

The Impact of Climate Change on Agriculture Production and Food Security Situation, In Abuharaz Administration in North Kordofan State, Sudan

By

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A Thesis Submitted in Partial Fulfillment for the Requirements
of the Degree of Master of Science
in Agricultural Economics

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August, 2018

DEDICATION

To

The Soul of My father and My Mother

My Brothers and sisters

My daughter

My family in Elobied

And to My Colleagues in Vet care Organization

ACKNOWLEDGEMENTS

Full praise and thanks to Allah the Almighty who gave me health, strength, and patience to finish this study.

I am deeply indebted to my supervisor Prof. Dr. Maruod Elnu Maruod, for many things, his guidance, advice, patience and encouragement helpful and insightful.

My thanks are also to Mohammed Sheekh Eldeeen Elteama, and extended to all those who helped or encouraged me in one way or another during my courses of study. I owe great to Dr. Ali Musa Abbakar, Dr.Mahmoud Amaseib, Dr. Ashraf and Dr. Ibrahim Elnour for their help.

My thanks are also extended to all the staff member of Agricultural Economics Department and friends.

Finally, I would like to express special gratitude and appreciation to my family for their invaluable help, support and encouragement through the study period.

ABSTRACT

The current study was conducted in Bara Locality, North Kordofan State; in 2017. The overall objective of this study was to identify options for rural women enhancement under climate change in dry lands. While the specific objectives were to evaluate previous intervention by Vet Care Organization and identify lessons, to investigate women indigenous knowledge about climate change and agricultural practices, to Identify opportunities for future development by determining the optimum crop combination that maximize the gross margin . Primary data were collected via constructed questionnaire introduced to households by direct interviewing. A sample size of 144 (72 with and 72 without the project) households representing about (18.3%) from total households (786) living in the study area were selected using simple random sampling technique. Data were analyzed using descriptive statistics, Gross Margin analysis, and linear programming model. The results showed that, majority of the respondents in and out project have knowledge about climate change (77.8% with project versus 80.6% without project) and they identify the indicators of climate change as fluctuation of rainfall, soil degradation and pests. VCO project of Women Empowerment succeeded to achieve a considerable amount of its objectives where 100% of the respondents received training in agricultural activities. Also gave good economic impact by improving productivity of crop production 50% more than before, 100% of the respondents received agricultural inputs, 100% of them confirm that they received drip irrigation system and technical training in installation and maintenance, 62.5% confirmed that they got benefits from drip irrigation system, 88.9% of the respondents confirmed that they has received training in vegetables production.. On average gross margin per feddan for sorghum, millet, groundnuts, sesame and Roselle were SDG 1025.25, 1422.5, 832, 1758 and SDG 661 respectively. The optimum crop combination was to cultivate 5.434 feddan of sesame to get maximum

gross margin equals SDG 9553 plus growing some food crops as millet and sorghum according to gross margin results. The study recommends the cultivation of sesame as cash crop and millet and sorghum as food crops. To improve access to credit for households in targeted villages, members of the project associations should be linked with Banks or microfinance institutions in Bara locality.

الخلاصة

اجريت هذه الدراسة في محلية بارا بولاية شمال كردفان, في عام 2017. الهدف العام من هذه الدراسة هو تحديد خيارات تعزيز وتحسين المرأة الريفية في ظل التغيرات المناخية في المناطق الجافة. أما الأهداف الخاصة للدراسة هي تقييم التدخل السابق من قبل منظمة فيت كير وتحديد الدروس ، والتحقق من النساء حول المعرفة الأصلية حول التغيرات المناخية والممارسات الزراعية ، لتحديد فرص التنمية المستقبلية بتحديد التركيبة المحصولية المثلى التي تعظم الهامش الاجمالي. تم جمع البيانات الأولية من خلال المسح الميداني باستخدام أستبانة تم تصميمها للأسر عن طريق إجراء المقابلات المباشرة. تم اختيار حجم عينة من 144 امرأة (72 من المستهدفات في المشروع 72 من خارج المشروع) تمثل ربات الاسر المستهدفات للدراسة حوالي (18.3%) من مجموع الأسر (786) الذين يعيشون في منطقة الدراسة. اعتمدت الدراسة أسلوب العينة العشوائية البسيطة. تم تحليل البيانات باستخدام الإحصاء الوصفي وتحليل الهامش الإجمالي ونموذج البرمجة الخطية. أوضحت النتائج أن غالبية المستهدفات داخل وخارج المشروع لديهم معرفة حول التغيرات المناخية (77.8% من داخل المشروع مقابل 80.6% من خارج المشروع) تم تحديد مؤشرات التغيرات المناخية من قبل المستهدفات بالدراسة من خلال تذبذب الامطار, تدهور التربة والآفات الزراعية. مشروع منظمة فيت كير لتمكين المرأة قد نجح في تحقيق قدر كبير من أهدافه ,حيث تلقى 100% من المستهدفات تدريباً في الحزم الزراعية. كما اعطي اثر اقتصادي جيد من خلال تحسين انتاج المحاصيل بنسبة 50% أكثر من ذي قبل, 100% من المستهدفات حصلن على مدخلات زراعية ، 100% منهن أكدوا علي منحهم نظام ري بالتنقيط والتدريب الفني في انهن تلقين التدريب على إنتاج الخضروات. بلغ متوسط الهامش الاجمالي لكل فدان للذرة ، والدخن ، والفول السوداني ، والسمسم ، والكركدى لكل على التوالي (1422.5 ، 1025.25 ، 1758 ، 832 ، 661جنيه) . التوليفة المثلى للمحاصيل هي زراعة 5.434 فدان من

السسم للحصول على أقصى هامش إجمالي يساوي 9553 جنيهاً سودنياً بالإضافة إلى زراعة بعض المحاصيل الغذائية كالدخن والذرة الرفيعة وفقاً لنتائج هامش الربح الإجمالي. توصي الدراسة بزراعة السسم كمحصول نقدي والدخن والذرة كمحاصيل غذائية. لتحسين الوصول إلى الائتمان وفرص التمويل الأصغر للأسر في القرى المستهدفة ، ينبغي ربط أعضاء الجمعيات بالمشروع مع البنوك أو مؤسسات التمويل الأصغر في محلية بارا.

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CHAPTER I

1.1 INTRODUCTION

Sudan is located between latitudes 8° 22'N and longitudes 22° 38'E, in an area of north eastern part of Africa with 1,882,000 square kilometers (USAID, 2012). The vast longitudinal extension gives the Sudan unique ecological characters, from dry sandy desert in the northern central parts to high rainfall areas in the south. The country is also covered with desert shrubs and stunted bushes (Sudanet, 2013). The combination of rainfall and soil texture determines the distribution of vegetation cover in the Sudan. There are thorny low trees of low rainfall savannah in the central belt to broad leaf high rainfall savannah in the southern part (Sudanet, 2013). In the year 2011, the Sudan Central Bureau of Statistics estimated the population of Sudan to be 39 million, growing at 2.7%. More than 30 million people live in rural areas of Sudan (USAID, 2012). Over 80% of Sudan's employment takes place in the agricultural sub-sector. The majorities of the population are farmers and pastor a lists living on subsistence farming and livestock herding in a nomadic way of life (USAID, 2012and Sudanet, 2013). Forests play an important role in the welfare of the Sudanese population and in conserving and protecting the environment and the development of the country's national economy. Climate change is a global phenomenon, closely tied to fossil fuel-based development, which exposes states to various degrees of vulnerability. International law needs to develop a system of mitigation and adaptation to climate change that enables states to adjust more readily to new data and requirements, and which takes into account the wide range of different national interests. Africa is within dry land conditions considered the most vulnerable to climate change impact:

- Climate Change and Drought are considered as the most important phenomena that Africa faces.

- Rising temperature, declining amount of rainfall, irregular rainfall distribution, reduced food yield, various aspects of insecurity, conflicts, war and increasing rates of mortality
- Poverty, hunger, diseases, mal-nutrition, illiteracy, un-healthy living conditions and poor health care

Factors contributing to Climate Change in Africa:

- Variability of rainfall and Temperature
- Vulnerability of ecosystems
- Over exploitation of marginal lands
- Fragility of the production systems

Food security is the state achieved when food systems operate such that “all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Growing world’s population, increasing demand for healthy and culturally accepted food, soaring food prices and global environmental change challenges are negatively affecting food security globally and more severely in sub-Saharan Africa. The Global Hunger Index remains high for sub-Saharan Africa. While several factors are responsible, high food prices are driving millions of people into food insecurity, worsening the conditions for many who are already food- insecure and threatening long-term global food security. The task of reducing the number of hungry people (as per Millennium Development Goals) will require both regional and global efforts among which biotechnology adoption could play a crucial role.

1.2 Problem Statement and Justification

Kordofan region in general, and North Kordofan State in particular, is facing a number of complex problems, which is composed of environmental, economical, social and political interrelated factors; these factors resulted in deterioration of resources, high living expenses, and shortage in potable water, continuous food deficit and lack of access to social service facilities. The studies carried in food security by different development agencies (Mahmoud, 2006) indicated that the majority of the some selected areas of North Kordofan population are living under the poverty line. Thus, many national and international agencies had implemented many programs to meet the human needs in areas in North Kordofan State. On the other hand; peoples in north kordofan state have common similarity in way and condition of living. Most of them are farmers having almost the same income sources and consumption patterns (Mahmoud, 2006). The traditional rain-fed sub-sector is considered as one of the most important components of the agricultural sector in the Sudan. However, it experienced sever episodes of droughts in the last three decades of the 20th century. Agriculture in North Kordofan State is integral part of traditional farming, before three decades productivity was high and household used to cover all grain or cereal needs from farm production i.e. through direct access. Over the years crop production has fluctuated due to many factors such as low/erratic rainfall, pest infestation and low soil fertility. The area has experienced high environmental degradations; resulted in declined productivity and depletion of large livestock herds along with plant species which makes most of the rural people living in highly vulnerable conditions. Accordingly, the area continuously experienced or food insecurity and getting food aids.

In spite of the huge natural resources bestowed upon the traditional agricultural sector, Kordofan has experienced situation of food insecurity in some seasons and in certain parts for number of factors; Desert and semi-desert climate most of North Kordofan State regions, The most risky area with regard to food availability and accessibility is the north part of north Kordofan, The main staple food crops in Kordofan region are sorghum and

millet and the tow cash crops as sesame and groundnut in addition to other minor Crops such as Roselle, cowpea and watermelon seeds. Recently, with increasing human and animal populations, severe pressure has been put on the land. The major problems stem from the recurring droughts, and desertification aggravated by miss-use of land in the form of over-cultivation and mechanizes farming, over grazing, illegal tree cutting and over exploitation. This has resulted in server losses in soil fertility and significant declines in yields of crops and trees (Ahmed, 1986).

1.3 Objectives of the study:

1.3.1 General Objective:

The overall objective was to evaluate the impact of climate change on crops production and food security situation in Abu-Haraz adminstration of North Kordofan State.

1.3.2 The specific objectives were to: hypotheses- or question-chapters

1. Know the socio-economic structure of households in the study area.
2. Determine the optimum crops combination that maximize small producers gross margin.
3. Identify which environmental factors that mostly affect crops production in the study area.
4. Evaluate the impact of climate change on food security achievement in the study area.

CHAPTER II

LITERATURE REVIEW

2.1 What is climate change?(sources

Climate is usually defined as the "average weather" in a place. It includes patterns of temperature, precipitation (rain or snow), humidity, wind and seasons. Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. But the climate we've come to expect is not what it used to be, because the past is no longer a reliable predictor of the future. Our climate is rapidly changing with disruptive impacts, and that change is progressing faster than any seen in the last 2,000 years. According to the report, Preparing for a Changing Climate, rising levels of carbon dioxide and other heat-trapping gases in the atmosphere have warmed the Earth and are causing wide-ranging impacts, including rising sea levels; melting snow and ice; more extreme heat events, fires and drought; and more extreme storms, rainfall and floods. Scientists project that these trends will continue and in some cases accelerate, posing significant risks to human health, our forests, agriculture, freshwater supplies, coastlines, and other natural resources that are vital to Washington state's economy, environment, and our quality of life. Because so many systems are tied to climate, a change in climate can affect many related aspects of where and how people, plants and animals live, such as food production, availability and use of water, and health risks. For example, a change in the usual timing of rains or temperatures can affect when plants bloom and set fruit, when insects hatch or when streams are their fullest. This can affect historically synchronized pollination of crops, food for migrating birds, spawning of fish, water supplies for drinking and irrigation, forest health, and more. Some short-term climate variation is normal, but longer-term trends now indicate a

changing climate. Our state and societies around the globe need to reduce human-caused greenhouse gas emissions to avoid worsening climate impacts and reduce the risk of creating changes beyond our ability to respond and adapt. Washington state is addressing this challenge and has adopted policies to reduce energy use, limit greenhouse gas emissions, and build a clean energy economy. Some changes in climate and impacts on our state are unavoidable, even if we reduce greenhouse gas emissions today. But we can take more actions to reduce progressively worsening impacts.

2.2 What Are Climate and Climate Change?

The climate of a region or city is its typical or average weather. For example, the climate of Hawaii is sunny and warm. But the climate of Antarctica is freezing cold. Earth's climate is the average of the entire world's regional climates. Climate change, therefore, is a change in the typical or average weather of a region or city. This could be a change in a region's average annual rainfall, for example. Or it could be a change in a city's average temperature for a given month or season. Climate change is also a change in Earth's overall climate. This could be a change in Earth's average temperature, for example. Or it could be a change in Earth's typical precipitation patterns.

2.3 Climate change impacts on global food security

Food security is defined by the Food and Agriculture Organization (FAO, 2002) as a “situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. The definition involves four aspects of food security, namely, food availability, food stability, food access and food utilization(, J. Schmidhuber et al, 2007). However, the existing studies are focused on the climate change impacts on food availability, scarcely referring

to the impacts of potential increase in climate variability, frequency and intensity of extreme events on food stability. The FAO 2002) mentioned that biotechnology can be an approach to improve food security and reduce the environmental pressure. Meanwhile, modified crop varieties, resisting drought, water logging, salinity and extreme climate, can expand the crop planting area such as in the degraded soils, consequently, to increase food availability in the future. Climate change will affect the food quality because of the increasing temperature and decreasing crop growth period. Global food security threatened by climate change is one of the most important challenges in the 21st century to supply sufficient food for the increasing population while sustaining the already stressed environment, (R. Lal and *et al*, 2005). Climate change has already caused significant impacts on water resources, food security, hydropower, human health especially for African countries, as well as to the whole world, (Magadza, 2000). Climate change could potentially interrupt progress toward a world without hunger. A robust and coherent global pattern is discernible of the impacts of climate change on crop productivity that could have consequences for food availability. The stability of whole food systems may be at risk under climate change because of short-term variability in supply. However, the potential impact is less clear at regional scales, but it is likely that climate variability and change will exacerbate food insecurity in areas currently vulnerable to hunger and under nutrition. Likewise, it can be anticipated that food access and utilization will be affected indirectly via collateral effects on household and individual incomes, and food utilization could be impaired by loss of access to drinking water and damage to health. The evidence supports the need for considerable investment in adaptation and mitigation actions toward a “climate-smart food system” that is more resilient to climate change influences on food security, (Science Magazine, 2013).

2.4 Climate change impacts on water availability

It is known that water resources play a vital role in human prosperity and crop productivity. The world's agriculture, hydroelectric power and water supplies depend on different components of the hydrological cycle, including the natural replenishment of surface and groundwater resources (Buchdahl, 2002). Water availability issues include how much water can be diverted, when the water can be available and how much water can be stored in surface and ground-water reservoirs. Assessment of seasonal and long-term water availability is not only important for sustaining human life, biodiversity and the environment, but also helpful for water authorities and farmers to determine agricultural water management and water allocation. Climate change is one of the greatest pressures on the hydrological cycle along with population growth, pollution, land use changes and other factors (Aerts and Droogers, 2004). Water availability is under threat from changing climate because of possible precipitation decrease in some regions of the world. In the light of the uncertainties of climate variability, water demand and socio-economic environmental effects, it is urgent to take some measures to use the limited water efficiently and develop some new water resources (Buchdahl, 2002). If the water resources are replenished by snow accumulation and the snowmelt process, the water system will be more vulnerable to climate changes (Dracup and Vicuna, 2005).

2.5 Climate change impacts on crop yield

The changes in crop production related climatic variables will possibly have major influences on regional as well as global food production (Abraha and Savage, 2006). The likely impacts of climate change on crop yield can be determined either by experimental data or by crop growth simulation models. To predict future impacts on crop yields, crop models present valuable approaches. Climate change

impacts on crop yield are different in various areas, in some regions it will increase, in others it will decrease which is concerned with the latitude of the area and irrigation application. The crop yield can be increased with irrigation application and precipitation increase during the crop growth; meanwhile, crop yield is more sensitive to the precipitation than temperature. If water availability is reduced in the future, soil of high water holding capacity will be better to reduce the frequency of drought and improve the crop yield (Popova and Kercheva, 2005).

2.6 Climate change impacts on soil water balance

Soil water balance is important for the water management and water use strategy. Climate change will make the temperature and rainfall fluctuates, consequently, influencing soil evaporation and plant transpiration. IPCC AR4 (Intergovernmental Panel on Climate Change Fourth Assessment Report), (Meehl GA, Stocker TF, Collins WD, et al, 2007). Climate change impacts on water balance will present changes in soil water storage, groundwater level, soil moisture status and can provide some information about irrigation quantity. The water balance will change with precipitation and evapotranspiration, and the resultant fluctuations in soil moisture status (Silva ,Weatherhead and Knox, 2007).

2.7 Sustainability and Food Security

North Kordofan is one of the four largest states in Sudan with a population of 2.9 million as per the 2008 population census. The state borders South Kordofan as well as North and South Darfur, and has therefore inevitably been affected by the security situation in these areas. An influx of IDPs from other states has led to increased pressure on already limited basic services related to health and education. Furthermore, North Kordofan is semi-arid and prone to both drought and desertification and lack of water is one of the key issues in the state and has been for decades. Consequently, North Kordofan is exposed to both chronic and

sporadic food shortages (Ministry of Health & UNICEF, 2009). According to the Sudan Social Development Organization (SUDO), poverty is a key challenge in the state, particularly in rural areas. Additionally, North Kordofan struggles with very poor health indicators and rates for maternal and infant mortality are high. North Kordofan is traditionally an agro-pastoral community, and the main source of livelihoods is a combination of rain-fed cultivation and livestock keeping. The key economic activity is farming, followed by animal husbandry and trade. During the last decades, drought as well as pest infestation has led to an increasingly difficult situation in North Kordofan (SUDO, 2008). The state is also characterized by complex linkages between environment, poverty and conflict over natural resources that are becoming increasingly scarce. This situation demonstrates the connection between drought, resource degradation and conflict on the one hand and vulnerability to food insecurity on the other. North Kordofan has been classified in the range of 'very severe' to 'moderately' affected zone by desertification. The desertification-affected area is estimated at 40% of the total State area. Agriculture is not a wholly benign actor on the environment, as it causes accelerated soil erosion by water and wind, through cultivation, and often introduces nitrates and other chemicals into water supplies through the application of chemical fertilizers and pesticides. The concept of "sustainable agriculture" endeavors to reduce chemical inputs and energy use in farming systems, in order to minimize environmental damage and to ensure longer-term productivity. Most agricultural assessments of global environmental change made to date have not focused explicitly on sustainability issues, and have neglected the considerable impacts of shifting agricultural zones, alterations in commercial fertilizer and pesticide use, and changes in the demand for water resources. Climate change can impact agricultural sustainability in two interrelated ways: first, by diminishing the long-term ability of agro ecosystems to provide food and fiber for the world's sources

population; and second, by inducing shifts in agricultural regions that may encroach upon natural habitats, at the expense of floral and faunal diversity. Global warming may encourage the expansion of agricultural activities into regions now occupied by natural ecosystems such as forests, particularly at mid- and high-latitudes. Forced encroachments of this sort may thwart the processes of natural selection of climatically-adapted native crops and other species. While the overall, global impact of climate change on agricultural production may be small, regional vulnerabilities to food deficits may increase, due to problems of distributing and selling food to specific regions and people groups. For subsistence farmers, and more so for people who now face a shortage of food, lower yields may result not only in measurable economic losses, but also in malnutrition and even famine (U.S. Global Change Research Information Office, 2006).

2.8 Adaptation

A wide variety of adaptive actions may be taken to lessen or overcome adverse effects of climate change on agriculture. At the level of farms, adjustments may include the introduction of later- maturing crop varieties or species, switching cropping sequences, sowing earlier, adjusting timing of field operations, conserving soil moisture through appropriate tillage methods, and improving irrigation efficiency. Some options such as switching crop varieties may be inexpensive while others, such as introducing irrigation (especially high-efficiency, water-conserving technologies), involve major investments. Economic adjustments include shifts in regional production centers and adjustments of capital, labor, and land allocations. For example, trade adjustments should help to shift commodity production to regions where comparative advantage improves; in areas where comparative advantage declines, labor and capital may move out of agriculture into more productive sectors. Studies combining biophysical and economic impacts show that, in general, market adjustments can indeed moderate

the impacts of reduced yields. A major adaptive response will be the breeding of heat- and drought-resistant crop varieties by utilizing genetic resources that may be better adapted to new climatic and atmospheric conditions. Collections of such genetic resources are maintained in germ-plasma banks; these may be screened to find sources of resistance to changing diseases and insects, as well as tolerances to heat and water stress and better compatibility to new agricultural technologies. Crop varieties with a higher *harvest index* (the fraction of total plant matter that is marketable) will help to keep irrigated production efficient under conditions of reduced water supplies or enhanced demands. Genetic manipulation may also help to exploit the beneficial effects of CO₂ enhancement on crop growth and water use. Recent studies by the National Research Council and other organizations have emphasized the ability of U.S. farming to adapt to changing conditions, since in the past technological improvements have indeed been developed and put into use when needed. The U.S. has substantial agricultural research capabilities and a wide range of adaptation options is currently available to farmers in this country. Hence, insofar as the U.S. is concerned, prospects for agricultural adaptation to climate change appear favorable, assuming water is available. Considerable investments may be needed, however, to utilize soil and water resources more efficiently in a changed climate. Other countries, particularly in the tropics and semi-tropics, are not so well provisioned with respect to both the research base and the availability of investment capital, (U.S. Global Change Research Information Office, 2006).

2.9 Uncertainties

Despite the substantial advances in understanding of climate change and its agricultural impacts, many uncertainties remain. Of particular concern are some of the limitations of the general circulation models used to simulate climate changes, and the way those limitations may affect the predicted impacts of climate change

on agriculture. Some of these limitations suggest that the generally optimistic predictions outlined above for the temperate regions of the world, may be too sanguine. On the supply side, a critical limitation of GCMs is their ability to predict changes in climate with the spatial resolution needed to model impacts on agricultural productivity. As discussed in the companion article in this issue by Adams and Peck, changes in water availability are especially difficult to predict, particularly on the site-specific basis needed to quantify agricultural yield impacts. A related uncertainty concerns impacts on pests which are also highly sensitive to site-specific environmental conditions, and are not well-represented in the models used to predict yield effects. Another key uncertainty that affects impacts on all biological processes, including agriculture, is the rate of climate change. The higher the rate of climate change, the higher will be rates of obsolescence of all types of capital, both produced and natural, and thus the greater will be the costs of adaptation be for farmers, the private sector providing technology and inputs to farmers, and for government institutions responsible for infrastructure and policy. A related, critical supply-side uncertainty is how technology will evolve so as to reduce impacts and facilitate adaptation. In the past, it has taken about 15 years to develop a new crop variety. A key question is whether biotechnology will speed adaptation and reduce vulnerability to drought, extreme temperatures and pests. Another uncertainty on the supply side is the environmental consequences of adapting to climate change. One example is the increased pressures on water resources in arid regions. Another example could be the increase in population density and agricultural intensity in highland tropical areas where soils are often fragile and vulnerable to degradation. On the demand side, impacts of changes in consumer incomes and in market infrastructure will be critical but highly uncertain factors. Given the predicted modest impacts of climate change on global food supply, the rate of economic growth is likely to be a key determinant of people's vulnerability to climate change. If the recent high rates of economic growth in

many developing regions continue, vulnerability to the impacts of climate change will be modest. However, those regions that are not participating in this growth, such as parts of sub-Saharan Africa and isolated mountain regions in central Asia and Latin America, are at risk of greater vulnerability if local food production decreases and becomes more variable. (John,2008).

2.10 Food Security

Extensive research in the late 1980s focused on understanding household food security, food insecurity, and hunger. This work led to the envelopment by an expert working group of the American Institute of Nutrition of the following conceptual definitions, which were published in 1990 by the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology.

2.11 Definition of Food Security

(Bichel,2000) stated that food security defined as access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum: (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).”Food security is a flexible concept as reflected in the many attempts at definition in research and policy usage. Even a decade ago, there were about 200 definitions in published writings. **(Maxwell, 1992)**.Whenever the concept is introduced in the title of a study or its objectives, it is necessary to look closely to establish the explicit or implied definition. **(Maxwell, 1996)**.The continuing evolution of food security as an operational concept in public policy has reflected the wider recognition of the complexities of the technical and policy issues involved. The most recent careful redefinition of

food security is that negotiated in the process of international consultation leading

to the World Food Summit (WFS) in November 1996. The contrasting definitions of food security adopted in 1974 and 1996, along with those in official FAO and World Bank documents of the mid-1980s are set out below with each substantive change in definition underlined. A comparison of these definitions highlights the considerable reconstruction of official thinking on food security that has occurred over 25 years. These statements also provide signposts to the policy analyses, which have re-shaped our understanding of food security as a problem of international and national responsibility. Food security as a concept originated only in the mid-1970s, in the discussions of international food problems at a time of global food crisis. The initial focus of attention was primarily on food supply problems of assuring the availability and to some degree the price stability of basic foodstuffs at the international and national level. That supply-side, international and institutional set of concerns reflected the changing organization of the global food economy that had precipitated the crisis. A process of international negotiation followed, leading to the World Food Conference of 1974, and a new set of institutional arrangements covering information, resources for promoting food security and forums for dialogue on policy issues (ODI, 1997). The issues of famine, hunger and food crisis were also being extensively examined, following the events of the mid-1970s. The outcome was a redefinition of food security, which recognized that the behavior of potentially vulnerable and affected people was a critical aspect. A third, perhaps crucially important, factor in modifying views of food security, was the evidence that the technical successes of the Green Revolution did not automatically and rapidly lead to dramatic reductions in poverty and levels of malnutrition. These problems were recognized as the result of lack of effective demand. Food security was defined in the 1974 World Food Summit as: “Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices. (*United Nations. 1975*). In 1983, FAO

expanded its concept to include securing access by vulnerable people to available supplies, implying that attention should be balanced between the demand and supply side of the food security equation: “ensuring that all people at all times have both physical and economic access to the basic food that they need. **(FAO, 1983).** The 1996 World Food Summit adopted a still more complex definition: “Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (FAO,1996). This definition is again refined in The State of Food Insecurity 2001. Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. (FAO, 2002).

2.12 Livelihoods

A livelihood zone is defined as, “an area where most households in that area obtain their food and cash income from, by roughly the same combination of means”. With HAC’s leadership an updated livelihood map for North Kordofan was developed in 2008. General and demographic findings. The findings from the household assessment show that rural head of households are on average two years older than urban heads. Households are larger in urban locations by one member and there is a slightly higher proportion of female-headed households in rural locations (16 percent in rural compared with 13 percent in urban areas). A state-level food security assessment was carried out in October 2010, partly to feed into the 2010 Crop and Food Security Assessment Mission (CFSAM) planned for November and December, but also to assist WFP and other stakeholders in determining the level of humanitarian assistance needed in 2011. This assessment was a jointly conducted by HAC, the State Ministry of Health and the Ministry of Agriculture. The

general objective of the assessment was to; assess the food security situation of the urban and rural population in North Kordofan.

Food security results indicate that more rural households are food insecure than urban, however, the severity of food insecurity is worse in urban areas where three percent were found to be severely food insecure compared to none in rural locations. The food security situation in Northern Kordofan reflects chronic poverty rather than a transitory situation and requires both long term and short term interventions that will look at tackling structural causes as well as preventing further environmental degradation.

CHAPTER III

STUDY AREA AND RESEARCH METHODOLOGY

3.1 Description of study area

The study area covers part of North Kordofan State, which includes (Sheikan, Bara, Um Ruwaba and Elrahad Localities). This area lies between latitude $12^{\circ}:00' - 16^{\circ}:30'N$ and longitude $27^{\circ}:00' - 32^{\circ}:25'E$. The State has been characterized by being desert north of latitude 16 with annual rainfall less than 100 mm; and semi desert features between latitude $14^{\circ}:25' - 16^{\circ}:00'$ with annual rainfall 100 -- 250 mm; arid features between latitude $13^{\circ}:25' - 14^{\circ}:25'$ with annual rainfall 250- 350 mm; and semi arid features south latitude $13^{\circ}:25'$ with annual rainfall more than 350 mm (Ministry of Agriculture, 1990). Generally the annual rainfall varies between 100—400 mm; the distribution of rainfall over the wet season is an important consideration in the explanation of the variation in crop yield. Broadly, the soil of the study area can be classified into three main groups as sandy soil (Goz) group, fine texture group and clay soil group. The sandy soil (Goz) consists of stabilized sand dunes. This type of soil, despite its low fertility and low water holding capacity, is intensively cultivated due to its loose structure, which makes it easy to cultivate and facilitates the development of fine root system of crops. Compensate for the major crops grown in the sandy soil are millet, groundnut, sesame, water elon and Roselle. Fine texture soil group consists of gardud, Jurraba and wadi soil. The gardud soil is group of non-cracking sandy- clay and it is very hard to cultivate by hand-tools, and suitable for cultivation of both milt and sorghum though better in sorghum. Jurraba is a soil type related to gardud and it yields good crops such as sorghum, okra, cowpea and sesame. Wadi soils consist of dark clays and they are generally found along seasonal watercourses and the crops grown here sorghum and okra, which require more water. In addition to the mentioned predominant soil types, there are scattered pockets of clay soils over the study area particularly in Er-Rahad area (Jebel El

Dair). This soil type is suitable for mechanized cultivation of sorghum and sesame crops. Diversification of soil types and climatic conditions resulted in diversification of vegetation cover throughout the study area. The northern part is generally covered with scarce desert and semi-desert scrub; the central part is covered with *Acacia* spp., which gives way to the broad-leafed Savannah woodland of South Kordofan. The area in general is subjected to further degradation due to hardship environmental condition, climatic instability, desert moving to the south, recurrent drought, cutting down of trees for various uses, over cultivation and over grazing. (Maruod, 2010)

3.2 Population

According to 2009 national population census, the population is about 2.9 million; representing 7.4% of the total population of the country. Rural population in North Kordofan State is estimated at 80% of the total population of the State. The State is administratively divided into twelve localities. These are Sheikan and Bara in the central part Sodari and Gbrat Elsheikh to the North, Um Rwaba and Er-Rahad in the Eastern part, Abu Zabad in the Southern part and Wad Banda, Gubeish En-Nhud and Ekhewei in Western part of the State (Faisal et al, 2009).

3.3 Farming System

The majority of populations in the study area are sedentary farmers, who cultivate crops and raise animals. Migratory farming system also occurred in the area. The southern part of area accommodates the Baggara migratory herders (cattle owners) where, Abbala migratory herders (camels' owners) are found in the northern part. Both types of herders have a directional movement in search of feed and water. The direction is usually South North.

3.1.4. Crop Production Situation

A traditional farming system is prevailing in the study area with millet, as a major food crop, sorghum as a minor one, while groundnut, sesame and gum Arabic are the main cash crops. Watermelon and Roselle are minor cash crops. Besides very limited area are devoted to cowpea and okra crops. In addition to the above-mentioned crops, there are scattered pockets of horticultural production in very limited areas, around towns, (Ministry of Agriculture, 1993).

3.1.5. Animal Raising

Animal husbandry plays a very important role in the economy of the sedentary rural in the study area. The drought of 1983-85 affected negatively livestock production. Population of livestock decreased either by death or selling. There is heavy concentration of camels in the northern part of the study area, represented by Kababeesh, Kawahla and Hawaweer tribes. The cattle owners dominate in the southern part of the study area, which is mainly represented by Hawazma and Misaria tribes. Sedentary also own sheep all over the study area. Goats are widely owned by population of the study area. Livestock raising is an integral component of farming in the study area. It is one of livelihood aspect and contributes significantly to the wellbeing of people. It sells readily to meet urgent household needs, occasionally slaughtered in social events and customs or butter for existence to some families.

3.1.6 Economic structure

The economy of the North Kordofan State is largely based on traditional farming system of cropping and animal husbandry with nomads at the northern part of the area. The farming system of the study area is predominantly rain-fed and shifting cultivation (*Maruod, 2010*). In this farming system, two types of fallow exist; short fallow, which is replacing crops by bare land, and long fallow, which is replacing crops by forestland. In both types of fallow arrangement, the concern is soil fertility enhancement. In the last two decades, productivity has declined and fluctuated markedly. Frequent drought is one among the causes. Consequences of low productivity are many, but miss-use of available

natural resources to compensate for loss prominent. Such mis-use has been manifold in excessive cutting of trees, expansion cultivation and over grazing. The family income in the study area is usually consisted of two main components, farm and non-farm income. The farm income includes: crop production as a source of income, either cash or food crops. Animal production as a source of income, either sale of animals or animals products, such as meat, milk, skin and milk products and forestry production, such as gum-Arabic, charcoal and other forest products as sources of income. (Maruod, 2010).

3.1.7 Abuharaz Administration

Abuharaz administration, lies in Sheikan locality of North Kordofan State.

3.1.7.1 Location

Abu-haraz administration, line in sheikan locality of north kordofan state between longitude and latitude ,about 55 km north west Elobied town. The population is about 57,453 persons (12183 households). administration of planning and agricultural economic, 2014). (Fig.3.1).

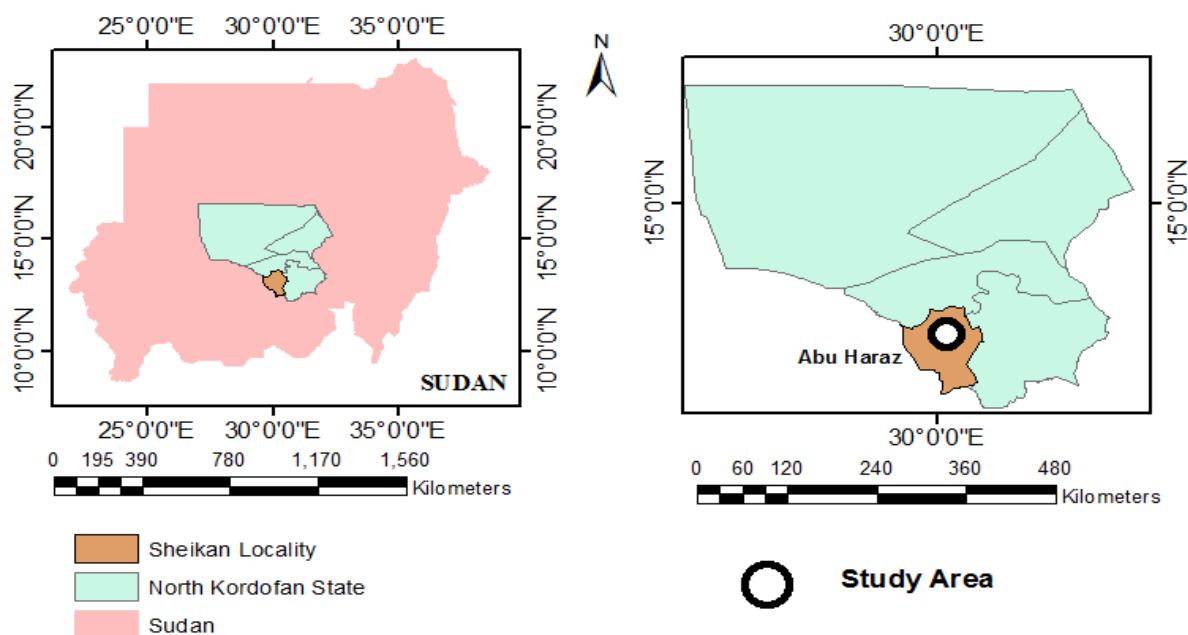


Figure 3.1 Abu-Haraz Administration

3.1.7.2 The vegetation:

Plantation was shrubs and semi desert about 50 – 60%. Vegetation was different according to the variance of rain, type of soil and land use and the density of plant and the yield was 3 ton/fedan. the vegetation contain, *Acacia Senegal*, *Acacia melifera*, *Banalities eagytiaca*, *Faderbia albida*, *Acacia nubica*, *Acacia nilotica*

(Dayf Allah, 2010)

3.1.7.3 Livestock

Animals in the study area were sheep, camel, cattle, goats and donkeys. sorces

3.1.7.4 Soil

In the south there is clay soil and gardoud soil, but in central and northern parts sandy and gardud soil are dominant.

3.1.7.5 Economical activities

The economy of the Abu-Haraz is largely based on traditional farming system of cropping and animal husbandry mainly cattle. The farming system of the study area is predominantly rain-fed and shifting cultivation (administration of planning and agricultural economics, 2014).

3.2 Research Methodology

3.2.1 Data Sources

To accomplish the objectives of the study, both secondary and primary data were collected using various tools. Primary data was collected using household questionnaire.

Structured questionnaire was designed, tested and administrated to head of households(Appendix A) in the study area selected on random basis .Hinton(1995) has advocated the advantage of the random sampling; each member of the sampled population can represent the whole population and has the same chance or probability to be chosen. Observation is an integral component of collecting primary data. Secondary data was collected through published and unpublished records and reports.

3.2.2 Sampling procedure and techniques

A sampling frame was developed from existing records at the State Ministry of Agriculture and used to accomplish random selection.A multi-stage random sampling technique was employed to select the needed sample. how

3.2.2.1 Sample size

About 105 householders were selected representing whole study area.

To achi study objectives 105 householders were selected to represent whole study

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3.2.3 Tools of analysis

To satisfy the objectives of the study; the Statistical Package of social Sciences (SPSS), partial budgets analysis (gross margin analysis), The Household Economy Approach (HEA), was used to analyze the collected data. Also the study used the linear programming tool for data analysis to determine the optimum crop combination in the study area.

3.2.3. 1 Household Economy Approach (HEA)

The household economy approach (HEA) was developed between 1992 and 1997 by save the children Organization (S.C.F.) in collaboration with the food and Agriculture

Organization (FAO) Global Information and Early Warning System (GIEWS) (Seaman et al, 2000). The aim was to find a method that could indicate the likely effect of crop failure or other shocks on future food supply. HEA has two main parts: 1– Quantitative description of the economy of the target population including determinant factors of household income and potential alternatives and how they are different among household. A standardized set of information is collected on how household is making living. This includes food, income, and expenditure on food and non-food items, saving, livestock and other assets, availability of wild food and its access. Information is collected using rapid field method. 2- A system to analyze the relationship between stocks, as crop failure from drought, and the ability of household to maintain their food and non-food consumption (coping mechanisms). The approach used in HEA is to model the most likely chain of events linking a shock and the outcome. The aim is not simply forecast one particular outcome, but to develop systematic, well-informed arguments about the most likely range of outcomes a given situation. In other words, entitlement to food constitutes the basis for analysis and is summarized as follows:

This model looks to risks of food insecurity through evaluating income and expenditure as determinants of food security. It calculates food entitlement matrix; this matrix is the most important framework of analysis (Davies, 1991). Uses food economy model in evaluating food security of target population based on:

A-Source of, and call on entitlement.

B- Mediators of these entitlements.

Sources of entitlement are based on production, exchange (market and non-market transfers) and assets (stores and claims on other) These Sources are the Income side of households food entitlement. According to Seaman's report 200" the household is the smallest coherent economic unit. It is define as is a group of people, each with different ability and share the food and other income from this economy. Household could be as

small as nuclear family (father, mother and children) or as large as extend family” Calls on entitlement are the expenditure side; they include consumption, claims by others, adaptation, cropping and livelihood /protection. Both sources of and call on entitlements are mediated by numbers of factors, all of which have structured and approximate dimension of natural mediators such as soil degradation and drought. Household mediators are gender mix household size, pregnancy and act (Davies, 1991).

The HEA provides a direct estimate of the food gap by establishing household food balance which matches resources (all income and foods sources converted into kilocalorie or cash equivalents) as mentioned by Stephen (2006),the calorie consumption estimate may be used directly to categorize the degree of severity of food insecurity as: above mentioned 2100 kcal / person /day is food soured ,between 1800 and 2100 kcal is marginally food insecure, between 1500 and 1800 kcal is moderately food insecure and less than 1500 kcal/person/day is severely food insecure.

3.2.3.2. Linear Programming

3.2.3.2.1 Theoretical Aspects of the Models

One of the core tools of farm management analysis is the linear programming model. Linear programming (LP) is a method of determining a profit maximizing combination of farm enterprises that is feasible with respect to a set of fixed farm constraints (Breima, 2006). Linear programming requires the following information:

- 1) The farm and non-farm activities and options with their respective resource requirements and any constraint on their production.
- 2) The fixed requirements and other maximum and minimum constraints that limit family or farm production.
- 3) Cash costs and returns of each activity.
- 4) Defined Objective or Objective Function.

The theoretical aspect of this study is centered upon economic characteristics of poverty groups and low resource farmers. The frameworks have painted a broad picture of the income distribution and poverty problems in developing countries. To improve levels of living for the very poor, many observers argue that direct attacks on poverty by means of poverty focused policies and plans can be more effective in both the short and long runs. Poor farmers are that they are disproportionately located in rural areas, they are primarily engaged in agricultural and associated activities, they are more likely to be women and children than adult males and that they are often concentrated among minority ethnic groups and indigenous peoples. (Todaro,2000) stated that, about two-thirds of the very poor scratch out of their livelihood from subsistence agriculture either as small farmers or as low-paid farm workers. Some of the remaining one third are also located in rural areas but engaged in petty services. We need only point out here that in view of the disproportionate numbers of the very poor who reside in rural areas, any policy designed to alleviate poverty must necessarily be directed to a large extent toward rural development in general and the agricultural sector in particular. This section is including a wide range of production activities representing the different crop varieties. Pomeroy *etal*(2005) stated that linear programming requires the information of the farm and non-farm activities and options with their respective resource requirements and any constraints on their production, the fixed requirements and other maximum, minimum constraints that limit family or farm production, cash costs and returns of each activity and defined objective function. The constrained optimization estimates profit-maximizing levels of factor inputs, environmental, crop and livestock production. In this context, a linear programming model has been developed to determine the area to be used for different crops for maximum contribution and for improving farmers' income. According to Schulze (1998) Linear programming is the name of a branch of applied mathematics that deals with solving optimization problems of a particular form. Linear programming problems consist of a linear cost function (consisting of a certain number of variables) which is to be minimized or maximized subject to a certain number of constraints. The constraints are linear inequalities of the variables used in the cost function. The cost

function is also sometimes called the objective function. Linear programming is closely related to linear algebra; the most noticeable difference is that linear programming often uses inequalities in the problem statement rather than equalities. Linear programming (LP) is a powerful analytical tool that can be used to determine an optimal solution that satisfies the constraints and requirements of the current situation. This method consists of three quantitative components: (1) objective function (maximization of profit or minimization of costs); (2) constraints (limitation of production sources); and (3) decision variables. In formulating the linear programming problem, the assumption is that a series of linear (or approximately linear) relationships involving the decision variables exist over the range of alternatives being considered in the problem. LP output not only provides an optimal solution, it also provides sensitivity analysis. Sensitivity analysis evaluates how changes in the objective function coefficients affect the optimal solution of a linear programming model. It could examine how well the changes of objective function coefficients and the right hand side value could affect the optimal solution. LP has been used in the evaluation and optimization of raw material resources, capital, machinery, equipment, time and manpower under certain restricting circumstances to get the most benefit. Linear programming model also used to determine the optimum cropping pattern as a prerequisite to efficient utilization of available resources of land, water, and capital for agriculture (yue, 2013).The simplex method has two basic steps, often called “phases.” The first phase is to find a feasible solution to the problem. For small problems, or larger problems of certain forms, this is not at all difficult. Often, a trivial solution such as $x = 0$ is a feasible solution, as in the production planning problem described earlier. We will omit the details of solving the first phase to find a feasible solution for now. After a feasible solution to the problem is found, the simplex method works by iteratively improving the value of the cost function. This is accomplished by finding a variable in the problem that can be increased, at the expense of decreasing another variable, in such a way as to effect an overall improvement in the cost function. This can be visualized graphically as moving along the edges of a feasible set from

corner to corner. A two-dimensional example follows.

3.4.1.1 Assumptions of linear programming

A number of assumptions about the production process, the resources and activities were discussed by Hazell (1986) as follows:

1. Optimization. It is assumed that an appropriate objective function is either maximized or minimized.
2. Fixedness. At least one constraint has nonzero right hand side coefficient.
3. Finiteness. It is assumed that there are only a finite number of activities and constraints to be considered so that a solution may be sought.
4. Determinism. All c_j , a_{ij} and b_j coefficients in the model are assumed to be known constants.
5. Continuity. It is assumed that resources can be used and activities produced in quantities that are fractional units
6. Homogeneity. It is assumed that all units of the same resource or activity are identical.
7. Additively. The activities are assumed to be additive in the sense that when two or more are used, their total product is the sum of their individual product. That is no interactions effects between activities are permitted.
8. Proportionality. The gross margin and resource requirement per unit of activity are assumed to be constant regardless of the level of activity used. Constant gross margin per unit of activity assumes a perfectly elastic demand curve supplies of any variable inputs that may be used. Constant resource requirements per unit of activity are equivalent to a Leontief production function (that is, a linear ray through the origin).

3.2.3.2.2 Expression of linear programming model

Objective equation

The household's objective is assumed to be the maximization of crops (Z) production

$$\text{Maximize } Z = \sum_{j=1} C_j X_j$$

$$C_j X_j \dots \dots \dots (1)$$

Subject to:

$$a_{ij} x_j \leq b_i \text{ (standard factors of production)} \dots \dots \dots (2)$$

$$\sum A_{ij} X_{ij} \leq b_j \text{ (Resource constraint)} \dots \dots \dots (3)$$

$$X_j \geq 0 \text{ all } j = 1 \text{ to } m \text{ non-negativity constraint activities}$$

Where:

Z = Gross margin

C_j = Price of production activities

X_j = level of *j*th production activity

a_{ij} = the *i*th resource required for a unit of *j*th activity

b_i = the resource available with the sample farmers

j = refers to number of activities from 1 to *n*

i = refers to number of resources from 1 to *m*

Under constraints of land/ha, labor/MH, working capital SDG/ha, temperature, rain fall, and humidity

Constraints

(i) Land

$$\sum a_{ij} x_j \leq OL \text{ and } \sum a_{ij} x_j \leq RL,$$

Where: OL and RL are the size of owned land and rented land holding, respectively.

(ii) Family labor

$$\sum a_{tj} - h_{tj} x_j^* \leq L_t, h_{tj} x_j^* \leq A_t$$

Where:

L_t and A_t = available family labor and hired labor in the t th period.

h_t = is the amount of hired labor required in the t th period for j th* activity.

A_{tj} = is the amount of labor required in the t th period for j th activity.

(iii) Working capital

$$\sum k_{ij} x_j \leq WK$$

Where:

WK = is the amount of available working capital

K_{ij} = is the amount of working capital required for production and non production activities.

Working capital is the value of inputs (purchased or owned) allocated to an enterprise with the expectation of a return at a later point. The cost of working capital is the benefit given up by the farmer by tying up the working capital in the enterprise for a period of time (Cimmyt, 1988).

3.2.3.2.3 The optimal solution

The optimal solution is the solution that satisfies both the conditions of the problem and the given objective (Goss, 1985).

3.2.3.2.4 Information of linear programming

Pomeroy ,(2005) stated that linear programming requires the following information:-

1. The farm and non-farm activities and options with their respective resource requirements and any constraints on their production.

2. The fixed requirements and other maximum, minimum constraints that limit family or farm production.
3. Cash costs and returns of each activity.
4. Defined objective or objective function

• **The objective function: maximize z.**

$$Z = ax_1 + bx_2 + cx_3 + dx_4 + ex_5 + fx_6 + gx_7 + hx_8 + ix_9 + jx_{10} + kx_{11} + Lx_{12}$$

Where $a, b, c, d, e, f, g, h, I, j, k$ and L are coefficients of objective function.

The general formula of the inequalities:

$$Ax_1 + Bx_2 + Cx_3 + Dx_4 + Ex_5 + Fx_6 + Gx_7 + Hx_8 + Ix_9 + Jx_{10} + Kx_{11} + Lx_{12} \leq H$$

Where $A, B, C, D, E, F, G, H, I, J, k$ and L are the coefficient of the *constraints inequalities* and H is the right hand side.

3.2.3.3 Partial Crop Budget Model

Partial budgeting is a method of organizing experimental data and information about the cost and returns of the various alternative treatments. Partial budgeting is concerned with limited change in farm plan, whereas complete or whole farm budgeting covers a wide range of change. The partial budgets method is a practical way to compare changes in production costs and revenue since it requires minimal data compared to other budgets. It has been used largely when production systems are subject to change, to compare two or more alternative sets of production practices (yue, 2013). All systems under comparison must be under the same production conditions, have the same fixed cost and vary only in explicitly specified components. The main point is to calculate the net change in return, which subtracts the total cost from the total return. The key requirement for using the partial budgets method is to identify all the changes (positive and negative) produced by shifting from a standard input to a proposed alternative.

3.2.3.4 Multiple Linear Regression Model in Economic Analyses

Ache et al (2012) stated that the situation in which economic correlations involves only two variables are very rare. Rather we have a situation where a dependent variable, Y ,

can depend on a whole series of factorial variables or regressions. For example, on analysis of climate change impact, the yield or net returns of specific crop depend mainly on temperature and rain fall. Thus, in practice, there are normally correlations as:

$$Y_t = \beta_1 + \beta_2 X_{t2} + \beta_3 X_{t3} + \beta_4 X_{t4} + \dots + \beta_k X_{tk} + \varepsilon$$

Where values X_j ($j = 2, 3 \dots n$) represents the variable factor or repressors, the values β_j ($j = 1, 2, 3, \dots, k$) represents the parameters of the regression and ε is the residual factor . Residual factor reflects the random nature of human response and any other factors other than X_j , which might influence the variable Y . Note that we have adopted the usual notation, we assigned to the first factor, notation X_2 , the second, notation X_3 etc. and t represent time and period. In fact, as we shall see, it is sometimes convenient that a parameter β to be considered a coefficient to a variable X_1 whose value is always equal to unity. Then it becomes possible to rewrite the equation in the form:

$$Y_t = \beta_1 X_{t1} + \beta_2 X_{t2} + \beta_3 X_{t3} + \dots + \beta_k X_{tk} + \varepsilon \text{ ---- } x_i = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_n x_n$$

3. 2.3.5 Time Series Data Analysis

Many statistical methods relate to data which are independent, or at least uncorrelated. There are many practical situations where data might be correlated. This is particularly so where repeated observations on a given system are made sequentially in time. Data gathered sequentially in time are called a time series (Term, 2010).

Here are some examples in which time series arise:

- Economics and Finance
- Environmental Modeling
- Meteorology and Hydrology
- Demographics
- Medicine
- Engineering
- Quality Control

3. 2.3.5 .1 Definitions

Assume that the series X_t runs throughout time, that is $(X_t)_{t=0, \dots, \infty}$, but is only observed at times $t = 1, \dots, n$.

So we observe $(X_1, \dots, X_n)$. Theoretical properties refer to the underlying Process $(X_t)_{t \in \mathbb{Z}}$.

The notations X_t and $X(t)$ are interchangeable. The theory for time series is based on the assumption of ‘second-order stationary’. Real-life data are often not stationary: e.g. they exhibit a linear trend over time, or they have a seasonal effect. So the assumptions of stationarity below apply after any trends/seasonal effects have been removed. (We will look at the issues of trends/seasonal effects later.)

A plot of r_t against t is called the correlation.

A series (X_t) is said to be lagged if its time axis is shifted: shifting by τ lags gives the series $(X_{t-\tau})$.

So r_t is the estimated autocorrelation at lag t ; it is also called the sample Autocorrelation function.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Results of descriptive statistics

4.1.1. Distribution of the respondents according to marital status

Table 4.1.1 shows that 78.1% of the respondents were married and 6.7 % were not married while 7.6% were widows and 7.6% were divorced this indicates the majority of the respondents were married and hence they are socially stable and this will positively affect agricultural activities and income generation as well as food security achievement.

Table 4.1.1 Distribution of the respondents according to marital status

Social status	Frequency	Percent
Married	82	78.1
Single	7	6.7
Widow	8	7.6
Divorced	8	7.6
Total	105	100

Source: Field survey, 2016

4.1.2 Distribution of the respondents according to their main Occupations

It was found that the percentage 82.9% of the target are farmers and this shows the importance of agriculture and the exercise of the rural population, followed by entrepreneurs and employees 9.5% and 7.6%, respectively.

Table (4.1.2): Distribution of respondents according to their main Occupations

Occupation	Frequency	%
Entrepreneurs	10	9.5
Employees	8	7.6
Farmers	87	82.9
Total	105	100

Source: Field survey, 2016

4.1.3 Distribution of the respondents according to their Secondary Occupations

The study showed that the percentage 29%, exercising the profession of entrepreneurship as secondary profession to spend their needs of food and other purposes after the planting season in the summer periods, followed by the rest of the other professions, such as agriculture 27%, livestock production 21%, merchants 11% and off-farm activities 12%. Table 4.1.3.

Table (4.1.3): Distribution of Household Head's according to their Secondary Occupations

Occupation	Frequency	%
Agriculture	28	27
Entrepreneurship	30	29
Merchant	11	11
Livestock production	22	21
Off farm	14	12
Total	105	100

Source: Field survey, 2016

4.1.4 The Knowledge of the respondents about climate change

The study found that 63.8% of the respondents were familiar with climate change , this demonstrates the importance and the impact of climate change on the life of humans and animals. Table 4.1.4.

Table (4.1.4): The Knowledge of the respondents about climate change

Heard about the climate change	Frequency	%
Yes	67	63.8
No	38	36.2
Total	105	100

Source: Field survey, 2016

4.1.5 Respondents perception about the causal factors of climate change

According to respondents perceptions about the causal factors of climate change, they mentioned High temperature, low rain fall, interaction of reasons, rain and heat and global warming representing 47.6, 30.5, 14.3, 3.8 and 3.8% for each respectively. Table (4.1.5).

Table (4.1.5): The respondent's perception about the causal factors of climate change

Mention	Frequency	%
High temperature	50	47.6
Low rain	32	30.5
Interaction of reasons	15	14.3
Rain& heat	4	3.8
Global warming	4	3.8
Total	105	100

Source: Field survey, 2016

4.1.6 Availability of schools in the area

The results showed that availability of schools in the area represents 81.9%, and this shows the importance of education, and in some areas there are no schools, and the ratio is 18.1%. Table (4.1.6).

The results showed that availability of school in the study area represents 81.9% , this shows the importance of education in the study area .

Table4.1.6): Availability of schools in the study area

Availability of Schools	Frequency	%
Yes	86	81.9
No	19	18.1
Total	105	100

Source: Field survey, 2016

4.1.7 Respondents opinion about having students at school

The majority of the respondents have students in schools, their proportion was 74.3% and this confirms community awareness of the importance of education.

Table (4.1.7): Respondents opinion about having students at school

Student	Frequency	%
Yes	78	74.3
No	27	25.7
Total	105	100

Source: Field survey, 2016

4.1.8 Students drop out of school

The study found that the students drop out of school was 21.9%. This is due to some factors, including, remote schools from their areas and sometimes for some natural conditions. Table 4.1.8.

Table (4.1.8) the student's drop out of school

Students drop out	Frequency	%
Yes	23	21.9
No	82	78.1
Total	105	100

Source: Field survey, 2016

4.1.9. Reasons behind school drop outs

The results showed that the reasons behind drops out were high fees, remoteness of schools, dislike going to school and other reasons which representing 61%, 20, 14.3 and 4.7% respectively.

Table (4.1.9) Reasons Behind school drop out

Reasons	Frequency	%
High fees	64	61
Remoteness of school	21	20
Dislike	15	14.3
Others	5	4.7
Total	105	100

Source: Field survey, 2016

4.1.10 whether schools are affected by climate change

The results showed that (58%) of the respondents confirm that their schools were affected by climate change and this shows that climate changes affects human life in all aspects of life. Table 4.1.10

Table (4.1.10) whether schools were affected by climate change

Affected	Frequency	%
Yes	61	58
No	44	42
Total	105	100

Source: Field survey, 2016

4.1.11 how schools are affected by climate change

According to the respondents perceptions the school were affected by climate change through, erosion, natural factors, destruction and immigration to other places, representing 29.5%, 28.1, 20 and 12.4% for each respectively. Table 4.1.11

Table (4.1.11) if yes specify how:

Specify	Frequency	%
Erosion	31	29.5
Natural factors	40	38.1
school destruction	21	20
Immigration to other places	13	12.4
Total	105	100

Source: Field survey, 2016

4.1.11 the respondents' major source of income

The major income sources were agriculture, agriculture and livestock, agriculture and merchants and off farm income representing 62%, 16, 12 and 10% for each respectively. These results assure that agriculture is the main source of income for the rural population. Table 4.1.11

Table (4.1.11) the respondents' major source of income

Major source of income	Frequency	%
Off farm	10	10

Agriculture	65	62
Agriculture & livestock	17	16
Agriculture & Merchant	13	12
Total	105	100

Source: Field survey, 2016

4.1.11 land ownership

The study showed that 75.2% of the respondents owned agricultural land since they are originally farmers and agriculture is essential profession for them while 24.8% just do not own agricultural land .Table 4.1.12

Table (4.1.12) land ownership

land Owner	Frequency	%
Yes	79	75.2
No	26	24.8
Total	105	100

Source: Field survey, 2016

4.1.13 type of land ownership

The study found that 74% of the respondents were agricultural land owners while 23% rent the land and 3% shared land. Table 4.1.13

Table (4.1.13) Type of land ownership

Owner land	Frequency	%
Renting	24	23

Owner	78	74
Sharing	3	3
Total	105	100

Source: Field survey, 2016

4.1.14 what are the environmental natural and economic factors affecting crops production in the area arrange according to important

According to the respondents point of view the factors were low rainfall, low soil fertility, price fluctuation, high temperature, Increase land moisture, floods heavy rains and others representing 41%, 19, 14.2, 9.5, 6.7, 2.9, 1.9 and 4.8% respectively. Table 4.1.14

Table (4.1.14). What are the environmental natural and economic factors affecting crops production in the area arrange according to important:

Items	Frequency	%
Low rainfall	43	41
Low land fertility	20	19
price fluctuation	15	14.2
High temperature	10	9.5
Increase land moisture	7	6.7
Others	5	4.8
Floods	3	2.9
Heavy rain	2	1.9
Total	105	100

Source: Field survey, 2016

4.1.15 Do you have enough food for your family through the year

The study found that the proportion 81% of the respondents do not have enough food for their families through the year which rank them as food insecure. table 4.1.15

Table (4.1.15) Do you have enough food for your family through the year

Enough food	Frequency	%
Yes	20	19
No	85	81
Total	105	100

Source: Field survey, 2016

4.1.16 if food is not enough, how do you make it available?

The study showed that in case of inadequate food, the respondents make it available by working off farm, animals sales, charcoal making and others representing 57.1%, 10.5, 28.6 and 3.8% each which confirm more efforts were exerted to make food available. Table 4.1.16.

Table (4.1.16) if food is not enough, how do you make it available?

Make available	Frequency	%
Off farm	60	57.1
Animal Sales	11	10.5
Charcoal Making	30	28.6
Others	4	3.8
Total	105	100

Source: Field survey, 2016

4.1.17 Animals ownership

The study found that 61.9% of the respondents have animals, some of which may be sold in times of stress and they benefit from milk in some cases, the proportion 38.1% do not have animals. Table 4.1.17

Table (4.1.17 animals' ownership

Ownership	Frequency	%
Yes	65	61.9
No	40	38.1
Total	105	100

Source: Field survey, 2016

4.1.18 Fruit collection

The study showed that the proportion 32.4% of the respondents are only interested in the process of compiling forest fruits and a little collected for the purpose of trade. The majority is collected for self-sufficiency, while the proportion 67.6% does not care of the process of compiling forest fruits. Table 4.1.18

Table (4.1.18) Fruits collection

Collection	Frequency	%
Yes	34	32.4
No	71	67.6
Total	105	100

Source: Field survey, 2016

4.1.19 Trees Fruit collected

The respondents used to collect *Ziziphus spina-christi*, *Blanites aegyptiaca*, *Blanites* and *Ziziphus*, *Grewia tenax* and *Adansonia digitata* representing 28.6%, 31.4, 9.5, 19 and 11.5 for each respectively, which gives additional source of income. Table 4.1.19

Table (4.1.19) Trees fruits collected

Tress fruits collection	Frequency	%
<i>Ziziphus spina-christi</i>	30	28.6
<i>Blanites aegyptiaca</i>	33	31.4
<i>Balanites & Ziziphus</i>	10	9.5
<i>Grewia tenax & Ziziphus</i>	20	19
<i>Grewia tenax & Adansonia digitata</i>	12	11.5
Total	105	100

Source: Field survey, 2016

4.2.1 Multiple Linear Regression Results,

Climatic data on average maximum temperature and total rainfall average rate of humidity were obtained from North Kordofan State Metrological Station (KMS) for years (2004– 2015) while crop total production and productivity data and prices of crops were sourced from North Kordofan State Ministry of Agriculture and Natural Resources. These data were analyzed to evaluate the impact of climate change on total crops production as well as food security. The results obtained in table (4.2.1). The regression analysis computed for the crops showed that millet, sorghum, groundnut, sesame, watermelon and Roselle have coefficient of determination (R²) of 62.5, 45, 22, 74, 33 and 80% respectively. This indicates that this variation can be explained by the climatic parameters (average maximum temperature, total rainfall and humidity rate) under study (Table 4.2.1). This result highlighted that climatic variables (average maximum

temperature and humidity rate) were negatively/significantly impacted millet as food crop and sesame as oil crop was negatively/ significantly being impacted by climatic variables mainly rainfall, Roselle as cash crop was negatively/ significantly being impacted by (average maximum temperature, total rainfall and humidity rate)at five percent from zero level. Climatic variables therefore, have strong and significance impact on all crops except groundnuts and water melon. This ensured that contribution of climate change through time is noticeable on food crops production mainly millet. This results goes with {(Dinar et al.(1998), Seo and Mendelssohn (2008),Mall et al. (2006) and Cline (2007)}. That climatic factors serve as direct inputs to agriculture, any change in climate factors is bound to have a significant impact on crop productivity and production. Studies have shown a significant effect of change in climatic factors on the average crop yield.

Table (4.2.1) Coefficients of Climate Change factors on cereal, oil and cash crops production in abuharaz adminstration .

Variable	Cereal Crops		Oil Crops		Cash Crops	
	Millet	Sorghum	Groundnut	Sesame	Watermelon	Roselle
Constant	0.006**	0.054	0.25	0.903	0.27	0.002**
Temperature (X ₁)	0.018**	0.127	0.186	0.646	0.527	0.031**
Humidity (X ₂)	0.026**	0.126	0.941	0.551	0.286	0.001**
Rainfall (X ₃)	0.086	0.506	0.737	0.024**	0.802	0.001**
R ²	62.5%	45%	22%	74%	33%	80%

** coefficients is significant at 0.05

$$Y_{Millet} = 86960 - 0.685X_1 - 1.32X_2 + 0.930X_3$$

$$Y_{Sorghum} = 86014 - 0.48X_1 - 1.003X_2 + 0.4X_3$$

$$Y_{Groundnut} = 51048 - 0.48X_1 - 0.054X_2 - 0.24X_3$$

$$Y_{Sesame} = -2625.9 + 0.092X_1 - 0.25X_2 + 1.09X_3$$

$$Y_{Watermelon} = 10361 - 0.20X_1 - 0.75X_2 + 0.16X_3$$

$$Y_{Roselle} = 3861 - 0.4X_1 - 1.75X_2 + 1.8X_3$$

4.2.2 Development of Crop Productivity and Climatic Variables in Abu-Haraz Administration (2004-2016 Cropping Season)

The crops were distributed to the group food, oil and cash crops and then applied the analysis to investigate the impact of climate variables on crops production across years.

Table 4.2.2 and figures (4.1, 4.2, 4.3 and 4.4) of Abu-Haraz Administration, showed that crop productivity varies from cropping season to another. The highest productivity of Millet (4038 ton) was in cropping season 2008/2009 while the lowest (213 ton) was in the cropping season 2004/2005 at average temperature 34.6, 35.2, and total rainfall equal 441 and 285 mm respectively. Sorghum produced highest (4859 ton) in cropping season 2008/2009 and lowest (707 ton) in 2004/2005 in the same climatic factors degree of Millet, this mean that the productivity increase with high rainfall and low temperature and decrease at low rainfall and high temperature. Highest production of Sesame (4598 ton) in cropping season 2007/2008 while the lowest (794 ton) in cropping season 2004/2005 at average temperature 35.2, 35.2, and total rainfall equal 562 and 285.9 mm respectively. Accordingly Groundnut showed the highest productivity (4052 ton) in the

cropping season 2008/2009 and lowest (725 ton) in 2013/2014 average temperature 34.6, 35.50c, and total rainfall equal 441 and 587.4mm respectively. The highest productivity of watermelon seed was (1117 ton) in 2010/2011 cropping season and the lowest was (52 ton) in 2004/2005, at average temperature 35.2, 35.60c, and total rainfall equal 265. and 285.9 mm respectively. With respect Roselle explored highest production (2271 ton) in cropping season 2007/2008 while the lowest was (142 ton) in cropping season 2004/2005, at average temperature 34.5, 35.20c and total rainfall equal 562 and 285.9 mm respectively. From table (4-24-1) the maximum average temperature for the period of growth of crop was (36 0 c) in cropping season 2005/2006 and the Lowest (34.5 0 c) in cropping season 2007/2008. Total rainfall for the period of crops growth showed that the highest annual rainfall (587.4 mm) in the cropping season 2013/2014 while the lowest was (242.1 mm) in cropping season 2005/2006; the highest Humidity percentage was 43% in 2013/2014 while lowest Humidity percentage was 37% in 2005/2006.

(4.2.2)

Table (4.1.21): Development of Crop production and Climatic Variables, in Abu-Haraz Administration (2004-2016 Cropping Seasons).

Year	Rain fall m.m	Temp.	Humidity%	millet /ton	Sorghum	Sesame	Ground nut	W.m. seed	Roselle
2004/5	285.9	35.2	39	213	707	794	1120	52	142
2005/6	242.1	36	37	1480	2576	1328	1302	917	601

2006/7	299.5	34.6	39	2763	4187	1408	3837	794	593
2007/8	562	34.5	41	2241	1222	4598	447		2271
2008/9	441	34.6	40	4038	4859	1575	4052	659	886
2009/10	322	35.6	39						
2010/11	265.6	35.6	38	1519	2676	1368	1342	1117	741
2011/12	459.9	34.9	42	424	595	1839	3193	668	209
2012/13	294	34.7	40	1580	1692	1912	789	788	306
2013/14	587.4	35.5	43	522	757	4380	725	118	228
2014/15	309.1	34.8	39	2790	4389	1609	3958	809	611
2015/16	308.4	34.9	39						

(Abu haraz administration, 2004)

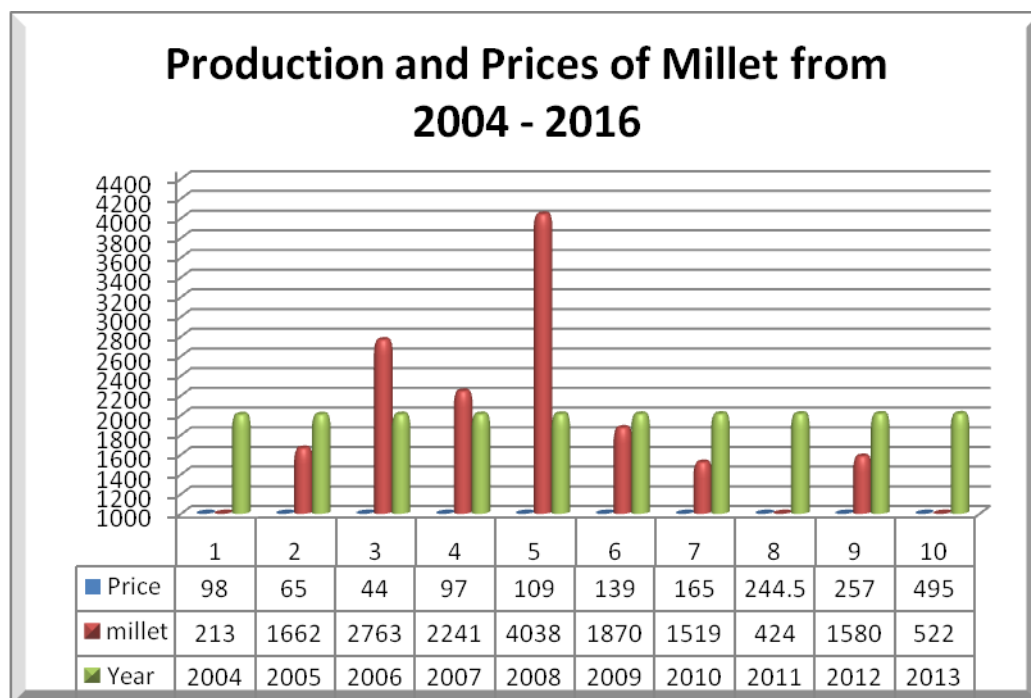


Fig. (4.1) production and prices of millet from 2004-2016

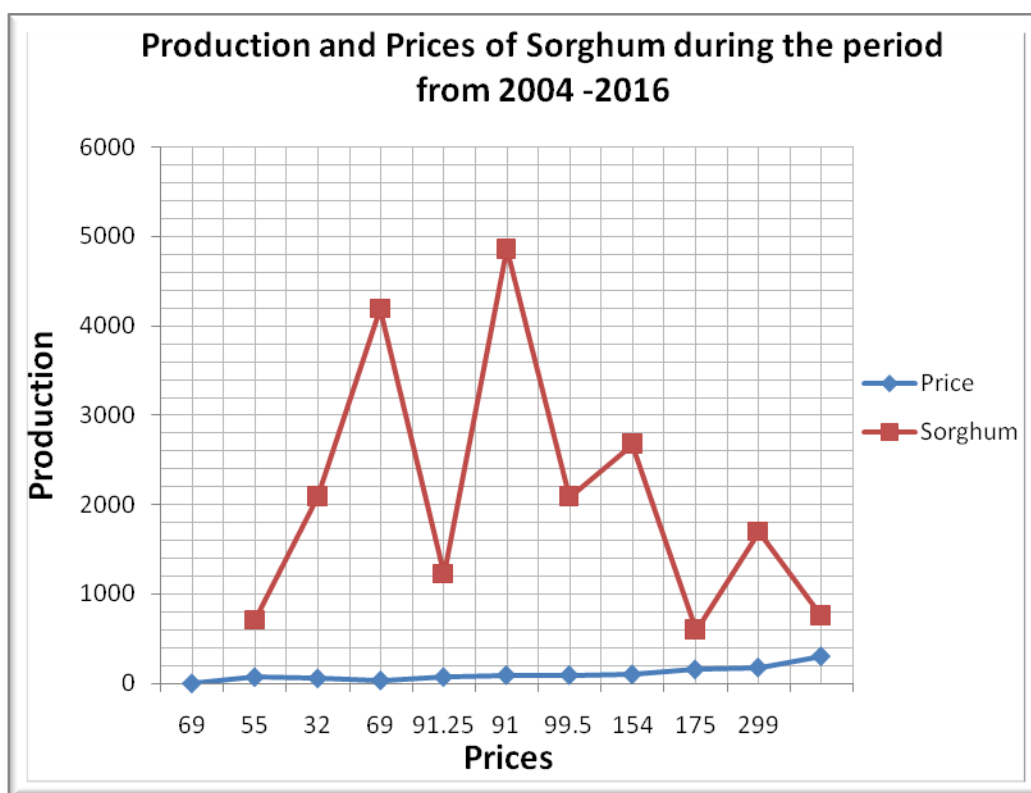


Fig. (4.2) production and prices of sorghum from 2004-2016

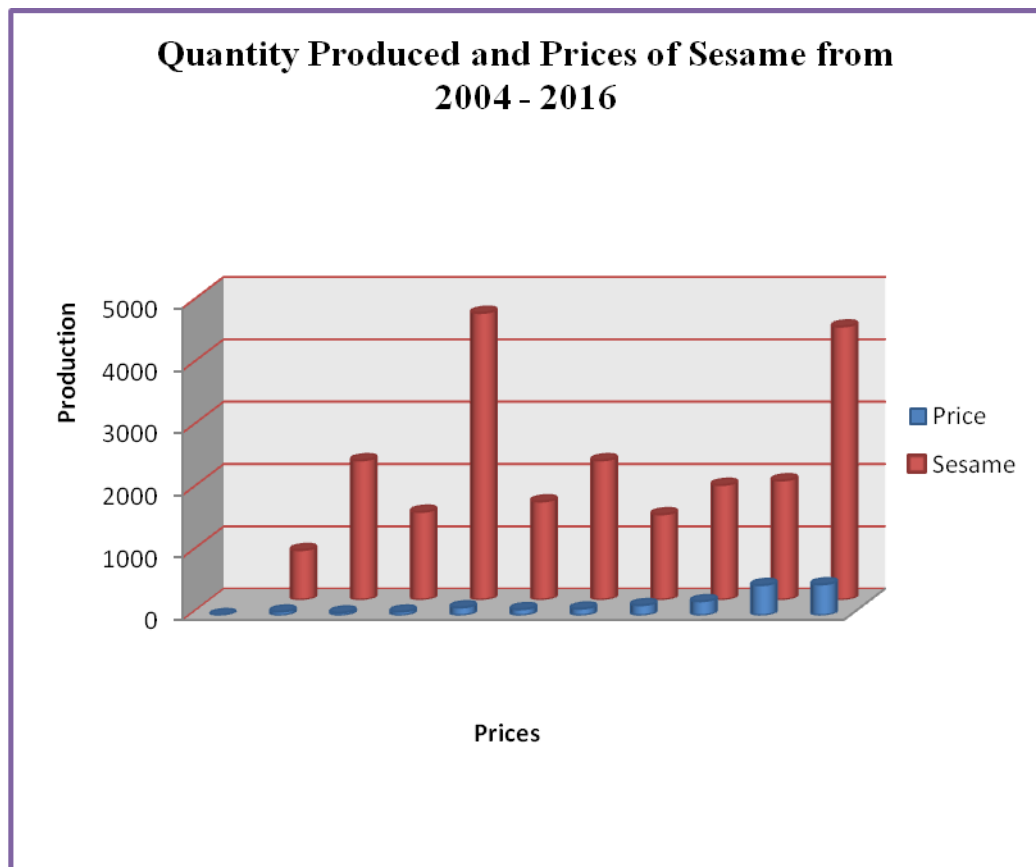


Fig. (4.3) production and prices of sesame from 2004-2016

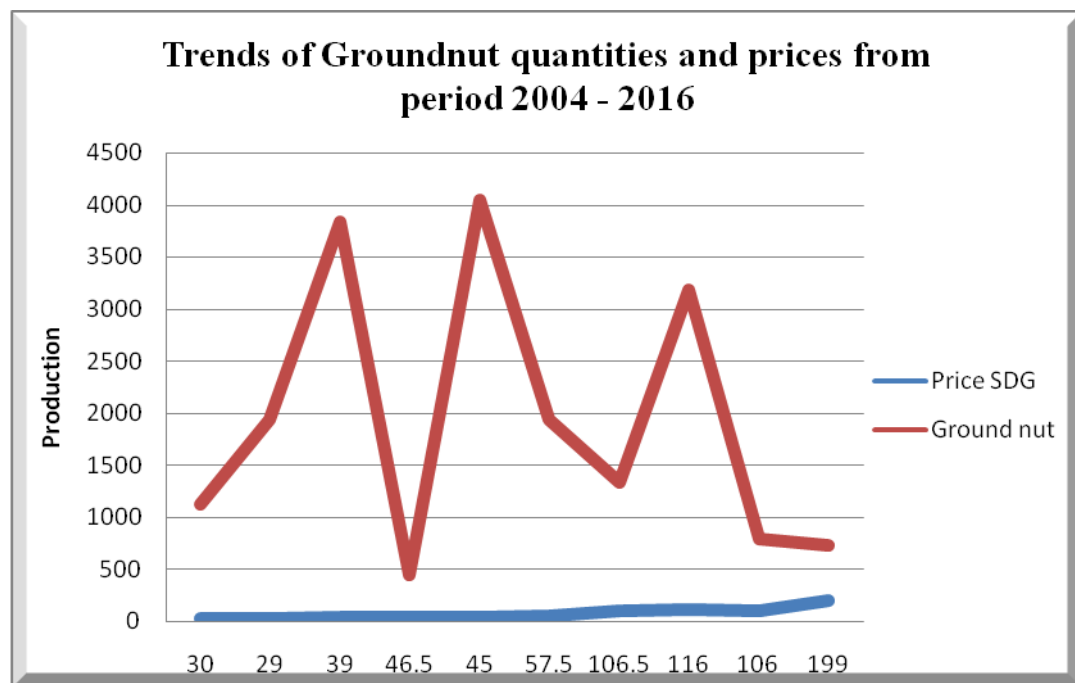


Fig. (4.4) production and prices of groundnuts from 2004-2016

4.3 Partial Crop Budget Model

Partial budgeting is a method of organizing experimental data and information about the cost and return of the various alternative treatments. Partial budgeting is concerned with limited change in farm plan, whereas complete or whole farm budgeting covers a wide range of change.

The partial budgets method is a practical way to compare changes in production costs and revenue since it requires minimal data compared to other budgets. It has been used largely when production systems are subject to change, to compare two or more alternative sets of production Practices, (yue, 2013). All systems under comparison must be under the same production conditions, have the same fixed cost and vary only in explicitly specified components. The main point is to calculate the net change in return, which subtracts the total cost from the total return. The key requirement for using the partial budgets method is to identify all the changes (positive and negative) produced by shifting from a standard input to a proposed alternative.

4.3.1 crop gross margin

Gross field return for each crop was calculated by multiplying the field price by the yield/kilogram. The field price of the crop was defined as the value of the farmer of an additional unit of production in the field, prior to harvest. It was calculated by taking the price that farmer receive (or can receive) for the crop when they sell it, and subtracting all costs associated with harvest and sale that are proportional to yield, that was, costs that can expressed per kilogram of crop (Briema, 2006). Statistical or economic analysis was done using standard units, on per/feddan basis, person man hours/feddan, yield kg/feddan, cost SDG/feddan, gross field return SDG/feddan and net returns SDG /feddan. The results of partial crop budget indicated positive gross margin of SDG For all localities.

4.3.2 Partial budget Results

The results revealed that, Sorghum, Sesame and millet accepted as best crops of SDG3, 271.73, 2,920.74 and 2,389.74 gross margins, while groundnuts, Cowpea, and Roselle came after with SDG1366.72, 551.77 and 364.73 respectively. Table (4.2.3). صاحب؟

Table (4.3.1): Partial Crop Budget for Abu-Haraz Administration by kg and SDG/Feddan

Item	SDG					
	Sorghum	Millet	G/N	Sesame	Roselle	Cowpea
Fertilizers	0.57	0.45	0.57	0.33	-	0.05
Seeds	22.44	21.10	170.76	26.57	3.99	7.29
Cultivation	56	53.24	54	75	-	-
first weeding	146.76	100	124	115.81	22.14	19.52
second weeding	106.10	100	141.24	164.64	27.02	26.33
harvesting	79	81.14	148.13	100.14	-	16.54
collecting	58	40	79	58	94	-
threshing	110.29	100.52	72.95	62.05	25.33	30.71
pesticide	2.52	2.84	3.19	6.10	0.19	0.24
deportation	24.48	21.77	29.52	20.05	3.5	3
sacks	15.05	10.69	7.97	5.54	-	-
Total cost	630.07	557.46	752.33	559.26	99.67	108.23

Yield (sacks/fed)	9.29	6.14	8.13	6.96	0.54	0.55
Field price	420	480	255	500	860	1200
Gross field output/Fed	3901.8	2947.2	2119.05	3480	464.4	660
Gross margin	3271.73	2389.74	1366.72	2920.74	364.73	551.77

Source: field survey 2016

Gross out put = yield * price

Gross margin = gross output- total variable

4.4.1 Linear programming analysis result:

Linear programming model tableau has been developed to determine the optimum cropping area to be cultivated for different crops to maximize the gross margin.

Table (4.4.1) linear programming tableau

Raw name	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	RSH?
Obj. function	3271.73	2389.74	1366.72	2920.74	364.73	551.77	
Land / fed	1	1	1	1	1	1	31.78
W.capital / SDG	630.07	557.46	752.33	559.29	99.69	105.33	2707
Labor/ MD	2.00	2.00	4.00	2.00	1.00	1.00	12

Source Survey (2016)

Were:

Obj = objective function, fed = feddan, SDG = Sudanese pound, MD = man day, W.capital = working capital.

The first row in the tableau, six crops were grown in this study area, X₁= Sorghum, X₂=Millet, X₃= groundnut X₄=Sesame, X₅= Roselle and X₆= Cowpea.

Objective function

The objective function represents the gross margin for the sorghum, millet, groundnut; sesame, Roselle and cowpea were SDG **3271.73, 2389.74, 1366.72, 2920.74, 364.73** and SDG **551.77** respectively.

4.4.2 Optimal solution of the linear programming model:

The optimum crops combination for the household in the study area was to cultivate 4.139 feddans of sesame and 3.721 feddan of cowpea to get a maximum total gross margin of SDG 14,142.05.

Table (4.4.2) optimal solution of the linear programming model in abu haraz administration:

Crop	Area/ feddan	Gross margin/Feddan	Value/SDG
X1	0	3271.73	0
X2	0	2389.74	0
X3	0	1366.72	0
X4	4.139	2920.74	12089.61
X5	0	364.73	0
X6	3.721	551.77	2053.44
Total			14143.05

4.5.1: Household food security situation in Abu-Haraz administration

Bichel (2000) stated that food security defined as access by all people at all times to enough food for an active, healthy life. In this report, households that meet a minimum of 2300 Kilocalories per person per day were considered as food secure. In the study area data were collected on household expenditure, quantities and type of foods, and number of days certain foods are consumed over a seven-day recall period, throughout the survey period. This information allows a calculation of household food security, based on kilocalorie (*K.cals*) intake data. The daily

energy received per person per day was calculated to be 1,888 K.cal so; households were border line or marginally food insecure. Table (4.5.1).

Table (4.5.1) household weekly minimum Food need and equivalent *K.cal* per person per day in Abu-Haraz Administration

Food item	Kcal /kg	Quantity/kg	Total Kcal
Millet	3350	1.06	3551
Sorghum	3350	1.24	4154
Wheat	3320	1.20	3984
Meat	2020	1.30	2626
Milk	660	3.20	2112
Sugar	4000	6.77	27080
Tea	1080	0.4	432
Coffee	685	0.43	294
Onion	410	3	1230
Oil	8840	1.00	8840
Salt	710	0.22	156
Okra	350	0.7	245
Vegetables	9000	1.80	16200
Rice	2000	0.60	1200
Macaroni	3350	.83	2780

Fruits	2080	9.00	18720
Total/H-H/Week	92,497		
Total/person/day	1,888		

Source: Field Survey,2016

CHAPTER V

CONCOLUTION AND RECOMMENDATIONS

5.1 Conclusion

This study tries to fill the existing research gap in the literature by examining the impact of climate variability and change and food security on farming activities in dry land agriculture.

- 63.8% of the farmers in the area were aware about climate changes.
- The results highlighted that climatic variables (average maximum temperature and humidity rate) were negatively/significantly impacted millet as food crop, and sesame as oil crop was negatively/ significantly being impacted by climatic variables mainly rainfall, Roselle as cash crop was negatively/ significantly being impacted by (average maximum temperature, total rainfall and humidity rate) at five percent from zero level. Climatic variables therefore, have strong and significance impact on all crops except groundnuts and water melon. This ensured that contribution of climate change through time is noticeable on food crops production mainly millet.
- 47.6% and 30% of the farmers mentioned the causal factors of climate change were high temperature and low rainfall respectively.
- Adaptation measures taken by farmers were crops diversification against climate change.
- Groundnuts and water melon were the most adaptive crops with higher net revenue and less sensitive to climate change.
- The analysis implies that climate change (average temperature, total rainfall and humidity rate) has a negative effect on crop production and productivity in the study area.

- 81% of the farmers mentioned, they don't have enough food for their families through the year. This is why the quantity of cereals ratio consumed by the respondents was 1888 K. cal. per person per day lower than the recommended ratio of 2300 k. cal. per person per day, so they were food insecure.
- The results revealed that, Sorghum, Sesame and millet accepted as best crops of SDG3, 271.73, 2,920.74 and 2,389.74 gross margins, while groundnuts, Cowpea, and Roselle came after with SDG1366.72, 551.77 and 364.73 respectively
- The optimum crops combination for the household in the study area was to cultivate 4.139 feddans of sesame and 3.721 feddan of cowpea to get a maximum total gross margin of SDG 14,142.05.

Recommendations

To reducing climate change effect and ensuring food security; The study recommended that:

- Farmers should adjust their crop combination to adapt climate change by adopting the optimum crop combination.
- Farmers should include groundnuts and water melon in their crop combination because of their high returns and climate adaptation.
- Further research and funds needed for climate change mitigation and adaptation should be encouraged in the study area.
- Awareness raising programs should be built up for farmers and local people regarding climate change and food production issues.

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بسم الله الرحمن الرحيم

Data collection form on the effects of climate change on crop production to improve the
standard of living and food security in North Kordofan State - Shikan Local -
Administrative Abuhraz

1. Basic data:

Form No. Management

2. Demographic data:

Family size Number of males Number of females Basic profession

Secondary profession Annual Income LE / Sudanese.

3. Marital Status 1. Married () 2. Single () 3. Divorced () 4. Widow () If you are married
how many wives are

4. Have you heard of climate change by yes ()?

If yes, please mention

- Education:

Are there any schools in the area? Yes No Do you have school students? Yes () No () Do
you have left school? Yes () No, Yes If yes, specify reasons: Post-school () High fees ()
Lack of desire () Other ()

Have schools been affected by climate change? Yes () No () Yes Specify the type of
impact

6 - Type of house: Brick (straw), House ownership: King (rent) (How many rooms in the
house

7- Income sources axis:

What are your main sources of income: 1- 2- 3-
.....

8. Crops:

Do you practice agriculture? 1. Yes. 2. No (). If yes, you own agricultural land 1. Yes ()

2. No (). Property Type: 1. Property 2. Rent 3. Partnership

How much is the area owned by the fifth

9 - mention areas and production of crops grown during the year 2015 and 2016.

The name of the year 2015 crop is 2016

Area / feddan production / mobile area / feddan production / mobile
Maize
millet
Beans
Sesame
The hibiscus
Cowpea

10 - What are the most important environmental, natural and economic factors affecting the production of crops in the region? Sort by importance:

1. Flood 2. Lack of rain. Weak fertility of soil 5. Increase soil moisture 6. High temperature 7. Price fluctuation 8. Others / Select
.....

Production costs per feddan of the following crops:

Crop Seed Fertilizer Pesticide Herb Cutter Cutter Punch Other Pigs / Select
Maize
millet
Beans
Sesame
Rugby
Cowpea

12. Do you have enough family food this year? Yes No Do you have production inputs (seeds / pesticides / fertilizers) 1. Yes 2. No In the case of insufficient food or inputs how do you provide it? 1 2 3.

.....

13. Livestock:

Do you own animals? Yes No In case of yes, check with ()): Cattle () Sheep () (goats) (horses) () Donkeys (). Proceeds from livestock sales per year

.....

Have your animals been affected by diseases and climatic changes (heat, dryness, humidity, etc.)? Yes. 2. No ().

14. Forests:

Is the collection of forest fruits: Yes () No () In the case of Yes What is, ..., ... How many are sold in the year?

15. Food and nutrition:

Types of food consumed per week:

Item	Type	Quantity	Unit	Price
Maize				
millet				
Wheat				
The wick				
the meat				
Milk				
the salt				
the oil				
Fish				
Sugar				
Tea				

Coffee
eggs
the fruit
Vermicelli
Macaroni
Vegetables





بسم الله الرحمن الرحيم

استمارة جمع بيانات عن آثار التغيرات المناخية على انتاج المحاصيل لتحسين مستوى المعيشة والامن الغذائي بولاية شمال كردفان
– محلية شيكان – إدارية أبو حراز

1. البيانات الأساسية:

رقم الإستمارة..... الإدارية.....

2. البيانات الديموغرافية:

حجم الأسرة..... عدد الذكور..... عدد الإناث..... المهنة الأساسية..... المهنة الثانوية..... الدخل السنوي..... جنسه/سوداني.

3- الحالة الاجتماعية.... 1. متزوج () 2. عازب () 3. مطلق () 4. أرمل () إذا كنت متزوج كم عدد الزوجات

4- هل سمعت بالتغيرات المناخية من قبل نعم () لا () .

إذا كانت الإجابة بنعم أذكرها

5- محور التعليم:

هل توجد مدارس بالمنطقة ؟ نعم () لا () هل لديك طلاب بالمدارس ؟ نعم () لا () هل لديك من تركوا المدارس ؟ نعم () لا () ، إذا كانت نعم أذكر الأسباب : بعد المدرسة () إرتفاع الرسوم () عدم الرغبة () أخرى ()

هل تأثرت المدارس بالتغيرات المناخية : نعم () لا () إذا كانت نعم حدد نوع الأثر

6- نوع المنزل : طوب () قش () ، ملكية المنزل : ملك () إيجار () كم عدد الغرف بالمنزل

7- محور مصادر الدخل:

ماهي مصادر دخلك الرئيسية: 1- 2- 3-

8- المحاصيل الزراعية:

هل تمارس حرفة الزراعة؟ 1. نعم () 2. لا () . في حالة نعم هل تمتلك اراضي زراعية 1. نعم () 2. لا () . نوع الملكية: 1. ملك..... 2. إيجار 3. شراكة.....

كم تبلغ المساحة المملوكة بالمخمس

9- أذكر المساحات والإنتاج من المحاصيل المزروعة خلال العام 2015 والعام 2016م.

العام 2016		العام 2015		اسم المحصول
الانتاج/جوال	المساحة/فدان	الانتاج/جوال	المساحة/فدان	
				الذرة
				الدخن
				الفول
				السمسم
				الكردي
				اللوبياء

10- ماهي أهم العوامل البيئية والطبيعية والاقتصادية التي تؤثر علي انتاج المحاصيل بالمنطقة رتب حسب الأهمية:

1. الفيضانات..... 2. قلة الأمطار..... 3. كثرة الأمطار..... 4. ضعف خصوبة التربة..... 5. زيادة رطوبة التربة..... 6. ارتفاع درجة الحرارة..... 7. تذبذب الاسعار..... 8. أخرى / حدد.....

11- تكاليف الانتاج للفدان الواحد من المحاصيل التالية:

المحصول	البذور	الأسمدة	المبيدات	الحش	الكديب	القطع	الدق	الترحيل	أخرى/حدد
الذرة									
الدخن									
الفول									
السمسم									
الكردي									
اللوبياء									

- 12- هل لديك غذاء يكفي للأسرة هذا العام؟ نعم لا هل لديك مدخلات انتاج (بذور/مبيدات/ أسمده) 1. نعم 2. لا في حالة عدم كفاية الغذاء أو المدخلات كيف توفر ذلك؟
1..... 2..... 3.....

13- الثروة الحيوانية:

- هل تمتلك حيوانات؟ نعم لا في حالة نعم حدد بعلامة (√): أبقار () ضأن () إبل () ماعز () خيول () دواجن () حمير () .الدخل من المباع للثروة الحيوانية في السنة
هل تأثرت حيواناتك بسبب الأمراض والتغيرات المناخية (حرارة, جفاف, رطوبة, أخرى/حدد) 1. نعم () . 2. لا () .

14- الغابات :

- هل تتم عملية تجميع الثمار الغابية : نعم () لا () في حالة نعم ماهي ،
، وكم يبلغ المباع منها في السنة؟

15- الغذاء والتغذية:

مانوع الغذاء المستهلك وكمياته في الأسبوع:

نوع السلعة	الكمية	سعر الوحدة
الذرة		
الدخن		
القمح		
الويكة		
اللحم		
اللبن		

		الملح
		الزيت
		السمك
		السكر
		الشاي
		البن
		البيض
		الفاكهة
		الشعيرية
		المكرونة
		الخضروات

النواقص :