

**THE IMPLICATIONS OF CLIMATE CHANGE ON SUBSISTANCE CROP
PRODUCTION, A CASE STUDY OF JUBA COUNTY,
SOUTH SUDAN**

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**RESEARCH PROPOSAL SUBMITTED TO THE COLLEGE OF APPLIED SCIENCES
AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE AWARD OF DEGREE OF SCIENCES IN ENVIRONMENTAL MANAGEMENT
OF KAMPALA INTERNATIONAL UNIVERSITY**

OCTOBER, 2014

DECLARATION

I KANG DENG RUEY do declare that to the best of my knowledge and ability this proposal is my original work and has never been presented to any institution for any academic award.

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APPROVAL

This proposal is to be submitted to the College of Applied Sciences and Technology Kampala International University under my supervision as the University supervisor.

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DEDICATION

This research proposal is dedicated to my beloved family members especially my uncle peter Jengmir Yat who supported me since my primary level to date and my wife Nyakong Gatwech Lual for their steadfast love they had showed me throughout my academic life. Special thanks to my sponsor Every Village South Sudan and Peter Jingmir Yat for their financial support I am greatly indebted to them.

ACKNOWLEDGEMENTS

First of all, I would like to thank The EveryVillage South Sudan for their financial support for sponsoring my Bsc in Environmental Management study here in Kampala International University. I would like to express my deepest gratitude to my supervisor, Mrs. Abong Betty for her guidance and continuous follow up in the entire process of the research work without which this research could not have been possible.

During my field work, I also got much assistance from Juba county farmers, chiefs, environmental officers, and agricultural extension officers. I would like to use this opportunity to thank them all. Especially, I am grateful to farmers of the study area who participated in this research.

Special thanks go to my friends Dak Bol Deng from Ulang County, Kueth Thiwat Dhol from Maiwut County, Upper Nile State South Sudan, Kaze Simplicie from Burundi and Aporo Denish from Uganda for their unreserved support and encouragements in the study period. My gratitude also goes to Peter Jingmir Yat and Simon Gatluak Wichien for their encouragement and support to me and my family at all times.

I would also like to express my profound gratefulness to my mother Nyareath Yat Bukjiok Thoar and my late father Deng Ruey Jang for helping me strive towards the realization of my potentials. Special thanks go to my younger brother Chudier Deng Ruey for his patience in his study.

Last but not least, my deepest gratefulness to my beloved wife Nyakong Gatwech Lual and our kids Goanar Kang Deng and Liep Kang Deng for all the inconveniences you have encountered during my absence and your wonderful support and patience during my stay away from home. Nyakong thank you so much for your endurance in shouldering family responsibilities. Finally, may the Almighty God be blessed for providing me this opportunity, and giving me the strength to start and go through with my study.

LIST OF ACRONYMS

IPCC	Intergovernmental Panel on Climate Change
FAO	United Nations Food Agriculture Organization
FEWS NET USAID	Famine Early Warning Systems Network
USAID	United States Agency for International Development
WFP	World Food Program
MAF	Ministry of Agriculture and Forestry
LAF	Livelihood Analysis Forum
IPC	Integrated Food Security Phase Classification
CAD	County Agriculture Department
CBO	Community-based organization
UNCERF	United Nations Central Emergency Response Fund
CFSAM	Crop and Food Supply Assessment Mission
CLiMIS	Crop and livestock market information system
CMV	Cassava mosaic disease
DRM	Disaster risk management
DRR	Disaster risk reduction
ECHO	European Commission Humanitarian Aid Department
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer field school
FSL	Food Security and Livelihoods
FSTS	Food Security Technical Secretariat
IPDM	Integrated pest and disease management
SSSA	Seed system security assessment
MOE	Ministry of Environment

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ABSTRACT

Unlike many areas of the world where agricultural producers exhibit the physical, economic and social resources to moderate, or adapt, subsistence agriculture in the Juba County South Sudan is seem to be particularly vulnerable to the impacts of climatic variability. This is in part due to the fact that the majority of the population depends on rain-fed agriculture for their livelihood. Adapting to climate change in the subsistence agricultural sector is therefore very imperative in providing food security and concomitantly protecting the livelihood of rural communities. This study examined the patterns of current climatic variables on some selected subsistence staple crops namely; millet and sorghum in the Juba County South Sudan. It also valorized and documented the community based adaptation strategies used by local farmers to cope with current climate change, explored the constraints and opportunities in adaptation and mitigation that could facilely be integrated and incorporated into policies and programs. The guiding premises were that climatic change impacts subsistence crop yields as the lower the rainfall, the higher the vulnerability of the yields of staple crops. It also hypothesized that the present community-based strategies used by the local farmers are relevant and crucial to the present day quest for climate change adaptation strategies. A participatory research approach was used in exploring adaptation patterns perceived by the rural areas in the face of variable climatic condition via administered questionnaires. The results suggested critical impact asymmetries due to climatic and socio-economic factors affected subsistence crops in the South Sudan. However, other factors such as increased droughts, floods and water shortages have undoubtedly caused enormous impacts on the agricultural system as seen in remote sensing analyses. Questionnaire survey findings also connoted that subsistence farming communities have a rich repertoire of strategies ranging from changing of planting dates, changing of crop varieties, switching from crops to livestock, use of local indicators, movement from rural to urban areas, increment in cultivated lands, irrigation soil conservation practices among many others as they perceive varying climatic conditions. Additionally, some of these indigenous strategies are inherent in ecological agricultural practices that offer a win-win scenario for the simultaneously tackling of climate change adaptation and mitigation and hence meeting the development goals. The results further highlighted the weather hazards, pest problems as some of the factors hindering subsistence farmers' ability to adapt. The study concluded that adaptation measures in subsistence agriculture were highly significant for poverty reduction, thus improving on the

wellbeing of the rural areas. The key to the ability of farmers to adapt would be access to relevant knowledge and information. Following the rich repertoire of strategies by local farmers, adaptation needed to be mainstreamed and institutional networks strengthened in order for effective community based adaptation.

CHAPTER ONE

INTRODUCTION

1.1. Introduction

This chapter explains the implication of climate change on subsistence crop production in Juba County, South Sudan and includes background of the study, problem statement, and purpose of the study, the goal of the study, objectives, and research questions, scope of the study, justification and limitation.

1.2 Background of the study

Several parts of Juba County, South Sudan have been devastated by decades of conflict, which have resulted in the implication of climate change on subsistence crop production, destruction of physical and human resources, and erosion of institutions and social capital. The various outbreaks of violence, including ongoing instability in the Darfur region, have forced millions of people to flee their homes and left millions of others facing extreme poverty implication. The conflict has been exacerbated by recurrent hazards, including droughts, floods, and outbreaks of climate change, which worsen the food security crop production situation throughout the Juba County, South Sudan.

The signing of the Comprehensive Peace Agreement (CPA) in 2005 signaled the end of the protracted conflict in Juba County, South Sudan. The Agreement provides for six years of joint rule before a referendum in 2011 to determine whether the South Sudan will continue as an autonomous part of the Sudan or form an independent sovereign state. The CPA also includes special provisions for South Sudan (also referred to as the Transitional Areas). The area has remained volatile since the signing of the CPA and the delay in implementing the Protocol led to a crisis in May 2008, with the destruction of property, environment, and loss of life and displacement of people which resulted to extreme climate change on subsistence crop production. There has been some improvement in the situation following the signing of the South Sudan Road map and formation of the Juba County Area Administration. However, this has an insufficient budget for providing services to local communities.

Within the context of the Agreement, the United Nations (UN) and its partners have generally reoriented their programmes towards recovery and development, while remaining ready to respond to humanitarian needs, such as those caused by floods. The situation in the Juba South Sudan remains a large-scale humanitarian emergency as the conflict is yet to be resolved. The result of this is ongoing disruption of the surrounding environment, economic and social arenas, and a heavy toll in terms of loss of life, the climate change on subsistence crop production since trees were destroyed to give space for fighting.

The agriculture sector plays an important role in Juba County, South Sudan's growth, industrialization, exports and environment, and contributes more than 39 percent to GDP. Agricultural activities and livestock rearing are the main sources of livelihood for an estimated 60 to 80 percent of the population. Agriculture in the Sudan comprises both subsistence farming and commercial production for local consumption and export. Traditionally, agropastoralism not only represents the primary production system, but also involves the majority of the Sudanese population. Approximately one-third of the total area of the Sudan is suitable for agriculture, yet only about 21 percent of arable land is cultivated. Despite its predominant position in the overall economy of the Sudan, agricultural productivity is variable and output remains far below potential performance.

Sorghum, millet and wheat are the major staple foods produced and are primarily consumed domestically. Crop cultivation is divided between a modern, market-oriented sector comprising mechanized, large-scale irrigated and rainfed farming (mainly in Juba County, South- Sudan), and small-scale farming following traditional practices, which is carried out in parts of the country where rainfall or other water sources allow for cultivation.

The climate change on subsistence crop production has resulted to total cereal production in the country accounts for about 35 percent of annual grain requirements, the balance being mainly imported wheat. Owing to the importance of these food grains in the population's diets, their price levels are crucial for determining people's access to food. This is especially critical given the already high and increasing poverty levels, especially in rural areas. Since the second half of

2009, the prices of staple foods have seen a continued upward trend compared with the longer-term average. This often further limits access to food by vulnerable groups, who may depend on markets to meet most or all of their food needs. This situation is likely to continue deteriorating until the next harvest between October and December 2010.

Animal production is an important livelihood activity throughout the Juba County, South- Sudan, with the county boasting the largest herd in Sudan. Livestock (and their associated products) are key capital assets, mitigating the implication of climate change of drought and crop failure. They are also important social capital for pastoralists. In the Juba, South-Sudan, livestock production contributes an average of 20.5 percent of the total value of national exports, more than 28 percent of agricultural exports and over 18 percent of GDP (federal Ministry of Animal Resources and Fisheries (MARF)).

About 29 percent of the Juba County South-Sudan's land area was covered by forests and the contribution of the subsector to subsistence crop production livelihoods and the national economy should not be underestimated. Forest resources account for 71 percent of energy consumption, more than 30 percent of livestock feed, and 15 percent of possible livelihood opportunities in rural areas. Forests also provide indirect benefits, including environmental and watershed protection, and soil conservation and enhancement. People that derive their livelihoods from the subsector include traditional gatherers of firewood and producers of charcoal (the main source of fuel for homes and some industries in urban areas). There is also a modern timber and sawmilling industry, which is state owned. However, the country's forests are being rapidly depleted – for building materials, firewood, charcoal, and burning bricks – particularly in areas around internally displaced person (IDP) camps and urban centers.

Competition over land and natural resources has long been a source of tension between various groups in the Sudan, and remains a central issue for both rural and urban communities. Before 1970, unregistered land belonged to the state, which held ownership in trust for the people, who had customary rights to it. In 1970, the Unregistered Land Act declared that all waste, forest, and unregistered lands were government land. Before the act's passage, the Government had avoided

interfering with individual customary rights to unregistered land, and in the late 1980s, it again adhered to this policy. The area of land used for pasture and subsistence cultivation was communally owned under customary land laws that varied somewhat according to location but followed a broadly similar pattern. In agricultural communities, the right to cultivate an area of unused land became vested in the individual who cleared it for use. The rights to such land could be passed on to heirs, but ordinarily the land could not be sold or otherwise disposed of.

The Sudan has a coastline of 720 km². The useable area of the continental shelf is about 9, 800 km², of which 800 km² is suitable for trawling. The rest is used for traditional fishing. Marine fisheries resources include commercial finfish, ornamental fish, pearl oysters, trochus and other gastropods. Sudanese fisheries are artisan and conventional. Although freshwater aquaculture is not developed, the Sudan has considerable potential in terms of land, water, warm weather and fish species that are suitable for aquaculture.

Fishing was traditionally a largely subsistence activity. A number of small operators also used the country's major reservoirs in the more populated central region and the rivers to catch fish for sale locally and in nearby urban centers. However, the few modern fishing ventures – mainly on Lake Nubia and along the Red Sea – were small. Freshwater fisheries resources include the River Nile and its tributaries, natural and artificial pools of water (hafirs), irrigation canals and temporary streams. Within this area, these resources are concentrated in dam reservoirs and the Sudd region. Some 115 species and 29 genera of fish are present in the dams and reservoirs, and the available stock is estimated at 140 000 tones annually.

1.3. Problem Statements

Juba County South-Sudan are characterized by general underdevelopment, poverty and an influx of returnees, who have overstretched the already limited capacities of infrastructure and services in the communities to which they return, making them vulnerable to natural and human-induced shocks. However, the recovery and re-establishment of livelihoods have been hampered by persistent implication of climate change on subsistence crop production, instability and political tension. The reintegration of demobilized and demilitarized ex-combatants, women and

children associated with armed groups continues to be a priority for the Food Security and Livelihoods (FSL) Cluster. The implication of climate change on subsistence crop production in South Sudan is the main problem in the livelihood strategies especially in crop production and livestock rearing. The implication of climate change on subsistence crop production has resulted to the changes in dry season, the collection of firewood, burning of charcoal, and collection of thatching grass and wild fruits serve as key coping mechanisms in the implication of climate change on subsistence crop production. Food insecurity is predominantly linked to prolonged dry spells and displacement resulting from recurrent conflicts over unresolved border disputes and the use of natural resources by farmers and pastoralists.

South Sudan Livelihoods are mainly based on crop and livestock production, with food insecurity predominantly caused by dry spells, floods, and the presence of large numbers of returnees and refugees this as result of climate change. The region continues to host large numbers of refugees from Sudan, Eritrea and Ethiopia, as well as a significant number of IDPs who cannot return to their places of origin owing to the presence of mines and unexploded ordnance which resulted to climate change. Ongoing efforts to disarm and demobilize ex-combatants have increased the need for support to their reintegration and re-establishment of their livelihoods. The majority of people's livelihoods are agricultural, pastoral and agro pastoral. The main factor underlying food insecurity is drought, which negatively affects rain fed crop production and pastures in the state. Desertification and the large number of returnees and refugees also impact on food security. The implication of climate change on subsistence crop production has resulted to the occurrence of drought, floods and pests is expected to continue in some areas, damaging the production and livelihoods of rural and urban people and increasing dependence on external assistance and negative coping strategies this is as result of climate change. It is expected that food production will diminish over the coming years owing to consecutive natural disasters and the impact of conflicts, leading to food shortages and food insecurity. This will require an increase in life- and livelihood-saving measures. The number of food-insecure people in need of assistance is likely to lead to heavy dependence on direct food aid. In 2009; rainfall was generally poor, characterized by a late start, early finish, and less than

average precipitation during the main part of the season. This resulted in a shortened season, with an uneven distribution of less rain than usual in all states of South Sudan.

According to the 2009 CFSAm, the national expected cereal areas harvested will decrease for all three main cereal crops, culminating in a harvested area of 7.5 million hectares compared with 9.4 million hectares harvested in 2008. In particular, the low level of production (33 percent lower than last year's estimate and 30 percent lower than the average estimate for the previous five years) in 2009 is seriously impacting on the food-security situation in most parts of South Sudan as stocks are depleted before the harvest in October/November 2010.

1.4 Purpose of the study

The main purpose of the study will be to establish the implication of climate change on subsistence crop production, to enable Juba County South Sudan to overcome climate change, get means of improving subsistence crop production , be able to view current climate change and establish people knowledge on climate change .

1.5 The Goal of the study

The major Goal will be to obtain and identify the implication of climate change on subsistence crop production.

1.6 Specific Objectives

1. To examine the implication of climate change on subsistence crop production in Juba county South Sudan.
2. To investigate how the changes on subsistence crop production has affected peoples livelihood in Juba county South Sudan.
3. To determine how the farmers are coping with the challenges of climate change.

1.7. Research Questions

- (i) What are the subsistence crops produced in Juba County?
- (ii) What are the methods of production involved?
- (iii) How have the climate change factors affected crops production in Juba County?
- (iv) What is the people's livelihood activities related to the crops produced?
- (v) How have the crop production changes affected the livelihood of the people?
- (vi) How can climate changes impacts can be mitigate?

1.8. Scope of the study

This will specify the boundaries of the research. **Time scope:** the research will take a period of 5 months from January to August of year 2013 **Content scope** will concentrate on implication of climate change on subsistence crop production . **Geographical scope:** the study will take place in Juba county South Sudan

1.9. Justification of the study

- 1) The study will help the Juba county South Sudan to easily identify the implication of climate change on subsistence crop production in the area.
- 2) It will help people to keep and maintain subsistence crop production
- 3) Juba County will be able to know the implication of climate change on subsistence crop production.
- 4) The study will help the researchers to learn and have more knowledge about implication of climate change on subsistence crop production.
- 5) It will help researchers attain Bachelor of Sciences in Environmental Management since its one of the requirement for the award of the Degree.

1.10. Limitations of the study:

The study ought to face a lot of limitations that may affect its smooth running and hence may not be finished in the required time. These are;

- 1) Some of the people who will to be interviewed may be in their farms, which delay the researcher will have to move to the next stage of the project.

- 2) The project will be costly in terms of finance, accrued from transport.
- 3) It will be difficult to convince some of the people about the implication of climate change on subsistence crop production

Definition of Key terms used

What follows below are the definitions of some of the key terminologies used in this research.

FAO

Borrowing the definition of Mary Kaldor (2007/08) in the Food Agricultural Organization publication by Oxford University Press, FAO is defined as “the medium through which food agricultural organization network are overseas in the World and the centers of agriculture authority”. In this study shall be treated as representatives. Therefore the terms FAO shall be interchangeably use throughout this research.

CPA

The signing of the Comprehensive Peace Agreement (CPA) in 2005 signaled the end of the protracted conflict in Juba County and South Sudan at large. The Agreement provides for six years of joint rule before a referendum in 2011 to determine whether the South will continue as an autonomous part of the Sudan or form an independent sovereign state.

CSFAM

The 2009 Crop and Food Supply Assessment mission (CSFAM) estimated the level of production in North Sudan to be 33 percent lower than the 2008 estimate, and 30 percent lower than the average estimate for the previous five years, due to poor rains in the main rained production areas and poor performance in the irrigated sector.

Climate Change Implication

Gerald M. Steinber (2003) defined climate change as autonomous non-productive session and changes in rain session affiliated that advance a particular cause or set of causes in an area. Deborah Eade (2007) further calls climate change as sub species of much dry session, dating to back to the ancient philosophers of Greece. For this study, climate change will include big

change in the environment that often plays an intermediary role because of their changes capacity.

SSSA

Therefore, FAO proposes that a Seed System Security Assessment (SSSA) be conducted in 2010–12 to review the formal and informal seed systems on which farmers depend. The SSSA will examine whether seeds of adequate quality are available and accessible to farmers. This approach promotes strategic thinking about the wider vision for relief, recovery and development.

Development

Todaro and Smith (2006), defined development as a multidimensional process involving major changes in social structures, popular attitudes and national institutions as well as the acceleration of economic growth, the reduction of inequality and eradication of poverty. For the purpose of this research, the rural citizen in the selected Juba County of this study defines development as the qualitative positive change from a better to bad state in the quality of life, and the enjoyment of basic needs of life.

Sustainability

Dempster (1998) in David W. Chapman et al (2006) define sustainability as the ability of an activity or system to persist. For the purpose of this research, sustainability is defined as the ability of climate change programs to create environment that continue to deteriorating and impact on the beneficiaries even after the study are wound up.

UNDP

(United Nations Development Programme [UNDP], 2010).

CAHW

Community animal health workers (CAHWs), who interact closely with rural livestock owners, has sought to address this weakness, but their role should be more grounded in the needs of the

community and a more holistic approach should be the protracted crisis has meant that the Sudan is currently the largest operation globally, with the international community providing USD 1.3 billion in humanitarian assistance during 2009

Grassroots

The term grassroots in this research is defined to mean the lowest level of administration and normally this is at the village level, presumably targeted by the study to cause social and economic change.

Empowerment

For this research empowerment is defined as the progressive ability by an individual or community through external assistance to advance in skills development and in the quality of services provided cross social and economic indicators of development.

Active poor and the very poor

Term used by Juba People, to mean poor people but those involved in some activity- trying to help themselves. The term very poor is defined by the same study to refer to a category of people who are not able to meet their own basic needs.

IPCC

IPCC, 2007. Implication of Climate change on subsistence crop production 2007: stated that The projections of future rainfall generated by the model show significant declines in rainfall by 2050 and 2080 for South Sudan compared to current conditions respectively.

UNOHCA

(United Nations Office for the Coordination of Humanitarian Affairs [UNOHCA], July 2010). Insecurity has a serious impact on the delivery of this assistance

CHAPTER TWO

RELATED LITERATURE REVIEW

2.1 Introduction

This chapter emphasizes the review of existing literature basing on the stated objectives. It reviews the past work for other researchers, the methodologies they used, and all in all the definition of the objectives while relating it to the design of the implication of climate change on subsistence crop production.

2.2 Climate change implication in Sudan

According to Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., and Jarvis, A. 2005. Very high resolution interpolated implication on climate change on subsistence crop production surfaces for global land areas. *International Journal of Climatology* 25: 1965–1978. 24 IPCC. 2007. *Implication of Climate change on subsistence crop production 2007*: stated that the projections of future rainfall generated by the model show significant declines in rainfall by 2050 and 2080 for Southern Sudan compared to current conditions respectively. The sample of farms included in the study shown they will be affected by these changes. For the farms under consideration, the model predicts decreases of up to 33% of current rainfall by 2050 and up to 48% by 2080, with the largest reductions occurring in the central region. Slight increases in rainfall are predicted for a farm in Luderitz district, in the south west coastal area. Most of the farms in the Karas, Hardap and Erongo regions currently fall into the rainfall range of 111–234mm/year, with some receiving up to 271mm/year. By 2080, most of these farms will receive less than 153mm/year. In the Khomas region, current rainfall ranges from 196 to 478mm/year. By 2080, this range shifts to 111–271mm/year. Most of the farms in the Sudan region currently receive between 308 and 478mm/year, which is expected to fall to 154–307mm/year by 2080. Farms in the Otjizondjupa and Oshikoto regions currently receive between 390 and 569mm/year. This range will decline to between 235 and 433mm/year by 2080. Mean annual rainfall across Namibia by 2080, according to predictions generated by the model adopted in this study.

The projections of future mean temperature generated by the model used in this study show significant increases in temperature by 2050 and 2080 for Namibia compared to current conditions. For the farms considered, the predicted increases in temperature range between 0.4 to 3.7°C by 2050 and between 0.8 to 5°C by 2080, with the greatest increases occurring in the east, and the smallest along the west coast.

2.3 Climate change implication on farm revenues

According to Conroy and Kwala, (2006) Climate change found to have a significant implication on revenue per hectare, the implication of climate change on revenue per hectare consider only the projected changes in rainfall. However, it is important to note that the indirect effects of an increase in temperature, such as lower humidity, increased evaporation and lower soil moisture, are taken into account in the model but are likely to have a compounding effect on water availability to farmers. By applying the above climate change predictions to the model, substantial declines in revenue were forecasted for the majority of farms in this study.

Revenue per hectare is projected to decrease by up to 42% of its current value by 2050, and up to 59% by 2080, with the largest reductions occurring in Southern Sudan. The average predicted change in revenue across the sample of farms is a loss of 28% of current revenue by 2050 and a loss of 42% by 2080. A slight increase in revenue per hectare of 9% is predicted for one farm in the Luderitz district, which will see increasing rainfall. Revenue per hectare in the current and future time periods. The consequences of losses in revenue on this scale are alarming. The mean revenue for farms included in this study is N\$218/ha, and the mean area is 9,420ha. This amounts to an average loss of about N\$575,000 per farm by 2050 and about N\$860,000 per farm by 2080. Such large reductions in income will be devastating to farmers. If losses of this scale are experienced by all commercial land owners in Namibia, of which there are approximately 4,200, the losses to the economy resulting from climate change effects on commercial farming would be in the region of several billion Namibian dollars per year by 2080. Of course, this study has made a number of simplifying assumptions, one of which is that land use remains constant over time, and is based on values for revenue per hectare that are computed using current prices, therefore failing to take into account changes in prices of agricultural output that will inevitably

occur over time. In addition, it should be noted that the climate change predictions discussed here are those of a single general circulation model for one scenario of future development, and may differ from the results produced by other models and assuming a different development pathway.

2.4 Threshold effects on subsistence crop production

According to Mendelsohn (2006) important threshold factor to consider is whether the proportional effect of rainfall on agricultural productivity is really the same at all levels of rainfall. The results of this study suggest that a one percent reduction in rainfall would result in a 1.36% reduction in revenue per hectare, all other factors being equal. However, this does not take into account threshold effects that may occur if a farming system is currently operating at the lowest limit of rainfall at which production can be sustained.

Cattle farming take place in regions with a mean annual rainfall of between 150mm and 550mm, with only nomadic pastoralist being viable at the lower end of this rainfall range, and small stock farming is practiced in regions with mean rainfall of 100 to 250mm/year. The climate predictions generated by the model used in this study suggest that rainfall will decline to below 154mm/year in large parts of the Khomasand Omaheke regions by 2080, and to below 196mm/year in large parts of the Otjozondjupa region. Cattle farming, which is currently the dominant land use in these regions (Mendelsohn, 2006), will become non viable under the projected rainfall conditions for large areas in these regions. Mean rainfall is predicted to decline to less than 111mm/year over much of the Karas and Hardap regions, and to less than 49mm/year in the far south and west. The loss of grass cover that will result from these decreases will render much of these regions unsuitable for small stock farming, which is currently the dominant agricultural activity (Mendelsohn, 2006).

The productivity of livestock farming systems in Namibia generally is strongly constrained by rainfall, with stocking rates increasing in years of good rainfall and decreasing in years of drought (Mendelsohn, 2006). As a result, revenue generated per hectare of land used for livestock farming depends directly on rainfall. This is probably not the case for trophy hunting

and wildlife viewing tourism, where revenues depend on the number of tourists and not directly on the number of animals that the land can support. Wildlife are better adapted to arid conditions, and trophy hunting only removes a small percentage of the wildlife population (about one percent of the national wildlife stock; Brown, 2005).

2.5 Challenges of the implication on climate change on subsistence crop production

According to FAO report (2008). Beyond relief: Food security in protracted crises, many parts of the Sudan has suffered frequent periods of acute food insecurity, as well as chronic food insecurity, for decades. The causes are mainly related to conflict, but are also the result of natural disasters. The protracted crisis affecting many rural people results from chronic poverty, caused by long-term political and economic marginalization, environmental degradation and the increasing incidence of drought. The result has been a more or less permanent state of severe food insecurity with alarming declines in measures of human wellbeing, such as health and nutrition. An estimated 20 percent of the nearly 37 million people in the Sudan are chronically undernourished. Over the past decade, despite considerable economic and agricultural potential, between 1.5 and 3 million people have required some form of food aid each year (Food insecurity remains essentially a rural phenomenon linked to the fragility of rural livelihoods. In North Sudan, agriculture is characterized by four categories of farming system: irrigated, semi-mechanized, rainfed traditional, and livestock. The highest levels of poverty and food insecurity are recorded among traditional, rainfed farmers and pastoralists (World Bank, 2003). In North Sudan,

Protracted crises are defined as situations in which large sections of the population face acute threats to life and livelihoods over an extended period with the state and other governance institutions failing to provide adequate levels of protection or support. Flores et al., 2005

Darfur, Red Sea, southern parts of Southern Kordofan and parts of Blue Nile, Kassala and North Kordofan states face moderate to high levels of food insecurity due to poor harvests in 2009 and the ongoing conflict in Darfur.

For FAO, the impact of the Darfur crisis is a powerful demonstration of what happens to rural livelihoods in protracted crises. The initial years of the conflict were marked by the rapid destruction of livelihoods as millions of people became displaced when their villages were attacked or threatened. Pastoralists in North Darfur lost over half their livestock in the first three years of the conflict. As the crisis drew on, assets continued to be lost through a gradual process of erosion and livelihood options inevitably became fewer and more restricted. Many people became dependent on marginal subsistence activities. Rural people could not migrate for work or send remittances home, which had a serious impact on their livelihoods in the initial stages of the conflict. Furthermore, competition between pastoralists and farmers over the natural resource base in Darfur intensified as both groups become increasingly dependent on strategies such as collecting grass and firewood to replace pre-conflict livelihood strategies that were no longer possible.

The protracted crisis has meant that the Sudan is currently the largest operation globally, with the international community providing USD 1.3 billion in humanitarian assistance during 2009 (United Nations Office for the Coordination of Humanitarian Affairs [UNOHCA], July 2010). Insecurity has a serious impact on the delivery of this assistance and, in 2009, the expulsion of 13 international and dissolution of three national Non-governmental Organizations (NGOs) from Darfur severely constrained the provision of support to populations in need.

Food insecurity-triggering factors implication

The current socio-economic, political and environmental situation in the Sudan has resulted in chronic food insecurity, increased poverty levels and high levels of vulnerability. The main underlying factors contributing to this vulnerability are: (i) insecurity; (ii) dwindling agricultural production; (iii) reduced livestock production and productivity; (iv) recurrent natural disasters, particularly floods and droughts; (v) land tenure/use issues and the effects of environmental degradation/ desertification; (vi) limited economic opportunities; (vii) institutional factors/limited Government support; and (viii) the high number of IDPs.

Insecurity on food production

Insecurity, associated with ongoing conflicts in North Sudan, has led to the displacement of millions of people, some of whom continue to reside in camps and depend on humanitarian assistance for their survival. Ongoing insecurity and instability in parts of the country, particularly in the Darfur region, have negatively affected humanitarian operations, local food production and people's coping mechanisms. The prolonged conflicts (between Southern and North Sudan, in Darfur, and with the Eastern Front) displaced rural farming communities and destroyed infrastructure, impacting on agricultural production. Insecurity related to clashes between nomadic and settled farming communities has led to the destruction of crops and vegetation, as well as the loss of human lives (and therefore the labor force).

Dwindling agricultural production in Juba

The main constraints facing the agriculture sector include: limited water resources, a fragile land base, declining soil fertility, climatic shocks, and high levels of pest infestation, the use of poor quality seeds, unstable product prices, and conflicts over land and water resources. The unfavorable climatic conditions, and associated challenges for crop and livestock production, worsen food insecurity in most states, stretching the limits of communities' coping mechanisms. The current low levels of production are further worsening the food-security status of affected communities in North Sudan.

Agricultural production is also affected by: (i) a lack of essential agricultural inputs and machinery owing to the disruption of markets and distribution channels, which have forced farmers to use low quality inputs, particularly seeds and tools, and resulted in significant production losses; and (ii) poor soil and environmental management, which have led to low productivity for all the factors of production. Other constraints to production include the disruption of the extension system and plant protection capacity, which limit the transfer of essential modern technologies to farmers, and the lack of control of crop pests and diseases, which lead to heavy pre- and post-harvest losses.

Crop production is major activity in the Sudan, and is based on both rain fed agriculture and irrigation for the mechanized farms. However, production is hindered by a number of problems, including drought. The 2009 Crop and Food Supply Assessment mission (CSFAM) estimated the level of production in North Sudan to be 33 percent lower than the 2008 estimate, and 30 percent lower than the average estimate for the previous five years, due to poor rains in the main rainfed production areas and poor performance in the irrigated sector.

most farmers in North Sudan plant local landrace varieties or unimproved seeds owing to the inaccessibility and cost of certified grades produced by the commercial subsector. This is a key factor in the low yields normally obtained by farmers.

Reduced livestock production and productivity

Livestock production is an important component of the local economy, providing food, employment, foreign exchange earnings, a source of wealth, and supply of inputs and services, such as draught power, manure and transport. The prevalence of diseases limits livestock productivity through morbidity and mortality, which results in the loss of meat, milk, eggs, wool, skin and hides, manure and animal traction (Tambi, E.N., maina, O.W., mukhebi, A.W., and Randolph, T.P.). Livestock rearing follows predominantly traditional methods and is carried out throughout the Sudan, with the exception of the extremely dry areas of the North and the tsetse fly-infested area in the far south. Given its importance in providing employment for large numbers of people, modernization proposals have been based on improving existing practices and marketing for export, rather than moving towards modern ranching, which requires fewer workers.

Overall, livestock rearing is the second livelihood activity and the country has over 138 million head of domestic, food- providing animals (including cattle, sheep, goats and camels). The nomadic range system forms the backbone of beef production in the Sudan. Cattle are regarded, not as a primary source of income, milk and meat, but as a source of social prestige that depends on quantity irrespective of quality. This leads to overstocking and overgrazing, with long journeys in search of pasture and water resulting in lower productivity and quality (tough meat), competition over resources, and tribal conflicts that create instability. Rainfall fluctuations can

result in drought and the loss of livestock, or endemic diseases accompanied by heavy parasitic infestations that lower productivity and prevent livestock exports.

The livestock subsector faces numerous constraints, including a heavy disease burden, low productivity exacerbated by drought and insecurity, the lack of adequate marketing infrastructure, and poorly organized and informed livestock owners and traders.

In terms of animal health, considerable knowledge is unused by poorer farmers, either because it resides with professionals to whom they have little access, or because it is not presented in an easily understood format. The growth in training programmes for community animal health workers (CAHWs), who interact closely with rural livestock owners, has sought to address this weakness, but their role should be more grounded in the needs of the community and a more holistic approach should be used, moving beyond the original function of CAHWs.

Unfavorable climatic factors, deforestation and climate change

Natural disasters are recurrent in the Sudan and the droughts of 1983–84, 1997–98 and 2000–01 displaced large numbers of people and had a devastating effect on the agriculture sector. Drought and floods in some parts of the country result in the loss of agriculture and livestock assets, land degradation, food insecurity, shortages of animal fodder, and outbreaks of animal and plant pests and diseases. The Darfur region, Eastern Sudan, and Khartoum and Northern states continue to be affected by drought and floods.

Severe environmental issues, land degradation, deforestation, desertification and other effects of climate change affect the Sudan, threatening sustainable peace and development (United Nations Development Programme [UNDP], 2010). Over 60 percent of the country is affected by deforestation and desertification, with much of Northern, Eastern and central Sudan having lost or rapidly losing existing forest resources. The combined effects of drought and desertification in the Sudan, as in other Sahelian countries, have led to severe food shortages and famine over the years. A key cause of this is deforestation and overgrazing, particularly near urban centres and settlements such as IDP and refugee camps.

Dwindling livelihood options have forced many people to resort to collecting and selling already scarce natural resources. Strategies such as brick making, charcoal burning and fuel wood collection are unsustainable and place considerable pressure on the environment. Competition over limited resources has resulted in conflict throughout the Sudan. According to the United Nations Environment Programme (UNEP) 2003, there are clear links between environmental problems and the ongoing conflict in the Darfur region, as well as with other historical and current conflicts in the Sudan.

Limited economic opportunities

Lack of infrastructure has had a negative impact on food security, for example by limiting the marketing possibilities for moving food from surplus to food-deficit areas. Economic opportunities are also restricted by:

Limited economic assets: Limited roads infrastructure, bridges, water sources, agricultural and livestock markets, and other farm assets have direct and indirect negative impacts on economic opportunities for the people of South Sudan. Basic infrastructure is crucial for accessing markets, collecting agricultural inputs, and selling surplus produce which are important for agricultural growth and the improvement of household economies.

Loss of opportunities: Insecurity and risk of landmines restrict human movement, resulting in less investment and limited use of fertile agricultural land. In many locations, households are confined to limited land areas, cultivating only for subsistence, while large fertile fields remain uncultivated for years. Opportunities are also lost because of a lack of transparency and good

NEP, (2007), Sudan post-conflict environmental assessment report

Governance, lack of or inadequate funds and micro-credit facilities, or dominance of traditional production systems with weak technical, managerial and financial capacities. In addition, the lack of appropriate adaptive research and technology transfer, resulting in adoption and use of outdated production technologies in the agriculture sector, needs to be resolved.

Disruption of trade routes and communication: This is reflected in high transport costs, which inhibit trade and the distribution of food and production inputs. Poor market access and market infrastructure, as well as weak physical infrastructure (rural roads network) increase the cost and reduce the efficiency of agricultural recovery and development programmes.

Institutional issues

The Sudan has experienced conflicts for much of the time since its independence in 1956. While these often have religious, linguistic and ethnic overtones, at their core lies the issue of considerable inequality between the centre – dominated by Khartoum and the North, particularly the villages

Despite a decentralized Government structure, resources allocated to public institutions diminish through the administrative lines. Although, in practice, this set-up is designed to provide Government institutions with a direct implementing role in the delivery of public services over the long term, the resources available to these institutions are limited.

Key constraints linked to the food security institutional set-up in North Sudan include: (i) the duplication of mandates and functions, and poor coordination; (ii) weak linkages between federal and state ministries; (iii) weak institutions that are not in a position to deliver expected services; and (iv) project-based external support, which creates an unsustainable, parallel information system and does not contribute to the creation of national systems. This is exacerbated by inappropriate policies – in place before the conflicts – that focus on large-scale mechanized agriculture and irrigation instead of developing the smallholder farming sector.

Other institutional challenges that affect food security include the Sudan's over-dependence on oil revenue, which is intrinsically temporary and unreliable; macroeconomic deterioration; fiscal volatility and laxity; and Government lapses. Food security prospects are also affected by the large and rapidly growing public sector, which is impeding the development of a robust private sector. The fundamental challenges to the country's prosperity are unlikely to be the above economic factors and are, rather, deep-seated political issues. All indications are that the Sudan needs to undertake considerable food security and related policy and institutional reforms

in order to join the ranks of countries that have successfully managed non-renewable resource wealth.

High number of IDPs

The Sudan has a total population of about 39.2 million people, of who 7.5 million are in Darfur and 8.3 million in Southern Sudan. Approximately 4.9 million people are internally displaced as a result of the country's various conflicts, making up the largest internally displaced population in the world. The food security and livelihoods of IDPs, returnees, nomads, refugees, and rural resident communities are continually undermined by the prolonged disruption and loss of economic activities, decreasing agricultural production, limited opportunities, and reduced livestock production. Overall, the country's population is young, with 47 percent below 17 years of age (Central Bureau of Statistics of Sudan, 2009).

Cross-border issues

Insecurity in neighboring countries has led to the implication of climate change on crop production due to influx of refugees, placing further strain on available resources. In addition, border issues that affect the food security and agriculture sector include the spread of livestock and crop diseases due to unchecked/uncontrolled movement of livestock and planting materials to and from neighboring countries. Most pastoralists normally cross borders to neighboring countries seeking water and pasture for their livestock. This leads to the spread of diseases and pests across borders. However, in the case of border disputes and conflicts, nomads prefer not to cross borders, which lead to overgrazing owing to the concentration of animals, and shortages of water and pasture, igniting conflicts due to competition over resources. This may also cause the marginalization of border areas leading to problems in dealing with transboundary diseases.

2.6 Food security scenario in north Sudan

In 2010, the food security situation in the Darfur region, Red Sea and Southern Kordofan states, and the Transitional Areas is expected to worsen, driven by the impact of a poor harvest in 2009–2010, chronic food insecurity, continued conflict in Darfur, high food prices and reduced cash crop production. Unfavorable climatic conditions and associated challenges to crop and

livestock production are likely to exacerbate the situation in most states, stretching communities' diminishing coping mechanisms beyond their limit. The current low levels of food production point to a deteriorating food-security status among affected communities in North Sudan, with the situation likely to further worsen as the season becomes drier and limited resources are used up. See Figure 2 for a food security-related situation analysis.

Figure 2 - Food security-related situation analysis

Government policies

The Government is relying on aid agencies to support the population; although at the end of 2009, it implemented a cereal subsidy programme to lower or stabilize prices. However the programme has been affected by the lack of coordination with other actors.

Under nutrition

The Sudan has some of the highest prevalence rates of under nutrition. According to national estimates, 31 percent of children under five are underweight, 14 percent are wasted and 32.5 percent are stunted. These figures hide significant Food security information for decision-making (www.foodsec.org) for Sudan, May 2010. subnational and seasonal variations. The prevalence of moderately underweight children is estimated at 38.4 percent in Kassala, 39.6 percent in North Darfur and 19 percent in Red Sea state. In Eastern Sudan, wasting among children ranged from 19.7 to 30.8 percent in different localities. Localized surveys on micronutrient status report that night blindness caused by Vitamin A deficiency ranges from less than 1 to 4.8 percent. Under nutrition not only increases vulnerability to disease and death, it diminishes learning capacity and productivity, locking vulnerable households into a cycle of poverty and undermining sustainable livelihoods.

Malnutrition and micronutrient deficiencies among children are linked to a poor intake of nutritionally balanced diets, chronic household food insecurity, infectious diseases, and poor health services and sanitation. The Sudan Household Survey noted that poor community awareness and health care-seeking behaviors aggravate a situation characterized by extremely high rates of maternal and child mortality.

High prices for food commodities have left about 76 percent of the resource-limited rural population facing serious food insecurity and a threat to their very survival. Most farmers are producing below their subsistence requirements. Vulnerability and under nutrition among food-insecure populations are inextricably linked to a variety of social, political and economic factors, including limited opportunities and constraints to crop, livestock and fisheries production.

2.7 Future priorities Based on the situation analysis

A combination of insecurity and instability, natural disasters, chronic poverty and general underdevelopment continues to leave many people across North Sudan vulnerable to food and livelihood insecurity. Considering the humanitarian needs of the targeted populations, the security situation and context analysis in North Sudan, FSL Cluster support needs to reach the most vulnerable including IDPs, returnees, DDR participants, and resident households facing poor food security and food production, limited livelihoods and economic activities. Given the factors that trigger food insecurity, FAO's emergency and rehabilitation programme needs to address the following key issues:

2.8 Dwindling agricultural production

In North Sudan, most farmers lost their seeds and sources of other planting materials during the conflict, which resulted in the destruction of their traditional seed preservation systems. In emergency contexts, farmers mainly use seeds provided by humanitarian agencies, as opposed to normal seeds that are saved at home/on-farm. Over the years, FAO and other FSL actors have been implementing the following seed-related programmes: (i) direct seed distribution; (ii) market-based seed support using seed vouchers and fairs in selected target areas; and (iii) support to farm trials of seed varieties, basic seed multiplication, local community-based seed production, seed cleaning using the Agricultural Research Stations, and group or individual contract seed growers.

The introduction of seed vouchers and fairs by FAO and its partners in some areas in which local seeds are available indicated that the seed interventions of FAO have impacted on the seed business, owing to the recycling and production of improved versions. The seed production and

restoration programme that was introduced in South Darfur included the establishment of a seeds laboratory and seed certification at the Nyala Agricultural Research Station, and training of technicians and over 600 contract farmers in seed production. These activities have enabled farmers to restore their traditional seed system, as well as encouraging the seed markets within the state. For over a decade, FAO has been at the forefront in providing emergency seed aid to IDPs, returnees and other vulnerable community members. To-date in North Sudan, over 300 000 vulnerable households have received emergency seeds and tools, mainly through direct distribution, and support for seed multiplication activities. In addition, FAO has recently focused on re-collecting and channeling locally adapted crop varieties into general seed and tool distributions.

Community-based seed production and supply schemes have been initiated to increase the availability of and access to, and improve the quality and timely delivery of locally produced seeds. This has been done jointly with the State ministry of Agriculture, the National Seed Corporation, national and international NGOs, CBOs and farmers' groups. The emergency seed interventions, together with other seed security activities (such as community-based production and supply chains), are part of FAO's efforts to ensure seed and food security, as well as restore the livelihoods, of farming households.

Seed inputs

Seeds are vital to agricultural production because they determine what farmers grow, harvest and save as seed for the next season. Although the provision of high quality seeds facilitates the recovery of agricultural production systems, continued seed assistance can suppress the local economy and undermine indigenous and re-emerging market systems.

In the context of over six years of emergency seed provision in North Sudan, there is a need to review related activities to improve the effectiveness of resource use and sustainability of seed system interventions. An assessment would justify the need to either continue seed support or move completely away from this and continue diversification efforts (i.e. strengthen local seed systems and support other livelihood interventions). There is, therefore, a need to conduct a seed security assessment.

Cash crop seeds

The distribution of cash crop seeds, like groundnut, watermelon, tomato and onion, has increased crop diversification and reduced monocropping, which was very common in previous years. In 2009, support enabled farmers to harvest more than three crops from one plot, dramatically increasing their income. For example, one farmer in Srafi village of North Darfur obtained SDG 3 000 from one feddan of watermelon crop, which is a very good amount.

Seed security

Seed security in North Sudan has been unpredictable due to the impact of protracted civil conflict, inter- and intra-ethnic clashes and the challenge of pests and diseases. There is currently a gap in understanding the specific problems of seed security in North Sudan (i.e. whether the key constraint is the low availability of seeds, lack of access to seeds, or poor seed quality). It is essential for aid agencies and local agriculture offices to understand the key elements of seed security, including their availability, farmers' access to seeds, and quality issues related to viability/purity, adaptability and farmers' varietal preferences. Geographic and agro ecological diversity require the selection of seed types and varieties that are suitable to the environment.

The seed security situation in North Sudan is not clearly understood because there have been limited assessments (such as the Catholic Relief Services study in West Darfur state) that have specifically focused on ascertaining the seed-security situation. Therefore, FAO proposes that a Seed System Security Assessment (SSSA) be conducted in 2010–12 to review the formal and informal seed systems on which farmers depend. The SSSA will examine whether seeds of adequate quality are available and accessible to farmers. This approach promotes strategic thinking about the wider vision for relief, recovery and development.

An SSSA goes well beyond a conventional seeds' needs assessment as it explores the constraints communities face and steers response activities to alleviate these problems and often improve systems. The overall objective of the proposed SSSA will be to improve the food security and livelihoods of vulnerable farming households by identifying strategies to address acute and chronic seed insecurity.

Conservation agriculture (CA)

CA aims to achieve sustainable and profitable agriculture and, therefore, to improve the livelihoods of farmers, through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations. CA holds tremendous potential for all sizes of farms and agro ecological systems, but its adoption is perhaps most urgently required by smallholder farmers, especially those facing acute labour shortages. It combines profitable agricultural production with environmental concerns and sustainability and has been proven to work in a variety of agro ecological zones and farming systems. For this reason, FAO is actively involved in promoting CA, which combines the expertise of different technical areas in an integrated manner, and aims to promote its implementation throughout the Sudan as it touches on a number of key issues related to declining agricultural production.

2.9 Reduced livestock production and productivity

Livestock has the potential to make an important contribution to food security and the social and economic wellbeing of the Sudanese population. It is the backbone of livelihoods in all sub-systems (nomadic, agro pastoral and agricultural) and should therefore be a central element in the overall intervention strategy to address the humanitarian and food security situation in the region.

The priorities in North Sudan are: (i) vaccination and treatment of livestock; (ii) training and equipping of CAHWs and consolidation of the community-based animal health system; (iii) establishment of fodder banks and improvement of livestock supplementary feeding, especially during the dry season (animal feed preparation, balanced animal feeding); (iv) construction/rehabilitation of water points along migratory routes; (v) pasture and rangeland rehabilitation (pasture seed broadcasting, enclosure establishment); (vi) support to demarcation/rehabilitation of migratory routes; (vii) rehabilitation and equipping of veterinary clinics; (viii) enhancement of animal disease surveillance systems; (ix) beekeeping; (x) fisheries promotion through training on net-making, boat-making, fish processing; (xi) capacity building of local institutions; and (xii) raising awareness of and promoting the production of poor livestock owners and communities.

Environmental impact

The impact of environment-related activities is gradual. However, the nurseries rehabilitated have increased seedling production capacity and will meet the seedling requirements of other areas in the coming years to promote tree planting. Environmental education, community forest and community management practices initiated in some areas have stimulated understanding/knowledge about environmental conservation. The significant number of seedlings planted in 2010 has increased the size of areas covered with trees.

This has been done through the provision of fuel-efficient stoves, development of community forests and carrying out of a comprehensive study to address fuel wood shortages and associated deforestation around major settlements in Darfur.

In the Transitional Areas and Eastern Sudan, FAO has been involved in the implementation of environment-related activities such as the production, distribution and planting of tree seedlings, production and distribution of fuel-efficient stoves, construction/rehabilitation of water points and pastures along migratory routes, and fencing of rehabilitated rangeland to restore and protect the degraded environment. Interventions by FAO and other FSL actors have been significant but have not met the enormous needs, which have been compounded by desertification, drought and the unsustainable use of natural resources, especially forest products, in areas surrounding IDP camps, trading centers and towns. Concerted efforts are needed to sensitize communities and intervene in ways that will promote the sustainable use of natural resources and the protection and restoration of the environment.

2.10 Economic Factors

The 2009 Humanitarian Policy Group report indicated that although livelihoods strategies have considerably diversified since 2004, options remain limited and are insufficient to meet people's basic needs. Livelihoods in North Sudan are based on crop cultivation and livestock rearing/keeping. FAO's programme has focused on promoting livelihoods' diversification and technology transfers in areas that are prone to hazards and disaster risks.

Livestock marketing needs to be considered in the future, as well as the development of an agreed plan between neighboring countries that ensures smooth and fair marketing practices.

FAO-North Sudan procures inputs (seeds, tools and equipment) mainly from within the country, with the exception of those that are not produced or manufactured in the Sudan. A good example is the local production of hoes, donkey-/ ox-ploughs and carts by blacksmiths in many parts of North Sudan. FAO has been promoting the local manufacture of donkey-ploughs and hand tools in support of rural farming communities that lost their assets during the conflict. In 2009, 39 090 donkey-ploughs, hand tools (hoes) and hand weeders were manufactured locally. This enabled farmers to use ploughs and hand tools that are specific to and suitable for their farming conditions and practices. With more spare time, local blacksmiths were able to concentrate on improving their skills. Highly skilled blacksmiths have developed stronger and more efficient agricultural tools that further contributed to increased agricultural production.

CHAPTER THREE

METHODOLOGY

3.1 Study area

3.1.1 Location

The research was carried out in Juba County, Central Equatoria State; South Sudan. The Juba County, South Sudan lies between latitude and longitude of 4° 51' 0" N / 31° 36' 0" It is the largest county in Central Equatoria and one of the largest in the entire region of Equatoria. Its county seat is Juba, the state capital of Central Equatoria and the national capital of the Republic of South Sudan. Its population according to the disputed 2008 census conducted by the Republic of the Sudan, prior to South Sudanese independence, was 372,413.

The county also includes part of Bandingilo National Park in its northeast. It borders Terekaka County to its north and Lainya and Kajo Keji counties to its south, as well as Mundri East and Mundri West counties in the state of Western Equatoria to its west, and Eastern Equatoria, namely Lapon, Magwi, and Torit counties, to its east.

3.1.2 Topography

The landscape is the flat and is prone to flooding, although the city itself lies on higher ground than the surrounding plains. The city lies close to the confluence of the Lol River with the Pongo River. The average elevation of the city of Juba is about 425 meters (1,394 ft) above sea level. During the rainy season, the plain-dwellers seek refuge on higher ground in the city of Juba.

3.1.3 Socio-political aspect

Politically, socially and economically Juba is the most peaceful State in South Sudan's ten States. Having been so peaceful State in South Sudan is contributed to the following things in the State, economic boost and bumping is growing forward, secondly Juba are not affected by any decision making to cause them a problem among themselves, and they have no issues like cattle raiding, ethnic violence or tribal violence are not there, they people beliefs that, their only problem can be

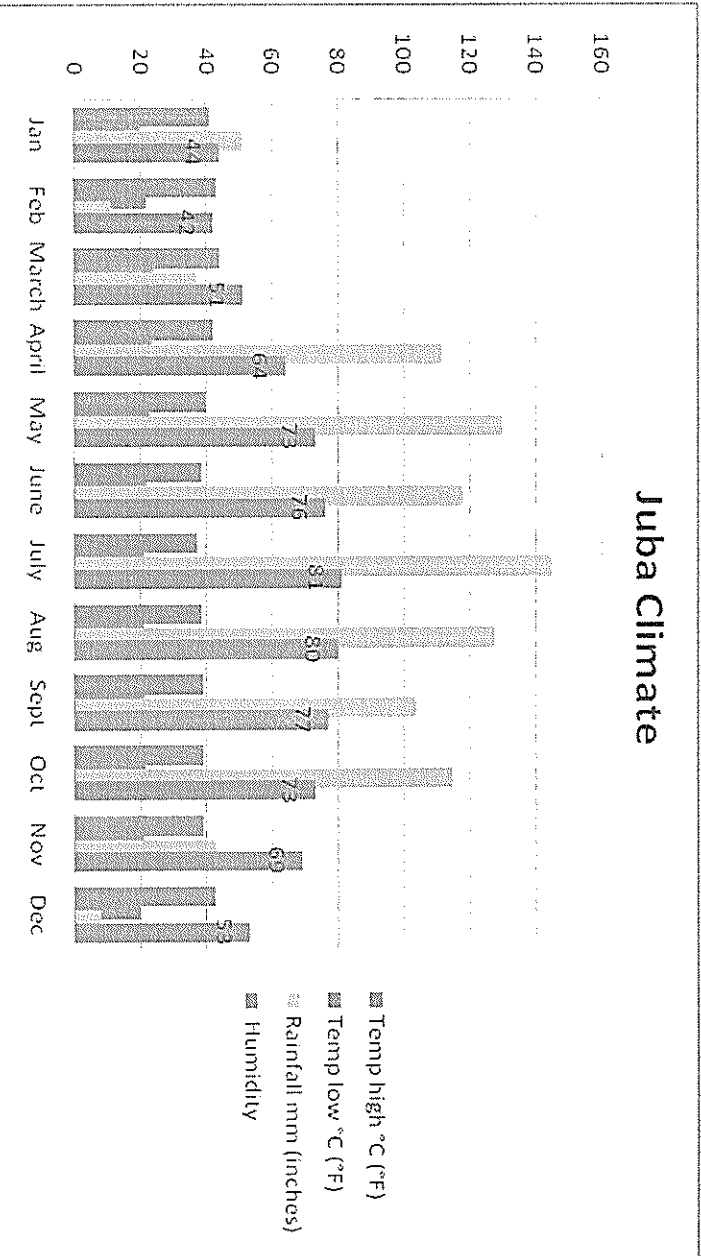
identified as Arabs from the North and nothing can here make them fight with each other apart from the patriots they possess in South Sudan. Juba are found being the peaceful and culturally and civilizations motivated with no claim or blame to be told them in South Sudan because they are impartial.

3.1.4 Climate

Although South Sudan lies within the tropics, the climate ranges from arid in the north to tropical wet-and-dry in the far southwest. Temperatures do not vary greatly with the season at any location; the most significant climatic variables are rainfall and the length of the dry season. Variations in the length of the dry season depend on which of two air flows predominates dry northeasterly winds from the Arabian Peninsula or moist southwesterly winds from the Congo River basin. From January to March, the country is under the influence of the dry northeasterlies. By early April, the moist southwesterlies have reached South Sudan, bringing heavy rains and thunderstorms. In September the dry northeasterlies begin to strengthen and to push south and by the end of December they cover the entire country. Yambio, close to the border with Zaire, has a nine-month rainy season (April-December) and receives an average of 1,142 millimeters of rain each year. Temperatures are highest at the end of the dry season when cloudless skies and dry air allow them to soar. The far south, however, with only a short dry season, has uniformly high temperatures throughout the year.

Juba County has a tropical wet and dry climate (Köppen Aw), and as it lies near the equator, the maximum temperature is 44 degrees Celsius and a minimum temperature is 20 degrees Celsius. The mean annual rainfall is approximately 1000 millimeters and occurs from rainy season, from April to October. It builds up gradually from small rains in March/April to a maximum in June, and then declines sharply, coming to a complete stop in mid-November when the dry season is approaching. From December till February, the County is characterized by very distinct climate with relative humidity dropping from 80% to 42%, which enables the farmers to dry harvested cassava roots naturally. The annual variability is quite high resulting in considerable drought and flood risks.

Figure 1: Climate of Juba County



Source #1: World Metrological Organization

Source #2: NOAA

3.1.5 Soil

The country's soils can be divided geographically into two categories. These are the clay soils of the central region, and the laterite soils of the South. Less extensive and widely separated, but of major economic importance, is a third group consisting of alluvial soils found along the lower reaches of the White Nile and Blue Nile rivers. Agriculturally, the most important soils are the clays in central South. Known as cracking soils because of the practice of allowing them to dry out and crack during the dry months to restore their permeability; they are used for irrigated cultivation. East of the Blue Nile, large areas are used for mechanized rainfed crops.

West of the White Nile, these soils are used by traditional cultivators to grow sorghum, sesame, peanuts, and cotton. The southern part of the clay soil zone lies in the broad floodplain of the upper reaches of the White Nile and its tributaries, covering most of Upper Nile and upper Bahr al Ghazal states. Subject to heavy rainfall during the rainy season, the floodplain proper is

inundated for four to six months--a large swampy area, As Sudd, is permanently flooded--and adjacent areas are flooded for one or two months.

In general this area is poorly suited to crop production, but the grasses it supports during dry periods are used for grazing. The laterite soils of the south cover most of western Al Istiwai and Bahr al Ghazal states.

They underlie the extensive moist woodlands found in these states. Crop production is scattered, and the soils, where cultivated, lose fertility relatively quickly; even the richer soils are usually returned to bush fallow within five years.

3.1.6 Vegetation

The natural vegetation of the study area is typical ranges from equatorial dense forests in the mountains through wooded savannah grasslands to semi arid to arid scrubland in the north and north east of the state

Vegetation cover of the area can generally be classified in five categories which depend on the elevation of the area above river flood level: the lakes and rivers themselves, the floating plant life of the swamp, river-flooded grasslands (Toic), rain-flooded grasslands, and wooded grasslands on the fringes. Grassland and woodland areas have been cultivated by local populations.

The density of the grasslands along the Sudd changes with the season, with tall grass in the rainy season and short dry grass in the dry season, when frequent fires also occur. The fluvial area is mostly overgrown with vegetation, with some main and side channels as well as lagoons of open water. The vegetation distribution is described in further detail in Sutcliffe (1974) and Petersen (2007).

The main species are: *Phragmites communis* (shallow flooded, buried roots) *Echinochloa pyramidalis* (shallow flooded, buried roots) *Oryza barthii* (shallow flooded, buried roots) *Echinochloa stagnina* (deep flooded, superficial/floating roots) *Vossia cuspidate* (deep flooded, superficial/floating roots) *Cyperus papyrus* (deep flooded, superficial/floating roots) *Typha domingensis*

The first three species are anchored so their distribution is limited to the depth of flooding. For the last species their root system needs to be permanently in water or saturated soil, which is a good indicator of flood patterns. *P. communis*, *E. pyramidalis* and *O. barthii* for example dominate only in areas where the depth of flooding does not exceed 130 cm over a period of ten years or 118 cm for one month in the year.

Floating vegetation of *C. papyrus* had caused blockages in the Sudd swamps on a number of occasions between 1879 and 1900, when the plants were torn out by increased flooding. *C. papyrus* needs saturated conditions and can tolerate flooding that is not more than 150 cm deep.

3.1.7 Hydrology

South Sudan is drained by the Nile and its main tributary, the White Nile (Al Bahr al Abyad). The longest river in the world, the Nile flows for 6,737 kilometers from its farthest headwaters in central Africa to the Mediterranean. The importance of the Nile has been recognized since biblical times; for centuries the river has been a lifeline for Sudan. The White Nile flows north from central Africa, draining Lake Victoria and the highland regions of Uganda, Rwanda, and Burundi. At Bor, the great swamp of the Nile, As Sudd begins. The river has no well-defined channel here; the water flows slowly through a labyrinth of small spillways and lakes choked with papyrus and reeds.

The White Nile has several substantial tributaries that drain South Sudan. In the southwest, the Bahr al Ghazal drains a basin larger in area than France. Although the drainage area is extensive, evaporation takes most of the water from the slow moving streams in this region, and the discharge of the Bahr al Ghazal into the White Nile is minimal. In southeast Sudan, the Sobat River drains an area of western Ethiopia and the hills near the Sudan-Uganda border. The Sobat's discharge is considerable; at its confluence with the White Nile just south of Malakal, the Sobat accounts for half the White Nile's water.

3.1.8 Economic and social aspect

Juba has been described as undergoing an economic boom, especially in the past five years and since independence. The prospect of an economic boom has brought thousands of merchants to Juba, mostly from northern Sudan and from East Africa. As of October 2010, several regional

and international businesses have established a presence in Juba. The Commercial Bank of Ethiopia and The Kenyan banking conglomerate Kenya Commercial Bank has its Southern Sudanese headquarters in the city and a branch network of eleven (11) branches throughout South Sudan.

The three indigenous South Sudanese commercial banks namely; Buffalo Commercial Bank, Ivory Bank and Nile Commercial Bank, all maintain their headquarters in Juba. Equity Bank, another regional finance services provider also has a branch in Juba. National Insurance Corporation (NIC), the leading Ugandan insurance services provider maintains an office in the city. Southern Sudan will be one of the poorest states in the world. Sudan's gross domestic product is \$2,300 per capita; economists say the south's is half that, and even lower outside of Juba, where foreign spending has helped bolster the economy for years.

Most of the new country's economic activity will come from just two sectors: the oil industry and subsistence farming. Southern Sudan has little in the way of industry, meaning that the majority of basic goods have to be imported, mostly trucked across the border from Uganda.

But that seems poised to change, and quickly. Juba is the fastest-growing city in Africa, with a population that has boomed from barely more than 100,000 people in 2005 to more than one million today. It has a frenetic boom-town feel, with businesses sprouting up everywhere – a brick-making factory that can't keep up with rising demand, new banks, a mobile phone company.

The prospect of an economic boom has brought thousands of merchants to Juba, mostly from northern Sudan and from East Africa. Most say they have more opportunities in Southern Sudan than in their home countries. But they also describe the new country as a difficult place to do business, full of uncertainty because of a weak government and tenuous security.

Social-economic environment of South Sudan, According to the disputed results of the 2007 Population and Housing Census of Sudan, South Sudan has a total population of 8, 260,490 with an average household size of 6.3. The sex composition of the population reveals that the proportion of male is slightly higher (about 52 %) than females (about 48 %). In terms of ethnic

composition there are many tribes in South Sudan of which the Dinka, Nuer, Murle, Mundari, Toposa and Boya are the main agro-pastoralist groups.

The distribution of population across the states, presented in Figure 3.2 demonstrates that Jonglei where 16.4 % of South Sudan's population living, Central Equatoria (13.4 %), Warrap (11.8), and Upper Nile (11.7 %) are relatively densely populated states. While Northern Bahr-El-Ghazal, Unity, Lakes and Eastern and Western Equatoria are moderately populated. On the other hand, Western Bahr-El-Ghazal is the sparsely populated State.

3.2 Methods

3.2.1 Research design

Study was cross sectional and descriptive in nature. Designs were referred to the overall plan aimed at addressing a research question, along with specifications to enhance the study's integrity. A plan specifically conceived and implemented to bring realistic evidence to bear on a research problem, question. It refers to the overall approach to or outline of the study that details all major components of the research (Houser2008:183; Polit & Beck 2004:730; Stommel & Wills 2004:26).

The study used a descriptive correlation design. Both qualitative and quantitative approaches were used. Primarily cross sectional study was conducted using interviewed administered questionnaire and inspection to see the condition of the nets in the households. This was followed by a qualitative approach to look deeper into factors that led to possession and different patterns of use of mosquito nets. The qualitative approach encompassed focus group discussion with community members and in-depth interview with relevant stakeholders.

3.2.2 Study population

The study included some famers and staff in the Juba County. The target population refers to a set of cases about which the researcher would make generalizations, in this study, the target population, which was accessible, was the entire household in the area.

The study population included 35 farmers and 15 county officials in Juba county location from the 8 villages of Buko, Mangalla, Tijor, Wulikare, Sindiru, Duro, Lololo, and Gondokoro these

eight villages were selected because they are easily accessible and are villages where the people are predominantly crop cultivators

3.2.3 Sampling framework

The sample size was 80 respondents in Juba County and the sample determination was purposive based on condition that the households in Juba County.

3.2.3.1 Sample size

The study was involved a purposive sampling research data collection because we choose the sample base on who would be appropriate for the study. Therefore am using this primarily because there are a limited number of people that have expertise in the area of research. The first stage was involved selecting the population of the study. Secondly the researcher was identifying the potential respondent who was including community and executive officer. From people two respondents were being selected to constitute a sample size to 80 respondents.

3.2.3.2 Sampling techniques

The study used a sample size of 80 respondents from Juba County. The study sample size will be calculated using the formulae of Solvent, which states that, for any given population, the required sample size is given by;

$$n = \frac{N}{1 + N(e^2)}$$

Where;

n = the required sample size;

N = the known population size; and

e = the level of significance, which is = 0.05.

Given a total population of 80 respondents in the selected area in Juba County. A sample of 100 will be involved in the study as illustrated below.

$$n = \frac{80}{1 + 80(0.05^2)} = 100$$

In order to get the actual sample number of each village, the interval technique of dividing sample size to population size was done as following:

$$\frac{n}{N} = \frac{100}{80} = 1.25$$

Table 1 Number of samples per villages

Village	The known population size			The required sample size		
Buko	10					9
Tijor	8					10
Wulikare	12					18
Mangalla	13					10
Sindiru	7					15
Duro	9					12
Lologo	11					16
Gondokoro	10					10
Total	80					100

The questionnaire was administered to 80 respondents and distributed in the eight villages as shown in Table 1.

3.2.4 Data collection instruments

Interview schedules was used to collect data from the respondents by asking them prepared questions which included both open and closed ended questions.

3.2.4.1 Questionnaires

The researcher was use a printed document to Juba County South Sudan which was contain standardized questions that was be answer by the people.

The method would be used because, it enable the respondents to answer the questions in their free time and it creates an opportunity for getting accurate information since it was be design using simple statements that are straight forward.

3.2.4.2 Oral interviews

With this method, the researcher was visit Juba County South Sudan and carry out interviews on the people. This would enable the researchers to get information about the implication of climate change on subsistence crop production and how the records would be kept. From this, the researcher was analyzed the study.

3.2.4.3 Internet and reading available documents

The growing popularity of the Internet brought a major shift in Electronic Data Reporting and data collection. The researcher intends to take advantage of the internet being an ocean of information and get more information about the implication of climate change on subsistence crop production.

The researcher was access information on the implication of climate change on subsistence crop production from the Internet and look at how the survey has been conducted which certainly will help in designing the proposed study and redesigning the forms to suit the study.

3.2.5 Data analysis methods

This was done after the fieldwork/data collection. When all the questionnaires, interview Guides and observation were collected, edited, coded and entered in the computer. I analyzed the data using Microsoft excel program to produce frequency tables, charts, percentages of respondents among others.

CHAPTER FOUR

STUDY FINDINGS

4.0 Introduction

This chapter presents the study findings relating to investigations on climate change scenarios and their impacts on the main crops produced which are a major subsistence of the people's livelihoods. The chapter also investigates the effects of the changes in crop production methods and types on the livelihood of the people.

4.1 The implications of climate change on subsistence crop production in Juba County South Sudan

South Sudan is particularly vulnerable to climate change because of their dependence on rain fed agriculture, high levels of poverty, low levels of human and physical capital, and poor infrastructure are some of the implications of climate on agriculture.

In Juba County at least one third of the country's population depends on the agriculture sector for their livelihood, with some 14% working in farms and plantations. From the land use perspective, about 39.2% of total land use or about 5.18 million hectares are planted with tree crops like rubber, oil palm, cocoa, coconut, fruits and vegetables.

Also the pressure on farmers to make more income or profit in order to better their living standards is extremely high. Being trapped of having little financial resources which makes investments into their agricultural businesses difficult as well as facing the consequences of climate change leaves most of the farmers in Juba County in a desperate situation. Furthermore, the increment of prices in Juba County (electricity, water, food, rental fees etc.) over the last five years threatens a secure livelihood of those farming families even more.

Thus, occurrence of disaster due to extreme climate change such as floods, could impact damaging effect on the economy, social and psychology of the people affected. Recent floods in Juba had displaced 110,000 people, damaging an estimate of over \$100 million worth of infrastructures and \$24 million of economics losses. An estimate of \$ 14 million worth of agriculture produce were damaged or losses affecting 7000 farmers.

The sustainability of food supply could also be affected by climate change. According to official projections, increasing in temperature and changes in rainfall pattern could affect yields directly. Increased in temperature and changes in rainfall pattern could fasten the spread of fungus and diseases directly or indirectly (for example in palm and rubber plantation), thus affecting yield.

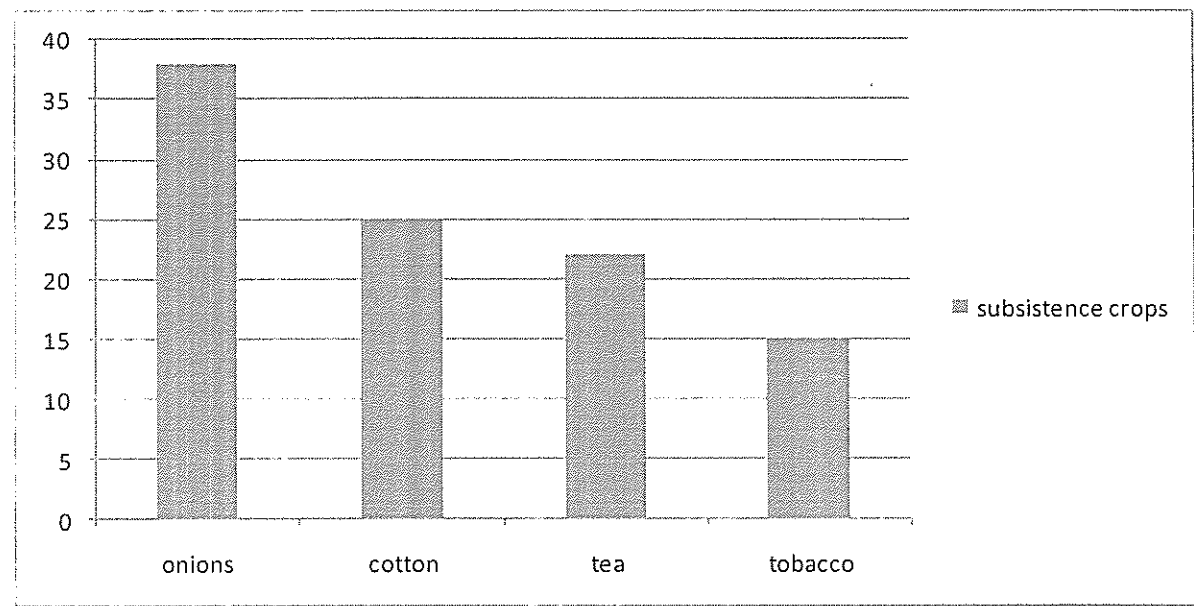
Based on agricultural cycle, increasing in rainfall is not good for rubber. Palm plantations could suffer due to lots of tapping days and crop washouts. Some crops like oil palm could flourish with higher rainfall. However, excessive rainfall is detrimental as yield is significantly affected. It was reported that flood related problems in Juba County had decreased the production of crude palm oil to 1.1 million metric ton or 26.3% in December 2006

Many weeds, pests and fungi thrive under warmer temperatures, wetter climates, and increased CO₂ levels. Currently, farmers spend more than \$11 million per year to fight weeds in the Juba County. The ranges of weeds and pests are likely to expand northward. This would cause new problems for farmers' crops previously unexposed to these species.

The impacts on agricultural differ from one to the other. Climate change signifies by decrease in rainfall will affected crops that need wet conditions such as paddy, vegetables and others. Rice grain yields also may decline by 9 to 10% for each 1 degree Celsius rise. Prolonged droughts make it impossible to sustain the flooded rice ecosystem and it will jeopardize security of food supply. Prolonged rainfall will also affect the sunshine hours. Thus, affecting yield of crops.

4.1.1 Subsistence crops grown in Juba County

Figure 2: A bar graph showing subsistence crops in Juba



Subsistence crops grown in Juba County

Subsistence agriculture is the main economic activity in the county. According to the study findings, Juba's main subsistence crops are food crops such as onions, cotton, tea, and tobacco. Major cash crops have been onions, cotton, tea, and tobacco; although in the 1900s many farmers sold food crops to meet short-term expenses. The elderly respondents said the production of tea, and tobacco virtually collapsed during the late 1970s and early 1980s. In the late 1980s, the government attempted to encourage diversification in commercial agriculture that would lead to a variety of nontraditional exports. Cotton is the second most important traditional cash crop in Juba, contributing 25 percent of total agricultural exports.

According to respondents, today subsistence crops production has decreased immensely, and government officials are pessimistic about reviving this industry in the near future. Farmers are turning to other crops in part because of the labor-intensive nature of cotton cultivation, inadequate crop-finance programs, and a generally poor marketing system.

Tea and Palm, with Favorable climate and soil conditions has enabled Juba County to develop some of the world's best quality tea and palm wine. Many tea farmers have also reduced production as a result of warfare and economic upheaval. According to statistics, Tea production has subsequently increased from 1,700 tons of tea produced in 1991 to 5,600 tons in 2005. These yields did not approach the high of 22,000 tons that had been produced in the peak year of 1974, however, and they declined slightly after 1985.

According to study findings, tobacco and onions, for several years' tobacco is one of Juba County's major foreign exchange earners, ranking fourth after palm cotton, and tea. Like all other traditional cash crops, tobacco production also suffered from Uganda's political insecurity and economic mismanagement. Most tobacco grew in the northwestern corner of the Juba County, where violence became especially severe in the late 1900s, and rehabilitation of this industry was slow

4.1.2 Methods of production

According to the study findings the method of crop production provides an ecologically friendly method of planting and harvesting a crop. The method includes the steps of initially planting the seeds of a crop to be grown in at least one row and, following the planting

According to the study the traditional agricultural methods from Juba County have always been organic, have to a great extent inspired today's modern organic agriculture. It must be remembered that artificial fertilizers and chemical based agro-industry is a relatively new development, only becoming prominent in the second half of the 20th century. In South Sudan, the indigenous farming systems that were used in the past could be referred as organic farming. These faming methodologies didn't utilize any biocides. The production methodology was dependent on the natural resource base.

Weed infestation is minimal, but some aquatic weeds do occur. Some of these are pulled out manually by use of hand and this is most common, although in high-technology production systems, herbicides may be added to the irrigation water, mulches are used to control disease and weeds but also slush and burn, use of simple tools like hand hoes, ox-driven ploughs, simple irrigation, cultivation in wetland and these has led to improvement in organic farming.

Intensive subsistence farming, farmers use their small land holdings to produce enough for their own consumption, while the little remaining produce is used for exchange against other goods. The cultivators use simple tools to produce the crop. It results in much more food being produced per acre compared to other subsistence patterns. These farmers try to obtain maximum yield from the available lands by intensifying cultivation techniques, including the preparation of paddy fields which can be used year after year. They may also intensify by using manure, artificial irrigation and animal waste as fertilizer.

Pest control includes the management of weeds, insects/mites, and diseases. Cultural practices are used. Cultural practices include crop rotation, culling, cover crops, intercropping, composting, avoidance, and resistance. Integrated pest management attempts to use all of these methods to keep pest populations below the number which would cause economic loss, and recommends pesticides as a last resort.

Nutrient management includes both the source of nutrient inputs for crop and livestock production, and the method of utilization of manure produced by livestock. Nutrient inputs such as nitrogen, phosphorus, calcium, magnesium, potassium, iron, can be chemical inorganic fertilizers, manure, green manure, compost and mined minerals. Crop nutrient use may also be managed using cultural techniques such as crop rotation or a fallow period which is maize, sorghum, tobacco and others crops. The primary nutrients are nitrogen, phosphorus and potassium. You may be most familiar with these three nutrients because they are required in larger quantities than other nutrients. These three elements form the basis of the commercial fertilizer bags. As a result, the management of these nutrients is very important. However, the primary nutrients are no more important than the other essential elements since all essential

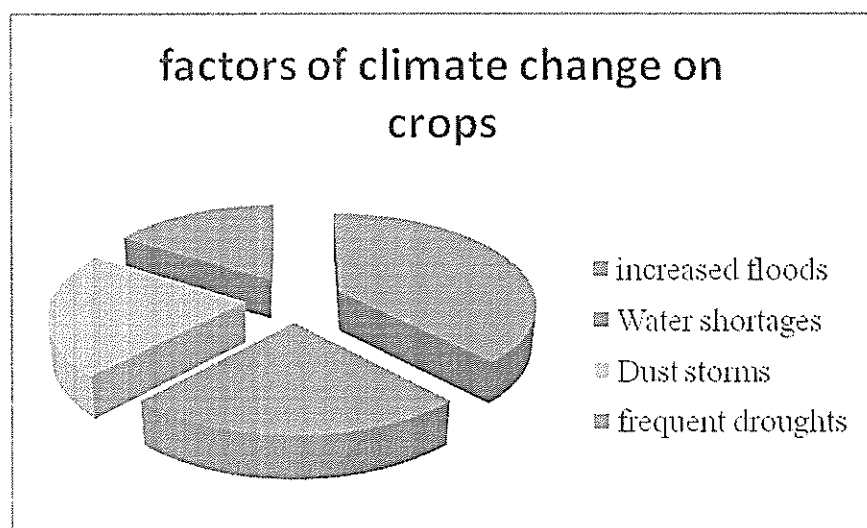
elements are required for plant growth. Remember that the ‘Law of the Minimum’ tells us that if deficient, any essential nutrient can become the controlling force in crop yield.

Land improvement is formed with the inclusion of charred biomass, human manure, kitchen waste, pottery shards, river muck (including the sand), aquatic plants and animals and some terrestrial plant material. The practice shared by all these farming societies was their use of raised beds, covered with thick layers of organic matter, or mulch. It appears that indigenous populations built such systems throughout the South Sudan. It was arguably their most important method of coping with the climate variability caused by the El Niño/La Niña cycle. Raised beds, when tied together with ridges every few meters, can retain 100 percent of the rain that falls on the field, compared with less than 10 percent infiltration in a flat, ploughed field.

According to study findings, soil improvement techniques have partially survived in a few remote communities of indigenous farmers. For over 2,000 years, over 30% farmers in the rivers of the Juba County were producing fertile soil on which to grow their crops, where no such soil had existed before. The pottery chards provide soil structure where no natural rock exists.

4.1.3 How climate change has affected crops grown in Juba County South Sudan

Figure 3: A pie chart showing climate change phenomena that have affected crop production



Source: field study

According to the study findings, 38% of respondents said climate change has increased floods; extreme weather conditions continue to decrease crop yields in the form of floods. While these weather events are becoming more common, there is still uncertainty and therefore a lack of preparedness as to when and where they will take place. In extreme cases, floods destroy crops, disrupting agricultural activities and rendering workers jobless and eliminating food supply.

The Juba county rates of depression and domestic violence are increasing and as of 2007 more than one hundred farmers had committed suicide as their thirsty crops slipped away. A flood is even more disastrous in the developing world, exacerbating the pre-existing poverty and fostering famine and malnutrition hence affecting human activities.

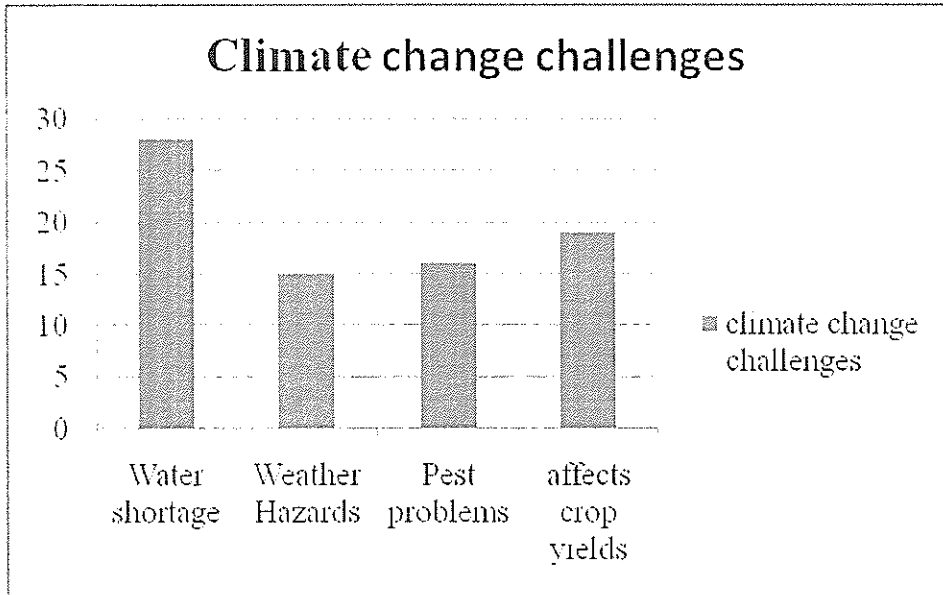
More other respondents with 24% said that climate change has led to water shortages which have affected crops; Most of the impacts of global warming on agriculture will come through water. In this many subsistence crops like tea and tobacco survive on water especially rainfall and this has majorly affected these yields. According to findings Climate is likely to result in a decrease in annual water availability in many parts of Juba County due to an expected reduction in summer rainfall.

22% of the respondents said that climate change has led to massive Dust Storms, In addition to dangerous wildfires, the current heat wave is helping to create massive dust storms in Juba and this has affected cotton because with that heat a lot of wild fires have broke out and this has immensely affected the crops and led to decrease in crop yields. These walls of dust and strong wind can be thousands of feet high, destroying property, setting off a chain of further environmental damage and killing an average of five people per year and also affecting the crop yields

More so 16% of the respondents said that climate change had frequent droughts in Juba County as whole have been of late experiencing frequent droughts alternating with periods of very high rainfall. This has led to increased pests and diseases in the area. More so, in some cases, floods and mid-season prolonged dry spells have been experienced during the same season. Most farmers indicated that the rain season used to begin in late October or early November and end as

late as mid May, but the late 1990s onwards trend is that the rain season can start as late as mid December and end as early as mid March and this has affected crops in Juba county and this has led to moisture deficiency among the crops and hence leading to a decrease in crop production.

Figure 4: A bar graph showing climate change challenges in Juba



Source: field study

According to research the respondents were asked to show challenges which have been brought about by climate change on subsistence crop production in Juba county South Sudan and majority of respondents (28%) agreed that Water shortage is the biggest challenge brought about by climate change, they argued that most of the impacts of climate change on agriculture comes through water. Agricultural analysts argued that climate change is likely to result in a decrease in annual water availability in many parts of South Sudan due to an expected reduction in summer rainfall mainly in southern areas and parts of central Equatorial.

Some of the respondents (15%) argued that climate change causes Weather hazards, Impacts from increasing frequency of extreme weather events such as hail, intense winter precipitation, heat waves and droughts will be felt everywhere in South Sudan. A succession of floods,

droughts and storms in recent years has shown South Sudan's vulnerability to extreme conditions, and their frequency could increase in the short to medium term.

More so some of the respondents totaling to 16% argued that climate change leads to increased pest problems, some farmers argued that adverse impacts can also be expected from the likely rise in the spatial distribution and intensity of existing pests, diseases, and weeds, due to higher temperatures and humidity. Existing pests include like locusts, squirrels, rats, caterpillars among others. The magnitude of the overall effect is difficult to assess but it is likely to be highly regionalized. Climate Change has indirectly on crops through effects on pests and disease. Increased temperatures also reduced the overwintering mortality of aphids enabling earlier and potentially more widespread dispersion. Evidence suggests that in sub-Saharan Africa migration patterns of locusts may be influenced by rainfall patterns.

Basing on findings, 19% of respondents argued that climate change has an impact on crop yields and crop distribution, projected climatic changes affects the level and variability of crop yields, livestock management, and the location of production as agro-climatic zones are likely to shift to more northern latitudes. These impacts even put domestic food supply at risk in certain parts of South Sudan; they can also lead to increased price instability; and they will mean greater risks for farmers' incomes. This may be exacerbated by the impact climate change will have on important non- South Sudan agricultural producer countries, from which the South Sudan imports significant volumes of agricultural and food commodities.

Through the interviews carried out during this study, smallholder farmers explained how the current weather patterns were affecting their farming systems and subsequently their livelihoods. They cited mainly precipitation and temperature-related weather events, as the ones that are a real cause for concern in relation to their agricultural activities. The high frequency of excessive rainfall and drought since the early 1980s has been the major challenge eroding the farmers' assets, leaving them more vulnerable to the vagaries of these climatic events. The high frequency of these events give farmers no time to recover from previous impacts through either asset accumulation or acquiring the skills and knowledge necessary for adapting to future climate changes.

Some farmers argued that climate change leads to Prolonged Wet Weather, Prolonged wet conditions during the crop growing season may lead to flooding, water logging, erosion, and excessive leaching - all of which lead to crop failure, depending on the intensity of the condition. Weeding, fertilizer and pests and diseases chemicals application becomes difficult. Farming costs increase as more fertilizers and other chemicals are required, leading to losses to insect pests and diseases of field crops, as well as those that are stored on the farm. If these conditions are experienced during harvesting and post-harvesting periods, heavy crop damage and loss are incurred as crops rot in the fields, as well as on open spaces since most farmers do not have water or moisture proof storage facilities.

Scientists predicted that some Juba county areas will also be widely affected by changing climatic conditions. Warming is likely to intensify the risk of forests fires and pests; in the longer term it will also affect tree species composition and timber production capacity, although the incidence of these impacts will be geographically different. Extreme weather events, such as heavy winds, storms, and prolonged heat waves and droughts will also have significant impacts on forests

4.2 To investigate how the changes on subsistence crop production has affected people's livelihoods in Juba County

A particular aspect and approach on the investigation of changes on subsistence crop production affected people livelihood in Juba County finding was recorded by the respondents.

4.2.1 The people's livelihood activities related to the crops produced in Juba County

Basing of the study findings, the people's livelihood activities involves producing and adding value to crops through innovative and sustainable support to farmers, breeders and palm wine growers, with an innovative and sustainable farming and wine growing approach that aims to continuously improve the performance of its members' and customers' farms and vineyards, among the activities involved include;

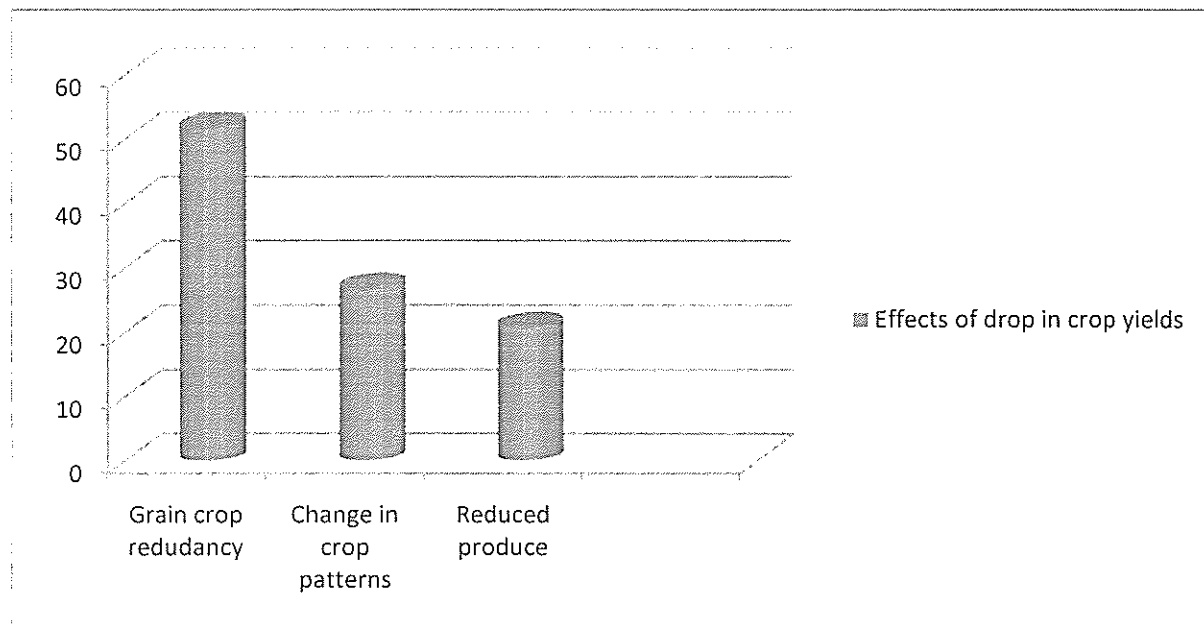
According to the study findings, biggest livelihood activity is agriculture of land and this is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements. It also has been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it" more so, another livelihood activity cited out by respondents was Irrigation, and it is the process of artificially applying water to soil to allow plant growth. This term is preferably used when large amounts of water are applied to dry, arid regions in order to facilitate plant growth.

The process of irrigation not only increases the growth rate of the plant but also increments the yield amount. In temperate and tropical areas rainfall and snowfall are the main suppliers of irrigation water, but in dry places with unfavorable weather conditions, groundwater serves as an essential source.

Another livelihood activity was food production and processing; the fundamental factor in the process of food production and processing is dependent on the properties.

4.2.2 How crop production changes have affected livelihood of the people

Figure 5: A graph showing how crop production changes have affected livelihood of the people



Source: field study

Basing on the study findings 52% majority of the respondents said climate change has led to grain crop redundancy.

More so, the respondents totaling 27% said agreed that climate change has brought about increased change in crop patterns, Adverse impacts can also be expected from the likely rise in the spatial distribution and intensity of existing pests, diseases, and weeds, due to higher temperatures and humidity. The magnitude of the overall effect is difficult to assess but it is likely to be highly regionalized. Most farmers have continuously faced the challenge of dealing with increased pest problems and this has affected livelihoods seriously.

Depending on respondents, 21% of the respondents said that it has impacted seriously on reduced crop yields and crop production, and this has projected to an impact on health of the people in the county. More so the climatic changes affects the level and variability of crop yields, livestock management, and the location of production as agro-climatic zones are likely to shift to

more northern latitudes and this has immensely affected the household of people in Juba county. These impacts even put domestic food supply at risk in certain parts of Juba County; they have also led to increased price instability; and they will mean greater risks for farmers' incomes. This has exacerbated the impact climate change have on important Juba county agricultural producer counties, from which the Juba county imports significant volumes of agricultural and food commodities and hence this has affected livelihoods of people in Juba and hence impacting negatively on the social economic activities of people in Juba county.

4.3 How the farmers are coping with the challenges of climate change

4.3.1 Climate changes impacts are being mitigated in the following ways:

According respondents especially farming experts said the best way to mitigate climate is by planting Trees and Re-forestation, The cleanest and most efficient remover of carbon dioxide from our atmosphere actually comes free. This remover is a gift from nature our green plants and trees. Unfortunately, we have taken this gift for granted. The rate at which we are cutting down our trees and forests to make way for human developments has greatly reduced the earth's ability to remove carbon dioxide from the atmosphere. This has in turn contributed to a faster rate of global warming and climate change. You can do your part by contributing to forest conservation and re-forestation efforts. Take part in your local community's plant-a-tree effort. Grow an organic garden of your own. Because carbon dioxide is the most important greenhouse gas, planting trees and other plants can slow or stop global warming. Plants take in carbon dioxide and release oxygen.

Other respondents suggested that climate change can be mitigated by a reduction of reliance on industrialized mono-cropping and diversification of the range of crops cultivated will reduce vulnerability as well as creating jobs and potentially reducing irrigation needs. Development of more and better heat and drought resistant crops would help fulfill current and future national food demand by improving production efficiencies in marginal areas, with immediate effect.

Some of the farmers in Juba County said that they have been able to mitigate climate change by maintaining a variety of seed types in that preserve biological diversity and provide subsistence farmers with an opportunity to make informed choices could be used to counteract the effects of

climate change, maintain food security and establish possibilities for profitable specialization. This should be adopted as a priority and needs to maximize the role of local communities hence mitigating climate change.

Some respondents in Juba city said climate change is being reduced by reducing Waste, The production of garbage contributes to climate change both directly and indirectly. Decomposing waste in landfills produces methane and other greenhouse gases. Waste also requires energy to manufacture in the first place. Reducing your consumption patterns and reusing items whenever possible minimizes your carbon footprint, since fewer new items need to be made. Recycling metal, plastic, glass and paper lowers greenhouse gas emissions, since recycled items take far less energy to manufacture than items produced from scratch hence mitigating climate change in a long run.

Basing on finding some farmers said that Organic farming can help to mitigate climate change; Soils are an important sink for atmospheric carbon dioxide. Nevertheless, deforestation to make way for conventional agriculture is increasingly depleting this sink. Sustainable and organic agriculture helps to counteract climate change by restoring soil organic matter content as well as reduce soil erosion and improve soil physical structure. Organic farming also does not use chemical fertilizers that release substantial nitrous oxide and methane (greenhouse gases) into the environment, and as such reduces climate change, while at the same time maintaining crop yields. As individuals, how to reduce climate change through organic farming is to switch to organic products. As the demand for organically grown produces increases, organic farming will become more economically viable and more popular. Or better still; grow your own organic garden. As a community, encouraging local farmers to cultivate various products by rotating their crops can also go a long way in reducing carbon emissions and restoring the ecological balance in the environment hence mitigating climate change.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATION

5.1 DISCUSSION

The above discussion highlights a number of important outcomes. Revenue per hectare was found to be lower for subsistence crop production. The marginal productivity of rainfall in generating revenue is less for subsistence crop production. Subsistence crop production is constrained by rainfall, and in many parts of South Sudan, farming systems are currently operating under rainfall conditions that are at or near the threshold of viability. Any reduction in rainfall in these regions is likely to make current farming practices unsustainable.

The result of the regression analyses

In determining what actually impacts the yields of the subsistence crops in this study highlights that millet and sorghum crop yields are influenced by other external factors different from climatic variability. In the case of millet, increase in harvested areas turned to increase crop yields, but this wasn't the case for sorghum. Based on the result of the remote sensing analysis, factors other than climatic factors have a role to play in agricultural crop productivity in the South of Cameroon. With a population growth rate at 2.6%, there is the tendency of exertion of pressure on the productive land area. Settlement patterns have changed, based on the availability of fertile zones, thus leading to more barren areas of land.

Climate change is likely to cause significant reductions in rainfall, leading to substantial losses in revenue to crops that remain productive. The central region of South Sudan is particularly vulnerable to climate change, as the largest rainfall reductions are predicted for this region. Large areas of the regions are also very vulnerable, as rainfall is predicted to fall below the threshold at which small-stock crop production can occur. In addition, the southern parts of the regions are at risk, as rainfall is predicted to fall below the threshold at which cattle's farming is viable.

Livestock farming is probably more vulnerable to the effects of climate change than trophy hunting, as its productivity is strongly constrained by rainfall. Climate change will exacerbate water scarcity, and it is therefore imperative that land owners adapt to climate change by

adopting farming practices that use water more efficiently. While efforts to use water more efficiently by farming with arid-adapted livestock species (such as cattle) may be effective as short-term adaptations, larger scale changes in land use will be required in order to adapt to the impacts of climate change over the long term.

A key land use change is a switch to farming with indigenous species which are better adapted to arid conditions. The combined effect of considerable declines in rainfall predicted for most of South Sudan and the lower productivity of rainfall in generating revenue under livestock production than trophy hunting suggests that farmers could benefit from diversifying their farming activities to include trophy hunting or wildlife viewing tourism. In areas that are currently marginal for livestock production, a switch to using wildlife production systems could be a key adaptation that allows farmers to avoid complete loss of production under climate change. Barnes and Humavindu (2003) note that livestock values will fall in the long term due to the increasing cost of producing the same unit of output, while the value of wildlife will increase.

The Government of South Sudan highlights the need to “capitalize on Sothorn’s comparative advantages and provide suitable incentives to use our natural resources in the most appropriate and efficient way possible”. Wildlife production systems provide a more efficient use of water, a scarce resource that is identified as being the key constraint to Sudan’s development, than does livestock farming. Moreover, tourism is on the increase in South Sudan, and has the potential to generate significant revenues and create considerably more employment than does agriculture.

Lastly some farmers in Juba said that Government of South Sudan should introduce taxes on environment polluters, taxes can be both cost effective and environmentally effective. Difficulties with emission taxes include their potential unpopularity, and the fact that they cannot guarantee a particular level of emissions reduction. Emissions or energy taxes also often fall disproportionately on lower income classes. In developing countries like South Sudan, institutions may be insufficiently developed for the collection of emissions fees from a wide variety of sources and thus will to reduction of climate change.

5.2 CONCLUSION

From the foregone account, the importance of subsistence agriculture in the South Sudan cannot be underestimated, for it plays an important role on the livelihood of the population. Large populations based in the rural areas depend solely on rain-fed agriculture for their subsistence with poverty levels stagnating and societal resilience to climatic variations not improving. Observed climatic trends have been changing with their variations very unambiguous, as rainfall shows a significant negative trend and temperature the reverse. These have all been indicated by the increase in the frequency and the duration of droughts. However, still on the results of the agricultural drought analysis, the trend lines show the presence of water, which tend to counteract the fact that the Juba is a totally dry area of land.

Subsistence farmers no doubt have been operating in marginal lands and most have already adopted some coping strategies in harsh climatic conditions that have prevailed over the past years. These indigenous adaptations range from the changing in planting dates, and crop varieties, movement to from rural to urban areas, increment in cultivated lands, irrigation and soil conservation practices, the use of local indicators and switching from crops to livestock.

Despite these perceived adaptation strategies, adapting to climatic change is a costly venture and most of the factors that hinder subsistence farmers' adaption to climatic change could be coined under the banner of poverty. A plethora of findings have already emerged that resonate with a battery of earlier literature on subsistence agriculture and options for adaptation.

Adaptation by subsistent farmers should go beyond the above mentioned practices, else climatic variation and change will continue to increasingly have devastating impacts on subsistent farmers in the South Sudan. Adaptive responses tend to be reactive, and there is little evidence of planning. Policy makers should pay particular attention on the role of local and indigenous knowledge when adaptation is concerned. These are some of the type of experiences passed down from generation to generation and offer very invaluable information regarding

5.3 RECOMMENDATION

The government of South Sudan should mitigate climate change by a reduction of reliance on industrialized mono-cropping and diversification of the range of crops cultivated will reduce vulnerability as well as creating jobs and potentially reducing irrigation needs. Development of more and better heat and drought resistant crops would help fulfill current and future national food demand by improving production efficiencies in marginal areas, with immediate effect.

The Value of Local Knowledge:

The current strategies in used by the subsistence farmers should be considered in the country national adaptation plan of action. For local and indigenous knowledge serve as a sink and could act a springboard in the formation strategies that could aid local farmers.

Research and Education

Through research, new crop varieties and hybrids that are able to withstand severe droughts, tolerate higher temperatures and mature early, could enable the farmers to be ready to meet the challenges of climatic variability and change in the South Sudan. New technologies, such as irrigation techniques, early warning systems could be developed. Education of the rural farmers is very much imperative if they need to adapt to climate change.

Agricultural extension Services

A successful agricultural adaptation requires better and clearer information combined with investments and advisory services to disseminate the information to the local farmers as well as strengthening the liaison between the bottom down farmers and the top-up officials. Adequate extension information services to ensure that farmers receive up-to date information about climatic patterns in the forthcoming season so that they can make well informed decisions about their planting dates. They could also play a role in land use changes and crop-farm management practices of subsistence farmers that could play a role in adaptation and concomitantly mitigation of climate change.

Governments and International Organizations have a very big role to play with regards to the adaptation of subsistence farmers to climate change. The effective implementation of an agenda for climate change adaptation will require mainstreaming climate change and improved practice

on a large scale requires investments in capacity-building, training program and policy dialogues, knowledge management and generation, as well as dissemination of best practices, development of suitable tools and transfer of appropriate technologies. Improved climate-related services in pro-poor services require capacity to tailor and communicate information to user needs. Technical advisory services on climate risk management provided by experts with a view to enabling translation of climate information products are very much needed. The effective dissemination of modern technologies via agricultural extension services plays a key role in agricultural development.

Governments and International Organizations have a very big role to play with regards to the adaptation of subsistence farmers to climate change. The effective implementation of an agenda for climate change adaptation will require mainstreaming climate change and adaptation into development planning, reforming climate-related governance and institutions, and undertaking massive new investments. Stable and supportive policies should be implemented to improve risk management of subsistence farmers and would require the engagement of core ministries in the South Sudan. The core programs of international development agencies and donors must encompass the impacts of climate change as it affects poverty, food security, and economic development of the rural poor.

Financial Support

Financing of the rural area by setting up suitable financial systems that will allow smallholders subsistence farmers to have access to credit. These policies that improve household welfare as well as access to credit are also a priority for both short and long-term adaptation measures.

In addition, a study that incorporates other land uses, such as crop production, would provide a broader understanding of how climate change will affect land owners across South Sudan. Crop farming is amongst the most vulnerable land uses to climate change due to its dependence on rainfall. This study did not consider commercial farming on communal land, or subsistence farming, due to the challenges involved in trying to estimate revenue per hectare on land that is not individually owned and managed.

However, it would be of particular interest to include communal and subsistence farming revenues in future studies, as subsistence farmers are generally poor, and likely to be highly vulnerable to the effects of climate change.

Areas for Further Research

Considering the extent of my research, I would suggest that further research would be done on implications of climate change on subsistence crop production.

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APPENDIX: A BUDGET

TASK	QUANTITY	UNIT PRICE	AMOUNT
Photocopying papers	2	15,000	30,000
Pens	5	1000	5000
Note books	3	3000	9000
Pencil	1	1000	1000
Flask disk	8GB	80,000	80,000
Ruler	1	1000	1000
Internet	10days	5000	50,000
Secretariat	5days	15,000	75,000
Research Assistant	4	5000	20,000
Transport	2		250,000
Supervisor	1		120,000
Airtime	2		20,000
Printing	3	20,000	60,000
Binding	3	10,000	30,000
Transport	5	10,000	50,000
Airtime	5	10,000	50,000
Grand total			851,000 Uganda Shilling

APPENDIX: B TIME FRAME

	January	Jan-Feb	Feb-March	March-June	June
Proposal writing					
Data collection and analysis					
Project design					
Project coding					
Project report writing and submission					

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