were married and this is consistent with the findings of Adebisi-Adelani and Oyesola (2013), who stated that marital status of a farmer provides a sense of responsibilities which makes him seek information about changing climatic trends and various adaptation strategies that can be put in place to combat the impact of changing climatic trends on their production and entire livelihood.

Table 4.2: Summary of demographic and economic profiles of respondents

Variable/question	Total sample
Gender	
% Male	62.50
% Female	37.50
Marital Status	
% Married	60
% Widowed	14.17
% Separated	13.33
% Never Married	12.50

Source: Author's computation from field work, 2014

In terms of age, it was observed that the average age of farmers was 46 years, with the age range of between 32 and 61 years (See Table 4.3). This shows that most of the respondents were in their middle ages hence their experience. According to Mutsvangwa-Sammie et al. (2013), old age is associated with more experience and in his estimation, older farmers are expected to have a better perception and adaption to changes in climate. Since climate variability takes place over a long time, experience is key in noticing changes in an area.

From the results, the average household size is six persons (see Table 4.3) which is consistent with an average household size within the peri-urban municipality. According to Tizale (2007), the influence of household size on the use of climate adaptation methods can be viewed in two ways. Firstly, households with large family members may be forced to divert part of the labour force to off-farm activities in an attempt to earn extra income. The other assumption is that the higher labour endowment

would enable a household to accomplish various agricultural tasks hence be able to better adapt to changes in climate.

Also, the study revealed that most of the farmers were highly experienced in the cultivation of crops. The average farming years was about 18 years. Deductions from the municipality showed that an experienced farmer who has resided in the municipality for a long time has better knowledge of the climatic history of the area. And thus, compares favourably with the assertions of Mutsvangwa-Sammie et al. (2013), who indicated that such farmers are more likely to adapt better to the changes in the environment compared to farmers with less farming experience in their area of operation.

It was observed that most of the smallholder farmers owned land between 0.8- 20 hectares with farmers in the region cultivating an average pineapple farm size of 3.5 hectares, as shown in Table 4.3. This account is consistent with the definition of smallholder by land size or production (Asuming-Brempong et al., 2012). This explanation was also consistent with the fact that since pineapple is a high value crop grown for commercial purposes, farmers will do their bit to protect their assets. Hence adaptation strategies will be high amongst the farmers.

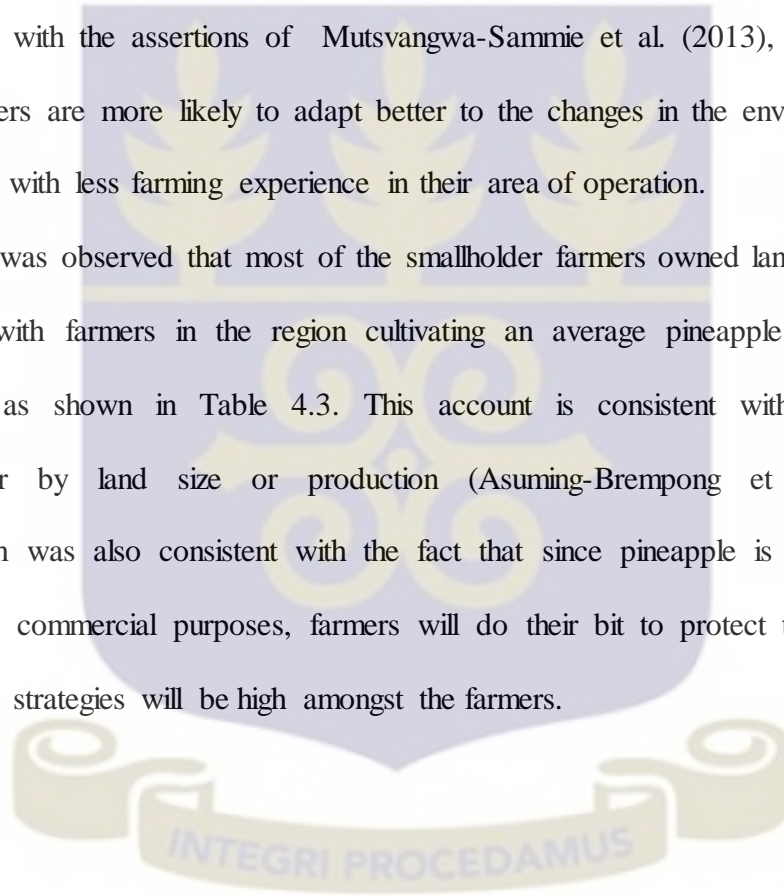


Table 4.3: Summary statistics of demographic and economic profiles of respondents

Variable/question	Mean	Mode	Min	Max	Std Deviation
Age	46.40	42	32	61	9.60
Household Size	6.23	6	3	11	2.34
Years of Farming	18.15	20	5	35	7.96
Size of Land	5.66		0.8	20	5.21
Size of Pineapple Farm	3.45		0.4	15	3.36

Source: Author's computation from field work, 2014

In the study, the value of education is proportional high with half of the respondents able to read and write in English. In terms of the differentiation, more males (57.3 %) could read and write in English compared to (37.8 %) in females (Table 4.4). This finding is perhaps indicative of the fact that the municipality being an urban centre, majority of people understand education and would want to get at least a basic education. D. Maddison (2007), asserted that education can help improve the productivity of households and help reduce vulnerability to changing climatic trends.

Also, it could be observed in Table 4.4 that there were more male headed households, (89 %) to female headed households, (33.3 %). The gender distribution for the head of households favoured males. In terms of decision taking for agricultural purposes, more males took decisions with their spouses (70.7 %), whilst female heads normally took their own decisions in farming (37.8 %).

More female farmers in the region also owned their lands compared to male farmers. The survey showed that most men, (66 %) had their production on hired land compared to females, (48.9 %). The survey account also shows that women are natural

custodian of inheritance and this explains their ownership of land resources compared to men

Table 4.4: Summary of demographic and economic profiles of respondents by gender

Variable/question		Male	Female	Total
Education (n=120)				
% Read and Write in English	Yes	57.3	37.8	50
	No	42.7	62.2	50
<i>Probability: 0.038 df =1</i>				
% Read and Write in Local Lang.	Yes	41.3	15.6	31.7
	No	58.7	84.4	63.3
<i>Probability: 0.003 df =1</i>				
Household Head (n=120)				
% Head of household	Yes	89	33.3	67.8
	No	11.0	66.7	32.2
<i>Probability: 0.000 df =1</i>				
Decision Making				
% Head of household		22.7	37.8	28.3
% Head with spouse		70.7	42.2	60.0
% Entire family		6.7	20.0	11.7
<i>Probability: 0.006 df =2</i>				
Land Acquisition				
% Own		33.3	51.1	40.0
% Hired		66.7	48.9	60.0
<i>Probability: 0.054 df =1</i>				

Source: Author's computation from field work, 2014

4.3 The impact of changes in the major climatic factors (temperature and rainfall) on pineapple yield over the last two decade.

Based on the literature on linear specification models and log-linear regression a number of variables were identified and included in the regression model. The variables were: rainfall, temperature, temperature range, rainfall squared and temperature squared. The estimated coefficients of the variables are displayed on Table 4.5 below.

Table 4.5: Log-linear regression estimates of the effect of climate change indicators on the yield of pineapple (1993-2012)

Model	Coefficients	T-statistic	Standard error	Significance
Constant (c)	4.039	2.061	1.959	0.058*
Rainfall	0.538	2.266	0.003	0.040**
Temperature	-0.732	-0.414	0.176	0.685
Temperature range	0.622	1.792	0.009	0.095*
Rainfall squared	0.068	0.281	0.000	0.783
Temp. squared	0.488	0.283	0.000	0.781

Dependent variable: LnYield

Goodness of Fit Measures

F Statistics = 2.29

Probability ratio = 0.000

R- Squared = 0.451

Adjusted R- Squared = 0.255

Observations 20

Note

* = 10%

** = 5%

It can be deduced from the Table 4.5 that after log-linear estimation, only the constant term, the average annual rainfall and the temperature range- which is the difference between the minimum and maximum average annual temperature were significant at 10 %, 5 % and 10 % respectively.

The average annual rainfall was positive and it was consistent with the apriori expectation, which implies that when mean annual rainfall increases by 1mm the yield of pineapple may increase by 53.8 % of a metric tonne all things been equal. This finding was consistent with the findings of de Azevedo et al. (2007), who studied that the importance of water requirement of pineapple especially at the phonological stages. They scored that water was (is) important for increased productivity and for the avoidance of water stress. This assertion by de Azevedo et al. (2007) were also supported by Ovuka and Lindqvist (2000), who concluded that it was necessary to study and understand both rainfall periods and growing seasons for the particular crops of interest, in this case pineapple, in order to be able to discuss changes in rainfall and its effects on crop production. They further stated that a change during the critical time for the crop could have greater effects on crop production than changes during the rainy periods which is often captured by metrological data.

The deviation between the minimum and maximum annual temperature also had a positive relationship on the yields of the pineapple, which implies that as mean temperature range increases by 1°C, the yield of pineapple increase by 62.2 % of a metric

tonne all things equal but it deviated from the apriori expectation as reviewed from Chang (2001). This finding highlights the needs to understand the effect of the rise in temperature on the ability of the pineapple crop to photosynthesise, grow and survive. Generally speaking, high temperature ranges, will likely increase the photosynthetic rate of pineapple crops. However this increase cannot continue indefinitely. Studies by Cohen and Waddell (2009) explained that CAM plants such as pineapple, incorporate both C₃ and C₄ carbon cycling as part of their adaptation to conditions of high daytime temperatures and low soil moistures and this may be a reason why pineapple production increases with temperature range

The other variable specified in the model such as the mean annual temperature, rainfall squared and temperature squared were not statistically significant but the coefficient of the temperature was negative and so was consistent with the apriori expectation, while that of the rainfall squared and the mean annual temperature variables were not consistent with the expectations.

The R-squared of 0.451 and adjusted R-squared of 0.255 which are the coefficient of determinations implies that about, 45.1 % and 25.5 % respectively of the variations that exist in the dependent variable which is the yield of pineapple is jointly explained by the independent variables. F-probability ratio of 0.000 also implies that there is high confidence level that the dependent variable highly correlates with the explanatory variables.

Validation of hypothesis

The t-statistic was employed to test both the null hypothesis and the alternative hypothesis stated to ascertain whether or not the estimated parameters are significantly different from zero.

The decision rule was that the null hypothesis should be rejected if the t-cal is greater than the t-table, otherwise; should not be rejected at 95% confidence interval with n-k degree of freedom, $20-6 = (14)$

Table 4.6: Results of the hypothesis testing using the t-statistic

Variable	t-Calculated	t-Table	Decision Rule
Constant (c)	2.061	2.145	Do not Reject the null hypothesis
Rainfall	2.266	2.145	Reject the null hypothesis
Temperature	-0.414	2.145	Do not reject the null hypothesis
Temperature range	1.792	2.145	Do not reject the null hypothesis
Rainfall squared	0.281	2.145	Do not reject the null hypothesis
Temperature squared	0.283	2.145	Do not reject the null hypothesis

From the Table 4.6, per the decision rules there is a positive relationship between the mean annual rainfall and the yield of pineapple, this implies that increase in mean annual rainfall will cause the yield of the pineapple to increase all things held constant. Whiles that of mean annual temperature, mean annual temperature range, rainfall squared and temperature squared per the decision rule from the hypothesis testing have no effect on

the yield of pineapple although the mean annual temperature range is statistically significant at 10% while the rest are not.



4.4 Smallholder pineapple farmers’ perception of changing climatic factors compare to the climate records.

4.4.1 Changes in Temperature: Perception and Actual Trend

According to Leiserowitz (2007), perception is important, because how farmers perceive the associated risks of climate forms the background within which policies are supported or disregarded. Similarly, Patiño and Gauthier (2009) demonstrate that local perspectives can be combined with scientific climate scenarios to draw policy recommendations from the community. The results from analysing the weather station data on temperature in Figure (4.1 and 4.2) and the quantitative survey on their perception to the changes in the temperature in Tables (4.7 and 4.8) identified some trends between the results.

By analysing weather station data, we were able to construct trend lines of average annual temperature for over a 30-year period. Figure 4.1 shows that there has been variability in the annual temperature records. Using the linear Holt-Winters trend line it was determined that temperature has been increasing since 1980. Figure 4.2 was also used to establish an average temperature anomaly over a 30-year average.

Figure 4.1: Aggregated Temperature Trend recorded between 1980-2012 in Akuapim South Municipality.

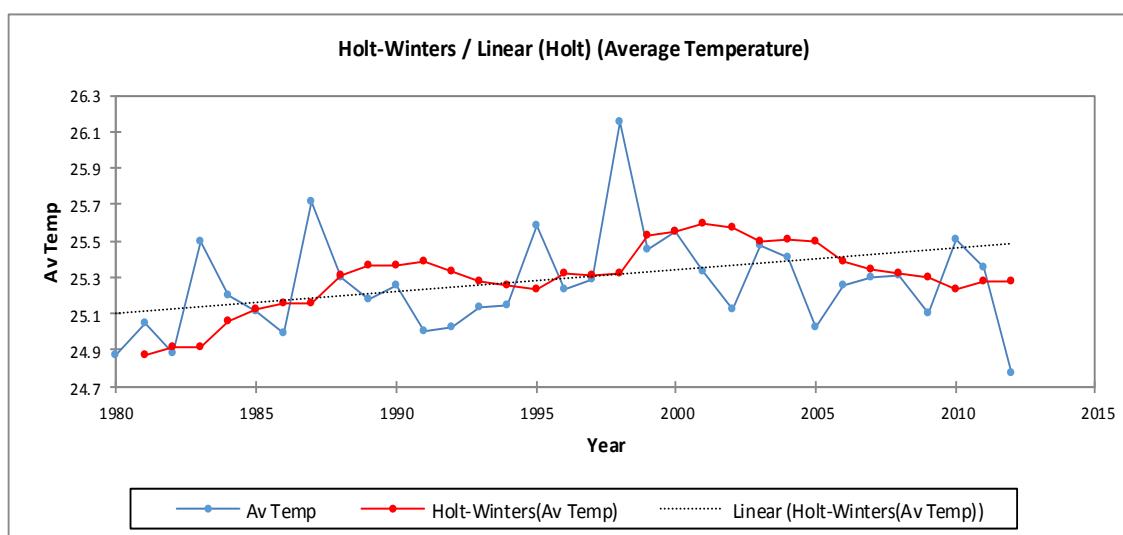
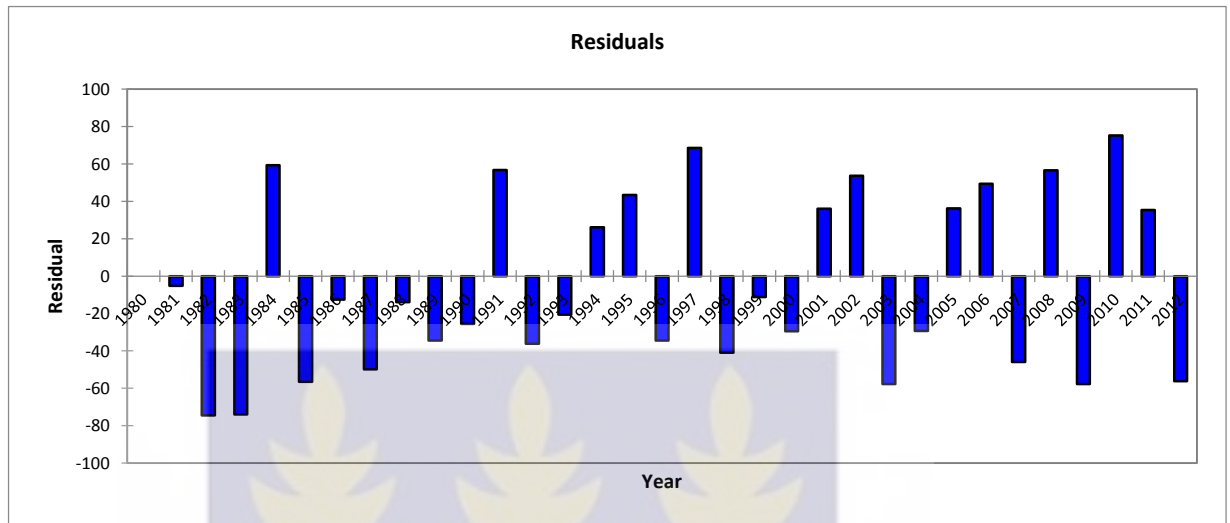


Figure 4.2: Mean Temperature Anomalies between 1980- 2012

Perception of temperature was asked to the respondents in terms of temperature intensity as well as duration. The results from the quantitative survey showed that smallholder's perception on the changes in temperature bore some similarities to the climate records. In the survey as shown in Table 4.7, about 68 farmers (56.7%) observed that the temperature pattern has assumed a variable nature. Thirty nine farmers (32.5%) has not observed any change in temperature and about 13 farmers (10.8%) could not tell if there has been any changes in the temperature pattern. In terms of intensity, 59 farmers (50.9%) had noticed an increase in temperature compared to 8 farmers (6.9%) who had noticed a decrease in the intensity of the temperature. Still 36 farmers (31%) maintained they had not observed any changes in temperature intensity whilst another thirteen farmer (11.2%) could not tell if the temperature intensity has increased or decreased (Table 4.7). This result is also consistent with other studies which have reported that most respondents perceive an increase in overall temperature. This result was also consistent

with the work of Sada et al. (2014), who indicated that the understanding of climate change by rural communities is a function of micro-level livelihood practices and is conditioned by the knowledge of human-climate interactions.

Table 4.7 Perceptions of Changes in Temperature

Variable/question		Frequency	Percentage
Changes in Temp Pattern	Unpredictable	68	56.7
	No Change	39	32.5
	Don't Know	13	10.8
Total		120	100
Changes in Temp Intensity	Increase	59	50.9
	Decrease	8	6.9
	No Change	36	31.0
	Don't Know	13	11.2
Total		116	100

Source: Author's computation from field work, 2014

With regards to the number of years of observed changes in temperature, Figure 4.1 shows that temperature has been increasing over the area for over 20 years. The survey (Table 4.8) also showed that farmers had observed changes in temperature for over 6 years. Most observations of the changes were between 1-10 years. These findings show that there is a range in which farmers can recollect environmental changes taking place (Burnham, 2014). Given this, analysis suggest that smallholders' observations of increased temperatures supports the perception of increase in temperature trends and intensity from records.

Table 4.8 Summary statistics of years of observation of the changes in Temperature

Variable/question	
Years of Observation	
Mean	6.35
Mode	6
Min	1
Max	10
Std Deviation	2.547

Source: Author's computation from field work, 2014

4.4.2 Changes in Precipitation: Perception and Actual Trend

The results from analysing the weather station data on rainfall in Figures (4.3 and 4.4) and the quantitative survey outcomes on the changes in the rainfall in Tables (4.9 and 4.10) identified some similarities as well as some contradictions between the results.

By analysing weather station data, we were able to construct trend lines of average rainfall over a 30-year period. Specifically, Figure 4.3 shows that rainfall has been variable in the area however the linear Holt-Winters trend line indicated a marginal increase since 1980. Figure 4.4 shows that the average rainfall anomalies from the 30-year average, and also indicated an upward trend in average rainfall.

Figure 4.3: Aggregated Precipitation Trend recorded between 1980- 2012 in Akuapim South Municipality

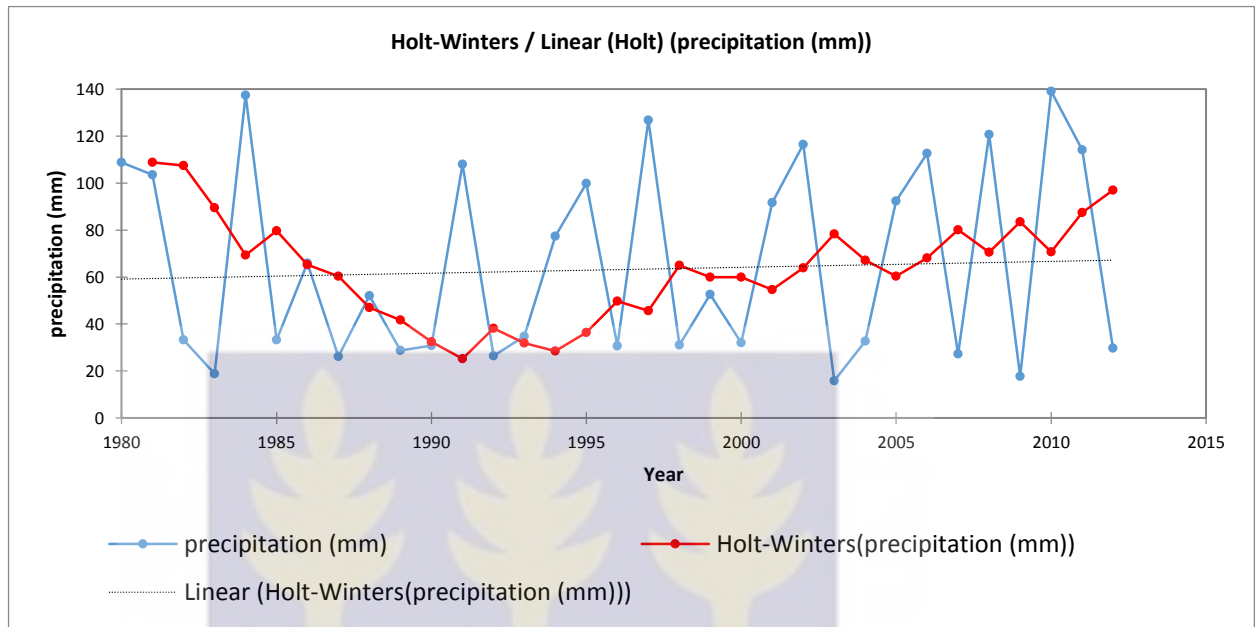
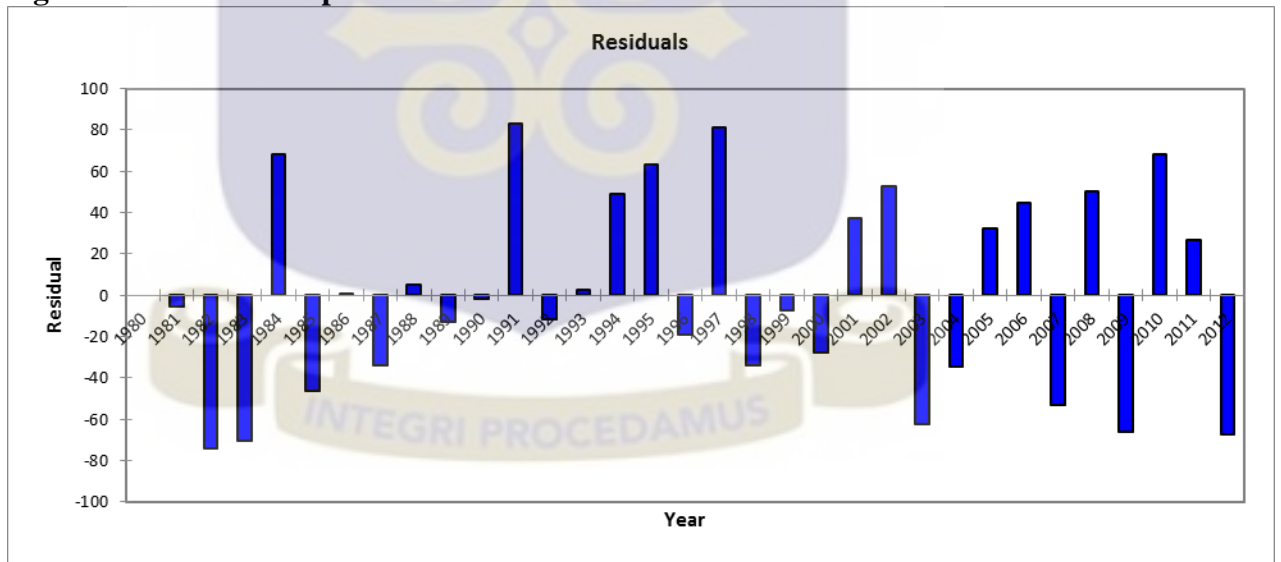


Figure 4.4: Mean Precipitation Anomalies between 1980- 2012



In the quantitative survey, we spoke to 120 farmers in Akuapim South about the changes they had observed and/or experienced in the rainfall (pattern and amount) over the past 30 years. Among them, 93 farmers (77.5 %) indicated that rainfall pattern has

become unpredictable, and 27 farmers (22.5%) claimed that they had not observed any change in rainfall. In terms of the amount, 84 farmers (70.0%) noticed that rainfall amount has decreased. Nine farmers (7.5%) had observed an increase and 27 farmers (22.5%) still maintained that they had not observed any changes in rainfall amount.

Table 4.7: Perceptions of Changes in Precipitation

Variable/question		Frequency	Percentage
Changes in Rain Pattern	Unpredictable	93	77.5
	No change	27	22.5
Total		120	100
Changes in Rain Amount	Decrease	84	70.0
	Increase	9	7.5
	No Change	27	22.5
Total		120	100

Source: Author's computation from field work, 2014

From the results, although there seem to be some similarities in the data (quantitative and climate records) especially with regards to the unpredictable nature of rainfall. There seem to be some discrepancy in results between the data collection methods. In particular, the survey respondents had different perceptions of rainfall amount i.e. the majority of respondents indicated a decrease in rainfall amounts (70%) contrary to what the climate data suggested. This result is also consistent with other studies which have reported that most respondents perceive rainfall to be very unpredictable (Bhusal, 2009; Dahal, 2005). In addition, Geoghegan and Leyson (2012) (Geoghegan & Leyson, 2012) indicated that smallholder epistemologies of climate variability and extremes are inclusive of multiple climatic variables and their interactions,

and are likely to be more holistic than scientific ways of knowing climate change, which often focus on individual variables and statistical aggregates of change.

Furthermore, in relation to the period the climatic variation and extremes have been taking place. The smallholder farmers provide further insights into the different perceptions of the period of the said changes, with a reported observed trend between 3-11 years and an observed average of 6 years (see Table 4.8). According to D. Maddison (2007), rural households tend to form their perception based on more recent events. Compared to the climate data (Figure 4.3-4.4), it seems that these changes has been going on long before these perceptions are drawn. This phenomenon is explained by the Holt-Winter trend indicating that this changes has been taken place over the last 20 years or more.

Table 4.8: Summary statistics of years of observation of the changes in rainfall

Variable/question	
Years of Observation	
Mean	6.55
Mode	5
Min	3
Max	11
Std Deviation	2.351

Source: Author's computation from field work, 2014

4.5 Factors that influences smallholder pineapple farmers' adoption of climate change strategies

Based on literature a number of economic and socio-demographic variables and perception variables were identified and incorporated into the choice of climate adaptation equation. The variables were gender, age, land acquisition, marital status, farming experience, education, household size, farm size, association membership, perception of temperature changes and perception of rainfall changes. The coefficients of the variables were estimated by the maximum likelihood estimation method using Eview. The results of estimation are presented in Table 4.9.

Table 4.9: Choice of Climate Adaptation Response: Logit Results

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	5.602145	7.122410	0.786552	0.4315
Member of association	0.733139	0.795539	0.921563	0.3568
Marital status	0.486758	0.271636	1.791952	0.0731*
Gender	-0.235179	0.627548	-0.374759	0.7078
Age	-0.271338	0.291589	-0.930547	0.3521
Rainfall amount	0.571170	0.574098	0.994901	0.3198
Temperature intensity	0.571940	0.278756	2.051755	0.0402**
Land acquisition	0.424822	0.285015	1.490527	0.1361
Farm size	-0.042925	0.063140	-0.679843	0.4966
Education squared	0.254235	0.140637	1.807745	0.0706*
Education	-0.469267	0.744370	-1.973838	0.0484**
Household size	0.009165	0.126100	0.072680	0.9421
Farming experience	-0.008244	0.037311	-0.220961	0.8251
Age squared	0.002951	0.003064	0.963135	0.3355

Source: Author's computation from field work, 2014

Dependent Variable: ADOPT

Goodness of fit

R-squared = 0.208335

Log likelihood = -58.08040

S.E. of regression = 0.430219

Prob(LR statistic) = 0.003896

Total observations = 116

Note

* = 10%

** = 5%

McFadden R-squared = 0.208 implies that about 20.8 % of the variation in the discrete dependent variable, whether to adopt or not to adopt climate change adaptation strategy is jointly explained by the explanatory variables.

S.E of regression = 0.430: this implies that the deviation of the dependent variable from the estimated regression line is equal to 0.430

From the results, four of the coefficients were significant and had the expected signs per the estimation of the factors using the binary logit; marital status of respondent, perception of respondents on the temperature intensity, education squared and education were statistically significant at 10% , 5% , 10% and 5% respectively.

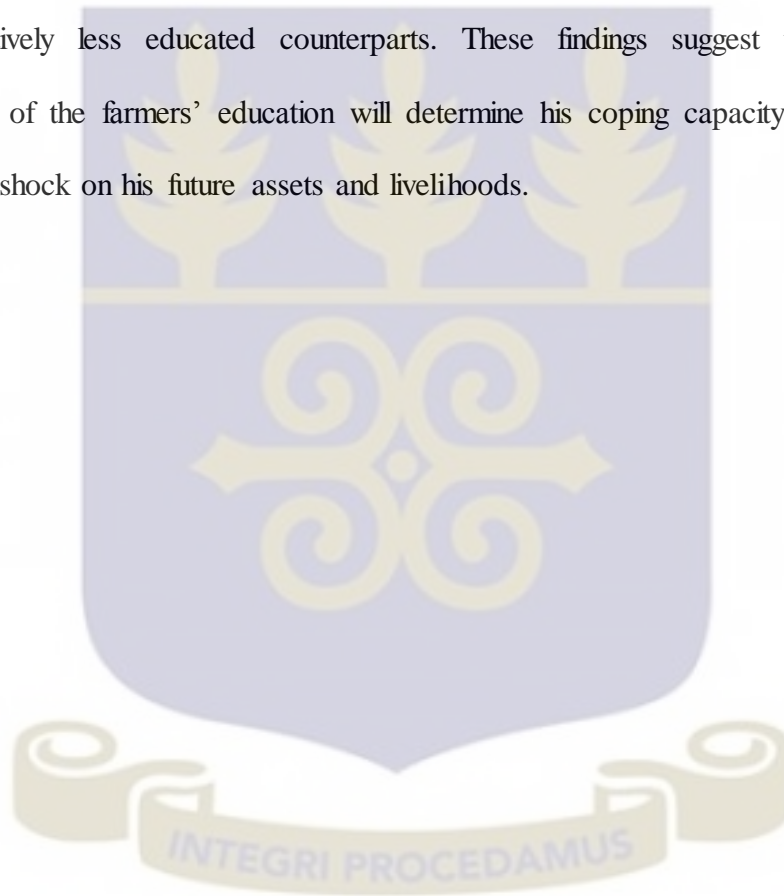
A look at the results in Table 4.11 reveals that marital status variable is positive and significant. The results suggest that marital status is important for climate adaptation choice. From Table 4.11 it can be inferred that if an individual is married the odds of the individual adopting climate variability and change strategies increases by 0.486. This implies that married farmers' adaptation to changing climatic trends is better than those that are single. It also signifies that the rate of adoption of adaptation response to climate

variability and extremes by farmers with large household size is higher and better. This result is consistent with the findings of Adebisi-Adelani and Oyesola (2013) and Oluwatusin (2014). They found that those that are married adapted better to changes in climatic trends.

From Table 4.11, it can be realized that if an individual has positive perception about the changes in the temperature intensity -whether it is increasing, decreasing or remaining the same, the log of odds of that individual adopting climate variability and change adaptation strategies increases by 0.571. It stands to reason that temperature intensity is an important determinant of choice of climate adaptation. This estimated result corroborates with the observations of T. Deressa et al. (2009), who indicated that farmers with higher perception of temperature are more likely to adapt to changes in climate through the adoption of different practices. According to the authors, the rise in temperature mean increases the probability of using soil conservation, different crop varieties, irrigation and changing planting dates, which is consistent with field observations.

Contrary to expectation, Table 4.11 reveals that the variable relating to education of the individual is negative. The negative sign of education variable indicates that the lesser the educational level of an individual, the log of odd of that individual in adopting the climate change and variability strategies decreases by 0.469. Education is measured in terms of highest level of education completed by the individual and was significant at 5 % level. This findings is supported by the findings of Oluwatusin (2014), who asserted that educational level of farmers plays a good role in perceiving and adapting to change in climatic conditions.

The study also shows that maximum attainment of education has a positive effect on adaptation. Farmers who have achieved the maximum level of education across time, could increase their adaptation by 0.254 units. This suggests that the summit of educational level one can attain smoothens the climate adaptation process. Studies by Nhemachena and Hassan (2007) and T. T. Deressa et al. (2009) have shown that the more educated farmers tend to seek for information and show better response to shocks, than their relatively less educated counterparts. These findings suggest that the maximum attainment of the farmers' education will determine his coping capacity and the effects of a random shock on his future assets and livelihoods.



4.6 The range of livelihood strategies used by smallholder pineapple farmers to cope/adapt to the major climatic factors.

This section of the results examines smallholder pineapple farmers' coping/adaptation strategies to climate variability and extremes in Akuapim South Municipality based on the cross-sectional study carried out in the area. Since changing climatic trends is a livelihood issue, which causes changes in food and livelihood security, it is important to note that farmers undertake various farm and off-farm strategies, in a complementary manner to adapt/cope to the various changes in climatic trends.

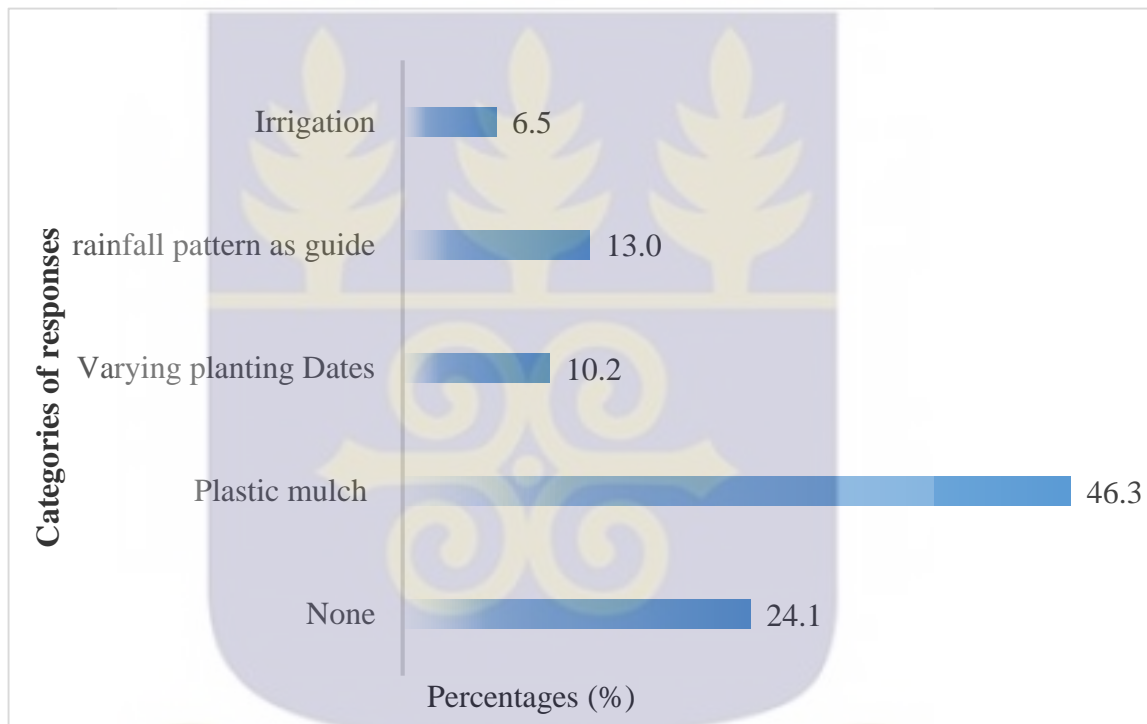
From the results presented in Tables 4.12 - 4.14 it was noted that farmers adopt various strategies to cope with the changes in climatic trends by adjusting on-farm strategies to cope with changes in climate variability and extremes on their pineapple production. The study revealed that about 72.2 % of the cases indicated that they undertake various strategies to changes in the rainfall. Similarly another 58.3 % of the cases had made various changes to adapt to changes in temperature on their production. (Table 4.12). As indicated in the results (Fig 4.5 and 4.6), less than 25 % of the respondents are not adopting any adaptation strategies whilst the remaining farmers are using crop management practices that include use of plastic mulch to conserve moisture, irrigation, varying planting and harvesting dates amongst others to ensure that critical, delicate growth periods do not coincide with harsh climatic trends within the season. These strategies the farmers are using is consistent with the findings of T. T. Deressa et al. (2009), who indicate that smallholders take various actions to reduce the impacts of climate variability and extremes on their production.

Table 4.10: Farmers’ response to adaptation to changes in Precipitation and Temperature

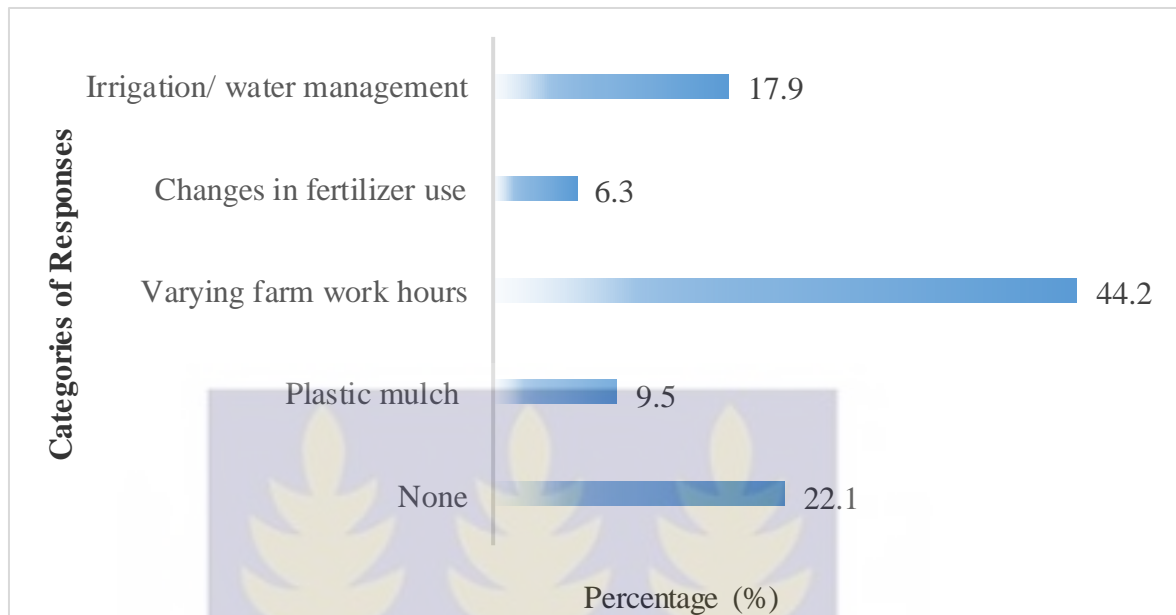
Variable/question	Percentage of cases (%)
Adjustments to changes in Rainfall	72.2%
Adjustments to changes in Temperature	58.3%

Source: Author’s computation from field work, 2014

Figure 4.5: On-Farm Practices to Adapt to Changes in Precipitation



Source: Author’s computation from field work, 2014

Figure 4.6: On-Farm Practices to Adapt to Changes in Temperature

Source: Author's computation from field work, 2014

Whilst it is important to note these on-farms adaptation measures (Fig 4.5- 4.6). Farmers may adopt other livelihood strategies to respond to changing climatic trends on their pineapple production. These livelihood adaptation strategies have been grouped into farmers for whom pineapple production is a main occupation, and farmers for whom pineapple production is not a main occupation. From the results in Table 4.13, 78 % of farmers were engaged in pineapple production as a main livelihood activity whilst 21.7 % as a secondary activity. The results in Figures 4.5 – 4.6, depict the range of livelihood options that smallholder pineapple farmers are engaged in, in order to improve their livelihoods. These activities range from producing other commodities to engaging in wage earning activities. From Figure 4.5, it could be inferred that farmers for whom pineapple production is a main activity also grew other commodities (83.9 %) and were engaged in some form of agro-processing (49.4 %). However those who did not have

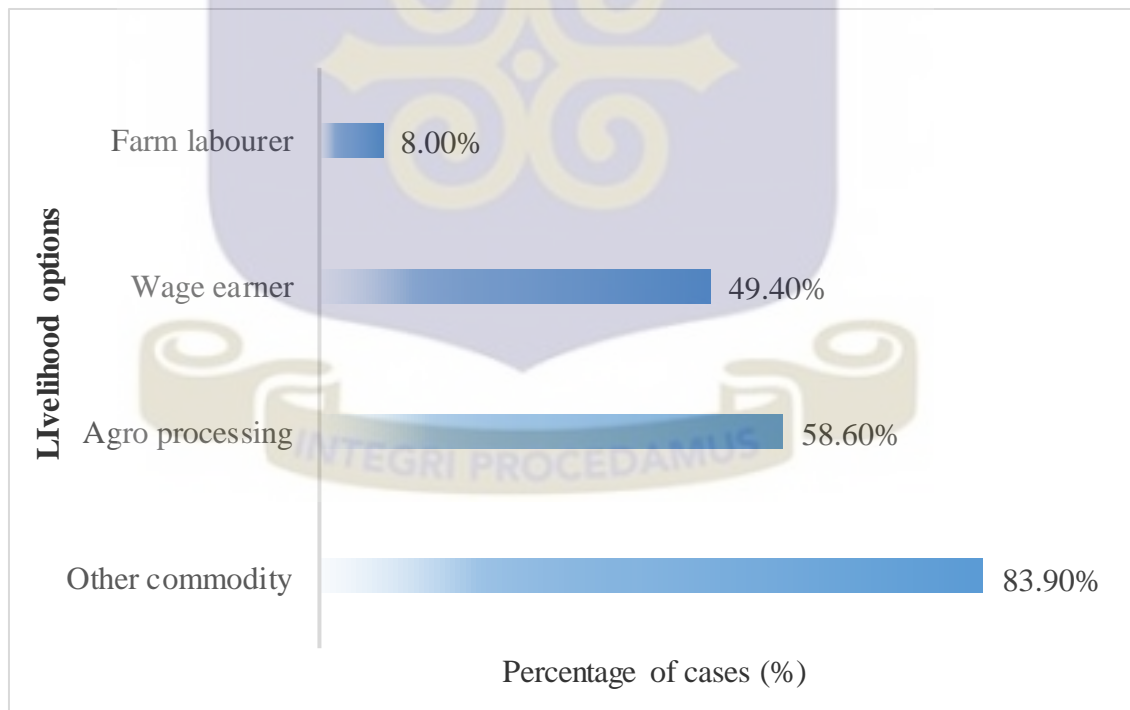
pineapple as a main occupation, (69.7 %) had jobs as wage earners and also grew other crops (53.6%). This was consistent with the findings of Huang et al. (2014) who stated that crop diversification is one adaptation practice recognised as a potential farm level response to climate variability.

Table 4.11: Livelihood Options of Smallholder Pineapple Farmers

Question/Variable	Frequency	Percentage	
Pineapple Production main			
Source of livelihood	Yes	94	78.3
	No	26	21.7
Total	120	100	

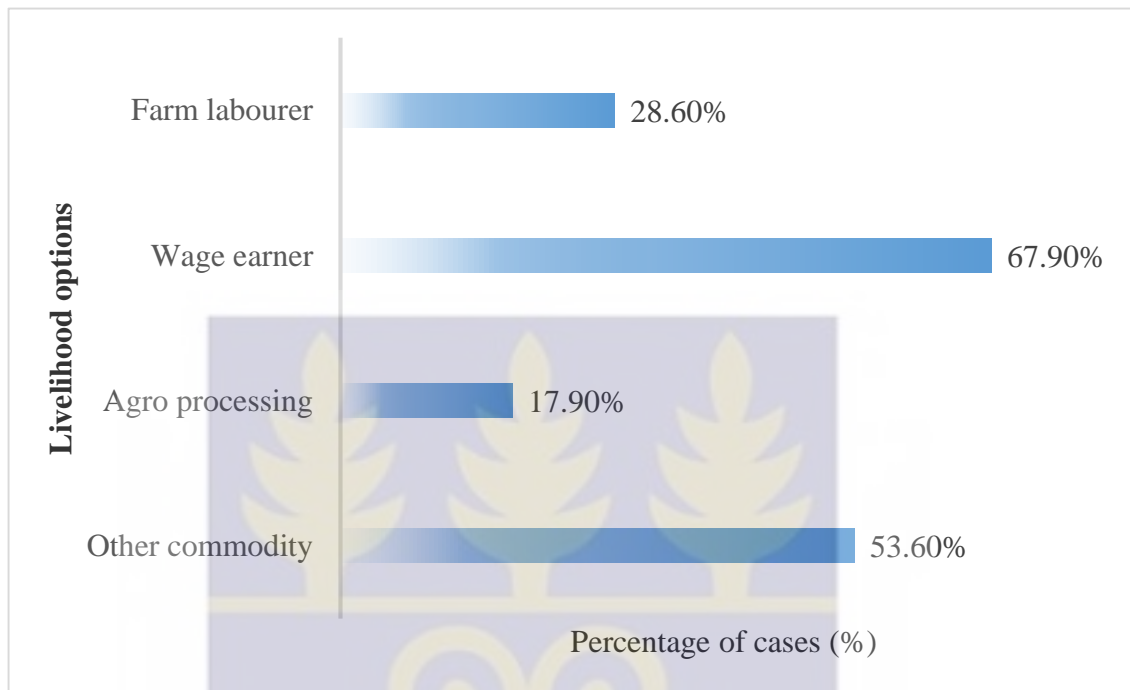
Source: Author's computation from field work, 2014

Figure 4.7: Livelihood options of smallholder with pineapple as main occupation



Source: Author's computation from field work, 2014

Figure 4.8: Livelihood options of smallholder with pineapple as secondary occupation

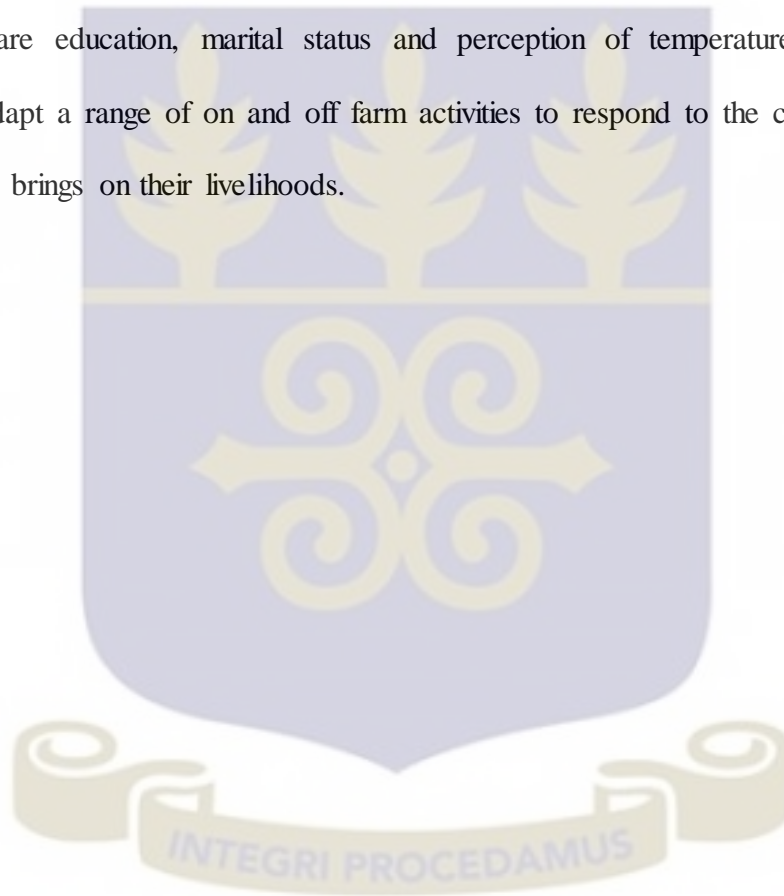


Source: Author's computation from field work, 2014

In this study on smallholder pineapple farmers' responses to changing climatic trends it is indicated that they used the various measures to cope/adjust to the changes in climatic trends, as shown in Table 4.12 - 4.13 and Figures 4.5 - 4.8. However, based on the survey of their perception and strategies they are using to adopt to changing climatic trends, it is acknowledged that these strategies might also be in response to other socioeconomic constraints and opportunities. Therefore, for the purpose of this study, it is assumed that farmers are using these measures as a response to climate change based on questions the study asked on farmer perception and the strategies they are using to adopt to the changing climatic trends.

4.7 Conclusion

This chapter presented the empirical results of the implication of changing climatic trends on the livelihoods of smallholder pineapple farmers. It was observed that rainfall and range of temperature variation significantly influence yield of pineapple farmers. Also, farmers' perceptions agreed with the climate records of changes in climatic trends over the area. With regards to the choice of adaptation, the factors to consider are education, marital status and perception of temperature changes. Finally, farmers adapt a range of on and off farm activities to respond to the changes that climate variability brings on their livelihoods.



CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents a brief summary of the key findings of the research work undertaken in Akuapim South Municipality. It outlines the major conclusions that were drawn from the results and make appropriate recommendations to address the observed issues.

5.2 Summary

This study began with an observation that the production levels of smallholder pineapple farmers in the Akuapim South Municipality over the last two decades had decreased in output. By the close of 1980's Akuapim South Municipality had become a major pineapple growing area and in 1995, two-thirds of the national outputs came from the municipality. However, between 2004-2007, the production volumes of pineapple has fallen to an all-time low, and this has affected the livelihoods of smallholder pineapple farmers within the municipality (Achaw, 2010; Takane, 2004).

Since climate variability is expected to increase with increased frequency and intensity across the region. The implications for smallholder pineapple farmers are that their productions will be affected by variations in the climate, especially for those who mainly rely on the climate for their production. Thus, the broad objective of this survey was to study the effect of changing climatic trends on the production and livelihoods of these smallholder commercial farmers. The study is essentially an evaluation of

smallholder pineapple farmers' perceptions regarding long-term climatic changes, current adaptation measures and their determinants.

In the study, questionnaires were used to collect data from 120 smallholder pineapple farmers in the pineapple growing areas of the Akuapim South Municipality using a multi-stage sampling procedure. The resulting data was analysed using a Statistical Package for the Social Sciences (SPSS) and the Eview software.

Descriptive statistics and regression models were then derived to explain the influence of changing climatic factors on pineapple production and to understand smallholder pineapple farmers' perceptions regarding long-term changes in climate and current response measures. In the analysis, descriptive statistics were used to illustrate the farmers' perceptions on the changes that they were experiencing in their farming, in terms of the changes in the long-term temperature and precipitation patterns. The results showed that the farmers were aware that the municipality was getting warmer with increased temperature and noticed variability in rainfall patterns. Observed temperature and precipitation records from the municipality's Agro-Metrological Stations supported these farmers' perceptions. A similar method was also used to describe the various livelihood responses smallholder pineapple farmers used to adapt/cope with the changes in the climatic trends. The inference is that farmers need to make adjustment in their livelihoods and farm practices to ensure that they are able to adapt or cope to the changes in climatic trends.

Also, two regression models were used to estimate factors that affect yield and the choice of adaptation of farmers. The dependent variable for the first model was pineapple yield, with average temperature, average rainfall, variation in temperature, and a host of

other individual factors of rainfall and temperature being the independent variables regressed on the yield. In the second model the dependent variable was choice of adaptation. Age, gender, education, and a host of other individual characteristics including perception on rainfall and temperature changes were regressed on the choice of adaptation.

5.3 Conclusion

From the perspective of the objectives, the following conclusions were drawn. In the first place, the changes in output levels of pineapple production at the municipal level were explained by the changes in rainfall and temperature parameters. It was realized, consistent with literature, that rainfall and temperature range were the most important climatic factors seen to have a positive impact on yield of pineapple over the years in the municipality. It was found that annual rainfall amounts explain the odds that annual outputs of pineapple will either increase or decrease. This implies that the water requirement of pineapple is necessary to promote increased yields for smallholder pineapple farmers. Also, temperature range was found to influence yield of pineapple. The implication is that, all other things being equal, the wider the temperature range the higher the likelihood that pineapple yields will increase.

Farmers' level of awareness about the phenomenon of changing climatic factors is quite high. At the local level, the trend analysis of temperature and precipitation provided some important insights. Farmers' perceptions on changes in climate parameters (i.e. rainfall and temperature) was fairly consistent with the Municipal climate records. In the case of temperature perception it was observed that a positive relationship existed between farmers' perceptions although perceptions were more inclined to short-term

trends rather than with long term records. Similarly, the farmers' perception of the changes in different attributes of rainfall is in some way matched especially in terms of their perception on variability in rainfall. However, the analysis did not establish clear visible pattern between the responses in their perception of rainfall amount and actual climate records. A possible explanation is that analysis of actual average yearly rainfall figures might give the picture of total amount of rainfall but might not be representative of the timing of rainfall.

Individual choice of climate adaptation was found to depend on their socio-economic and demographic characteristics as well as perception of climate parameters. Most farmers took into account their marital status, education and their perception of temperature changes when choosing to adopt or not to adopt to changes in the climate trends. The perception on temperature changes affects their choice to adapt or not to adapt. Again, their marital status had a positive impact on the individual choice to adapt or not to adapt. Moreover, it was discovered that individual decision to adopt any climate adaptation response is contingent on their quality of education and information dissemination. There were different reasons why some customers would not wish to adopt. The reasons were perhaps the low level of education and low awareness programs about changing climatic factors in the municipality.

A higher proportion of farmers are concerned with the associated risk and impact of changing climatic trends. It was indicated from the study that farmers understand that changing climatic factors has serious ramifications for their livelihoods, thus, explaining their range of adaptation responses. These contributions in terms of diversification by practice or by on-farm or off-farm approaches are all contributions to reduce such

changes in climate on their livelihoods. However, the use of these livelihood strategies was very limited in terms of the scope of adaptation. Few people used these options solely as a climate adaptation strategy.

5.4 Recommendations

On the basis of the findings of the study the following recommendations have been suggested;

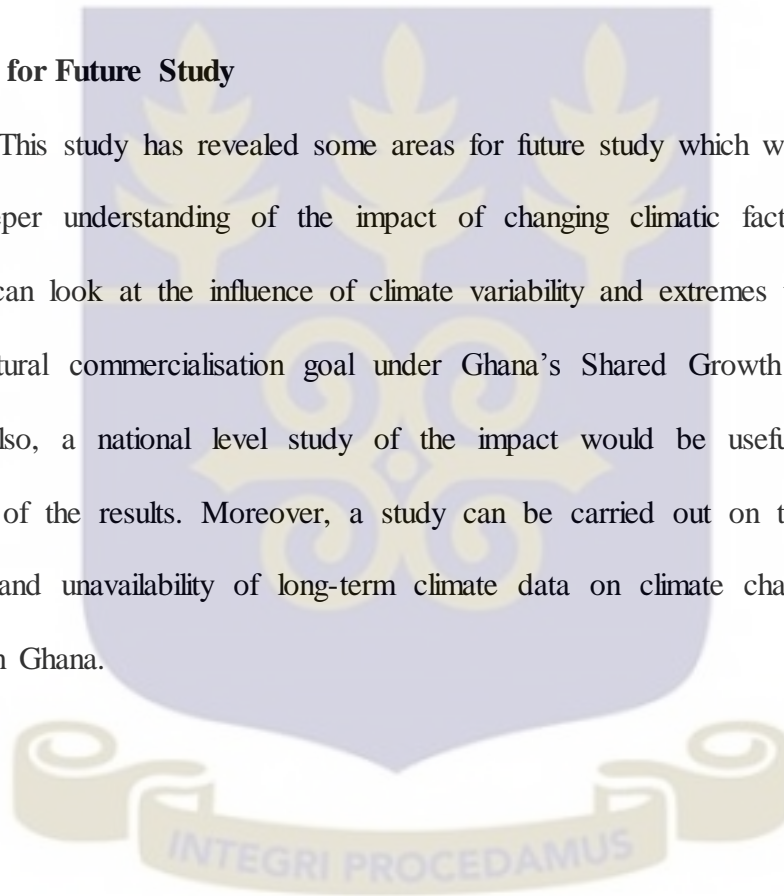
There is the need for the Ministry of Agriculture to implement a range of policies to reduce the risk of negative impact on smallholder pineapple farmers. One way is to intensify education and information dissemination amongst smallholder pineapple farmers. This will go a long way to increase the level of climate awareness prevailing in the municipality and gives smallholder pineapple farmers the choice to adapt to such changes in climate. The introduction of community level extension services will also make farmers' improve their knowledge and understanding of the phenomenon. Furthermore, development of innovative new technologies alongside what farmers are used to i.e. traditional methods will be needed for yield improvement.

Also, efforts should be made at farmer level to monitor crop development and growth together with appropriate information which will improve crop management. Therefore farmers should implement sustainable agricultural practices which will both conserve land and improve yield over the long-term. Additionally, changes to agronomic practices, such as earlier planting dates should be implemented as changes become pronounced.

In addition, Government and Non-Government Associations should, as a matter of concern, prioritise climate change and climate variability issues across the region. This they can do by mainstreaming climate change activities within the sector. In that way most of the smallholder farmers can afford to be part of the drive, learn and contribute to promote climate adaptation since the study revealed that education in general vastly enhances adaption and uptake of information.

5.6 Areas for Future Study

This study has revealed some areas for future study which will enable us gain a much deeper understanding of the impact of changing climatic factors. Firstly, future research can look at the influence of climate variability and extremes to the achievement of agricultural commercialisation goal under Ghana's Shared Growth and Development Policy. Also, a national level study of the impact would be useful to establish the generality of the results. Moreover, a study can be carried out on the impact of data limitation and unavailability of long-term climate data on climate change and variability research in Ghana.



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APPENDIX

UNIVERSITY OF GHANA- LEGON
CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

THE IMPLICATION OF CHANGING CLIMATIC FACTORS ON THE
LIVELIHOODS OF SMALLHOLDER PINEAPPLE FARMERS IN AKUAPIM
SOUTH MUNICIPALITY OF THE EASTERN REGION

INDIVIDUAL FARMER QUESTIONNAIRE

This interview schedule is designed to elicit information for the purpose of thesis writing at the University of Ghana, Legon. The purpose of the study is purely academic and does not in any way attempt to invade your privacy. You are assured that all the information supplied will be treated confidentially. Kindly respond as honestly and completely as possible.

Thank you very much.

Name of Interviewer: **Date**

Code Number of Respondent _____

Town/Village _____

Please provide the appropriate answers from the responses provided or supply the necessary information.

PART ONE: Socio-economic Characteristics of Respondents

1. Gender of respondent
1) Male 0) Female
2. Are you the head of your household? (if the man is away for >6mths, then the woman is head)?
1) Yes 0) No
3. How old are you?.....
4. What is your highest level of education?
0) No formal education 1) Primary 2) Other please specify.....
5. Can you read and write in English?
1) Yes 0) No
6. Can you read and write in your local language?
1) Yes 0) No
7. What is your religion?
1) Christian 0) Other religion, please specify.....
8. What is your marital status?
0) Married 1) Never Married 2) Separated 3) Widowed
9. What is your household size?.....
10. How many are adults (18 yrs)?
11. How many are children(less than 18 yrs)?
12. How is decision made in your household?
0) Head of household 1) The head with the Spouse 2) The entire family 3) Other (specify).....
13. What is your residential status
1) Native farmers 0) Migrant Farmers

14. How many years have you been farming?.....

PART TWO: Changing Climatic Factors and Adaptation

Rainfall

15. What changes have you observed in the rainfall pattern in this community?

- 1) Unpredictable 2) No change 3) Don't know

16. What changes have you observed in the rainfall amount in this community?

- 1) Increased 2) Decreased 3) No change 4) Don't know

17. For how many years have you observed this changes in rainfall in this community?

.....

18. What is the main impact of these changes on your activities?

.....

19. What adjustments have you made in your farming practices to cope or adapt to these changes?

.....

Temperature

20. What changes have been observed in the temperature pattern in this community?

- 1) Unpredictable 2) No change 3) Don't know

21. What changes have you observed in the temperature intensity in this community?

- 1) Increased 2) Decrease 3) No Change 4) Don't know

22. For how many years have you observed this changes in temperature in this community?

.....

....

23. What is the main impact of these changes on the local community?

.....

...

24. What adjustments have you made in your farming practices to cope or adapt to these changes?

.....

Cropping calendar

25. What changes have you noticed in the cropping calendar?
0) shift in crop season 1) No change 2) don't know
26. Can you describe the change, if you notice a shift in the cropping calendar?
.....
27. How long ago have you observed these changes?
.....
28. What is the main impact of these changes have on your productivity?
.....
29. What adjustments have you made in your farming practices to cope or adapt to these changes?
.....

Drought

30. Have you experienced the effects drought on your agriculture?
2) Yes 0) No
31. How often in the last decade did you experienced drought on your agriculture?
.....
32. Which months of the year is mostly associated with drought?
.....
33. What is the main impact of these changes on your productivity?
.....
34. What adjustments have you made in your farming practices to cope or adapt to these changes?
.....

Floods

35. Have you experience floods on your agriculture?
2) Yes 0) No
36. How often in the last decade have you experienced floods?
.....
37. Which months of the year is mostly associated with floods?
.....
38. What is the main impact of these changes on your productivity?
.....

39. What adjustments have you made in your farming practices to cope or adapt to these changes?
.....

PART THREE: Farming System

40. How did you acquire your land?

- 1) Own 0) Other, Please specify.....

41. If owned is it through

- 1) Purchased 0) Inheritance

42. What is the total size of the farm in hectares?
.....

43. Where are they located?

- 1) In a single area 0) Multiple location

44. How will you describe the topography of your land?

- 0) Uplands/ slopes
1) Lowlands
2) Plains
3) River valley
4) Other, please specify.....

45. What is the size of your pineapple farm?
.....

46. What is the size of other crops?
.....

47. Is Pineapple Production your main source of livelihood?

- 1) Yes 0) No

48. If no, indicate your main source of livelihood?

- 0) Other commodity, please specify.....
1) Agro processing, please specify.....
2) Wage earner, please specify.....
3) Farm Labourer.....
4) Other please specify.....

49. If yes, specify the other source of livelihood?

- 0) Other commodity, please specify.....

- 1) Agro processing, please specify.....
 - 2) Wage earner, please specify.....
 - 3) Farm Labourer.....
 - 4) Other please specify.....
50. What kind of pineapple variety are you planting?
0) Smooth Cayenne 1) MD2 2) others.....
51. Is there any reason for planting this variety?
.....
52. Are there any challenges associated with this variety?
.....
53. How long ago have you been cultivating this variety?
.....
54. How would you describe your yield in the last five years?
2009.....
2010.....
2011.....
2012.....
2013.....
55. Have you experienced any crop failure the last 5 years?
1) Yes 0) No
56. How many times in the last five years?
57. What accounted for the crop failure?
.....
58. What kind of water do you use for your pineapple?
0) Rain water 1) Borehole 2) River 3) Tanker water 4) other
specify.....
59. What kind of fertilizer do you use on your farm
0) organic 1) chemical fertilizer 2) mix of the two
60. What kind of market does your pineapple commodity target?
0) Local market 1) Export market 2) Processing
61. Where do you sell your pineapple commodity?
0) Farm gate 1) local market 2) urban market 3) factory gate

62. How would you describe sales of pineapples in the last five years?

2009.....

2010.....

2011.....

2012.....

2013.....

63. What was the source of your initial funds for production?

- 0) Own income 1) Relatives 2) financial institution 3) other please specify.....

64. How many people on the average work on your farm?

.....

65. Do you belong to any pineapple farmers association?

- 1) Yes 0) No

If yes, provide answers to

66. What is the objective of the association?

.....

67. When was the last time you attended a meeting?

.....

68. What services are provided by the association?

- 0) Savings and credit access
 1) Machine hiring
 2) Source of labour
 3) Source of other inputs
 4) Training in agronomic practices
 5) Others specify.....

69. Which of the following support do you receive from the government?

- 0) Community infrastructure for pineapple farmers e.g. Pack house
 1) Receive planting materials
 2) Extension services
 3) Other, please specify.....
 4) None

PART FOUR: Livelihood Assets and Welfare

70. Can you indicate what change you have noticed over the last 5 years?

		0) Increase	1) Decrease	2) No change	3) Don't know
--	--	-------------	-------------	--------------	---------------

a.	Food security				
b.	Income security				

71. What reasons do you attribute to the changes in?

82a.....

82b.....

72. Can you indicate which of the following assets you own?

	0)TV		6)Vehicle
	1)Radio		7)Tractor
	2)Livestocks (specify)		8)bicycle
	3)Water pump		9)Motorbike
	4)Mobile Phone		10) Cart
	5)House (specify)		11) other specify

73. Over the last five years, what change have you noticed in your assets?

Assets	0)Increase	1)Decrease	2)No change	3)Don't know
0)TV				
1)Radio				
2)Livestocks (specify)				
4)Mobile Phone				
5)bicycle				
6)Other specify				

74. What do you spend your income from pineapple sales on?

- 0) Food
- 1) School fees
- 2) Reinvest in the farm (farm labour, suckers)
- 3) Home maintenance and improvement
- 4) Build a house
- 5) Payment of debts
- 6) Funeral expenses
- 7) Health care
- 8) Other investment.....
- 9) Others please specify.....

75. What would you say is the major problem you face in your pineapple production over the last five years, that threaten you acquisition of new income and asset or erode you assets you possess now?



