

**THE IMPACT OF AGRICULTURE ON ARABLE LAND:  
A CASE STUDY OF BOR COUNTY, JONGLEI  
STATE, SOUTH SUDAN**

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## DECLARATION

I AWUOL BUL MAMUOR, a student of Kampala International University, hereby declare that this work is my original work and the best of my knowledge and that it has never been presented by any other person or institution for any academic award in and outside Kampala International University.



.....  
Signature

Date.. 20<sup>th</sup> MAY, 2010 .....

## APPROVAL

This research report has been submitted for examination with my approval as a university Supervisor.

Signature: .....

**Mr. Ammon R. Orashiba**

Date: .....

## DEDICATION

I dedicate this work to all my brothers and sisters for helping me in whichever way they managed in the course of my education.

## ACKNOWLEDGEMENT

I feel indebted to many people for the help, advice and support in as far as my education is concerned. Special thanks go to my brothers Mathiang Bul Awuol and Riak Bul Awuol for thier continued support.

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## **LIST OF ABBREVIATIONS**

UNHCR	:	United Nations High Commission for Refugees
CPA	:	Comprehensive Peace Agreement
USAID	:	United States Agency for International Development
NPA	:	Norwegian People's Aid
SPLA/M	:	Sudan People's Liberation Army/Movement
IDPs	:	Internally Displaced People
NGOs	:	Non Governmental Organizations
GOSS	:	Government of Southern Sudan

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## **CHAPTER ONE**

### **INTRODUCTION TO THE STUDY**

#### **1.0 Introduction**

Agriculture is the biggest single activity in most of Sub-Saharan Africa. According to the World Bank report on Human development index 2005, about 73% of the people in Sub-Saharan Africa survive on subsistence agriculture. The most widespread methods of farming are the primitive ones, using the traditional hoe as the main tool of agricultural production. This type of farming also depends mainly on the natural seasonal rains for their crops, (World Bank. Human development index 2005).

Sudan is one of the largest countries in Africa. It has a large area of cultivatable land, making agriculture one of the lifeline activities of the people. Most of this cultivatable land is in the southern semi-autonomous part of the country. Southern Sudan has a huge agricultural potential, with more than 90% of the arable land being suitable for farming (Diehral 2001).

However, the 20-year civil war has had a devastating effect. Much of the south of the country has been left in ruins, with little discernible infrastructure and a lack of social services like education and healthcare. United Nations High Commissioner for Refugees (UNHCR) estimates that up to eight million people were displaced from their homes, and they are gradually returning with few possessions and prospects. Aerial raids and ground attacks meant that those who stayed were unable to work in the fields and reluctant to invest in their farms.

The war that finally ended with the signing of the Comprehensive Peace Agreement in 2005 had deprived the people of South Sudan any chance for their farming skills to evolve and so there was the need to introduce updated practices and technologies to the traditional skills still held by farmers. But equally important was the need to support returnees in their attempts to rebuild their lives in their home areas. This was closely coordinated with the relief food distribution project so that any agricultural inputs provided would be used optimally, as the returnees would have enough time and energy to cultivate and take the first steps on regaining basic food security, ([AllAfrica.com/Sudan/28744/htm](http://AllAfrica.com/Sudan/28744/htm)).

The higher proportion of the rural population in Southern Sudan obtains its income solely from subsistence farming. For transforming lives and livelihoods in the rural areas of Southern Sudan, the starting point should be the improvement of agricultural productivity. Even though Southern Sudan is blessed with abundant natural resources, yields are very low and there are plenty of opportunities to raise them through technological change and diversification. Farmers in Southern Sudan need to improve both the quality and quantity of their production to ensure food and livelihood security (Sudan Tribune 12<sup>th</sup> May 2008).

Jonglei state is one of the ten states that constitute Southern Sudan (formerly called Bahr el Jebel state). Jonglei state covers a total land area of 110,115 square kilometers, of which 21403 square kilometers is for settlement while 31298 square kilometers 57414 Square kilometers are forest and arable land respectively. It is bordered by Eastern Equatorial state to the south and Lakes state to the west, Western Upper Nile state to the North West, Upper Nile state to the north and the Ethiopian border to the east.

### **1.1 Background to the Problem**

Sudan is one of developing countries in Sub-Saharan Africa and the world in general, widely dependant on subsistence agriculture. The biggest number of the country's poor population lives in the south of the country. According to the national population census report of 2007, about 8.3 million people live in the Southern Sudan. Most of them living in abject poverty, surviving on one US dollar or less a day. Therefore agriculture is a very important activity in the livelihood of these people, as most of them entirely depend on it for their survival. They exploit the natural environment in its entirety in order to live.

### **1.2 Statement of the Problem**

For a long time, most of Africa has been depending on agriculture for survival, Southern Sudan Inclusive. The vast majority of the people are subsistence farmers, depending on seasonal rains for their cultivation. They till as much land as possible in order to harvest enough food to take them through the whole season. This part of the country has been suffering a civil war for many decades and throughout all this time, agricultural activity was largely abandoned. It's after the signing of the CPA in 2005 that relative peace returned to the country. Many displaced people left camps to go back to their homes to start new lives.

Given the fact that these people depend on traditional methods of farming, their resumption of farming activity by very many people at the same time, all struggling to get their maximum from the natural environment has devastating effects on the most basic natural resource available, i.e. land.

The focus of this study was to assess how agricultural activities affect the arable land and conservation of the natural environment in Bor County of Jonglei state, Southern Sudan.

### **1.3 Purpose of the study**

The purpose of this study was to investigate the effects that agricultural activities have on sustainable environmental conservation of arable land of Bor County in Jonglei state of Southern Sudan.

### **1.4 Study objectives**

The study was aimed at achieving various objectives, some of which include;

#### **1.4.1 General Objective**

To assess how agricultural activities affect conservation of the natural environment in Bor County, Jonglei state in Southern Sudan.

#### **1.4.2 Specific Objectives**

1. To identify the various agricultural activities in the farming communities.
2. To find out the environmental resources affected by agricultural practices in the area.
3. To investigate how these problems are being mitigated.
4. To identify what was missing in the mitigation strategies and suggest possible review tactics.

## **1.5 Research Questions**

The study will attempt to find answers to the following questions;

1. What is the effect of agriculture on the sustainable conservation of the natural environment?
2. Why has been/is being done in order to address these problems?
3. How can the government and donor community help in solving this problem?

## **1.6 Scope of the Study**

### **1.6.1 Conceptual scope**

The research was concentrated on assessing the impact of agriculture on arable land. It mainly focused on how agricultural activities affect the sustainable conservation of the natural environment. That is why the researcher put emphasis on how the people exploit the natural environment and what effect this exploitation has on the natural resources, land being the most basic of them all.

### **1.6.2 Geographical scope**

The study was carried out in Bor County, Jonglei state in Southern Sudan. Bor County covers an estimated area of 19 square miles and is about 190 kilometers from Juba, the capital city of Southern Sudan. It's located in the eastern part of the country, on the border with Ethiopia.

### **1.6.3 Time scope**

The study covered the agricultural activities of the people in farming communities for the last three years. The study was carried out for one month.

Due to the time and financial limitations, the researcher sampled 60 respondents randomly selected from the local people in the communities,

politicians and leaders. These included local leaders, religious leaders, cultural/clan leaders and opinion leaders in society.

### **1.7 The Significance of the Study**

The findings of the study will be useful or important in many different ways and to many different persons or groups of people;

- The findings of the study will help to bring in new knowledge of the extent to which agricultural activities affect uncultivated arable land.
- The study findings will help in the assessment of the causes of the decline in agricultural production in these communities.
- The findings of the study will help in reviewing the contribution of agriculture on the natural environment of farming communities.
- The study findings shall help local and central government leaders to identify the gaps in their environmental conservation policies and suggest on how to address them.
- The study findings will help in the assessment of how the current trend of environmental destruction can be reversed.



## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.0 Introduction**

This chapter summarizes the literature of the study. It covered different views of various authors who have written on the subject area and have included various arguments arrived at from different studies in line with the research problem.

#### **2.1 Review of Literature**

For ages, Africa has depended on the natural environment for its entire survival. Due to poverty, ignorance and conservativeness, most communities have been reluctant to adopt new and modern methods of agriculture, thereby overstraining the natural environment of the available resources to sustain the ever increasing population. However, many projects have been set up to help stimulate agricultural production and these have had a significant impact. Many scholars have written widely about the impacts of agriculture on arable land and others natural resources and the various projects that have come up to either improve or deteriorate arable land status. Among these are the following;

#### **2.2 Global environmental impact of agriculture**

Agriculture imposes external costs upon society through pesticides, nutrient runoff, excessive water usage and other assorted problems. A 2000 assessment of agriculture in the UK determined total external costs for 1996 of £2,343 million, or £208 per hectare. A 2005 analysis of these costs in the USA concluded that cropland imposes approximately \$5 to 16 billion (\$30 to \$96 per hectare), while livestock production imposes

\$714 million. Both studies concluded that more should be done to internalize external costs and neither included subsidies in their analysis but noted that subsidies also influence the cost of agriculture to society. Both focused on purely fiscal impacts. The 2000 review included reported pesticide poisonings but did not include speculative chronic effects of pesticides and the 2004 review relied on a 1992 estimate of the total impact of pesticides (Alexandratos 1989).

The global food system may influence the global environment in a variety of ways. The direct impacts of agriculture on the environment include modification of land for agricultural purposes and byproducts of production such as methane released by rice paddies and livestock. Activities such as food processing, distribution and preparation use fossil fuels, fuel wood, refrigerants, and other inputs and generate wastes. Indirect impacts include the effects of energy, materials and pollution entailed in constructing and maintaining equipment, transportation and storage facilities, and other infrastructure used in food production, fisheries and related activities as well as in supporting the populations involved in them. Of course it is especially difficult to quantify such indirect impacts and to attribute them consistently to particular activities, and to ascertain whether alternative uses of resources would have resulted in greater or lesser impacts (UNEP 1989).

### **2.2.1 Environmental impact of livestock**

In arid and semi-arid areas (less than 20 inches of rainfall per year), grazing of livestock can result in competition with wildlife seeking food and water but also may make habitats more attractive to other species. Migratory pastoralists affect biodiversity by collecting wood and building settlements. Still, the nutrient patches left behind in old livestock corrals may enhance wildlife habitat rather than degrade it. In areas of Africa

that receive moderate rainfall (20 to 60 inches), livestock populations are moderate to high and their impacts on the environment can be extensive through grazing and by allowing farmers to plow more land. In the rainforests of Africa (more than 60 inches of annual rainfall), unlike South America, there are currently few livestock and the disease constraints on production are strong. As a result, Impacts are low although this may change in the future (Liverman 1990; Mabbutt 1989).

The environmental impact of export-orientated horticultural production has some parallels with the issues discussed earlier in relation to the intensification of the staple food sector. Increasing the intensity with which water, fertilizer and pesticides are applied may allow the land to yield higher volumes and/or higher value per hectare, but also comes with attendant environmental problems. As noted in the horticulture chapter, high value fresh produce requires intensive pest and disease control using hazardous agrochemicals which can contaminate local ecosystems and can be very to harmful to agricultural workers and consumers if not used carefully. (Becht et al 2006).

A senior UN official and co-author of a UN report detailing this problem, Henning Steinfeld, said "Livestock are one of the most significant contributors to today's most serious environmental problems". Livestock production occupies 70% of all land used for agriculture or 30% of the land surface of the planet. It is one of the largest sources of greenhouse gases, responsible for 18% of the world's greenhouse gas emissions as measured in Co<sub>2</sub> equivalents. By comparison all transportation emits 13.5% of the Co<sub>2</sub>. It produces 65% of human-related nitrous oxide (which has 296 times the global warming potential of CO<sub>2</sub>) and 37% of all human-induced methane which is 23 times as warming as CO<sub>2</sub>. It also generates 64% of the ammonia, which contributes to acid rain and acidification of ecosystems. Livestock expansion is cited as a key factor

driving deforestation, in the Amazon basin 70% of previously forested area is now occupied by pastures and the remainder used for feed crops. Through deforestation and land degradation, livestock is also driving reductions in biodiversity. (Bakun 1990; Chen and Pally 1988; WRI 1990).

### **2.2.2 Impact of sugarcane growing**

Due to the scale of production and associated land clearance in tropical forests and coastal wetland areas it is quite likely that the production of sugarcane has caused a greater loss of biodiversity on the planet than any other single agricultural crop. In Sub-Saharan Africa sugar production has generally been developed more recently and much of it takes place away from coastal areas in landlocked countries such as Zimbabwe, Malawi, Zambia and Swaziland and in regions that are ecologically less vulnerable. The impact of sugar on biodiversity in Sub-Saharan Africa depends upon where it has been grown (Clay 2003, p.166).

### **2.2.3 Tobacco growing and its environmental impacts**

Two harmful effects stand out in relation to tobacco. The most obvious one is the harm it does to the health of consumers. Whilst tobacco consumption is falling in the rich countries, the market for tobacco in the developing world is growing and with it the associated risks to human health.

On the production side, the most significant environmental impact relates to deforestation caused by the huge demand for wood used in drying and curing tobacco. It is estimated that tobacco production accounts for 5 percent of Africa's total deforestation (Geist 1999), for 12

percent of deforestation in Southern Africa (Clay 2003) and for 20 percent of deforestation in Malawi (Geist 1999).

In Southern Africa 200.000 hectares of forest are cut down each year for tobacco production. The majority of this (69%) is used as fuel, while the remainder (31%) is used for constructing barns and racks, including those used for air cured tobacco which does not require fuel. It is estimated that where wood is used as the fuel for curing tobacco, 19.9 cubic meters of it are used to cure one metric tone of tobacco. In Malawi, Tanzania and Zimbabwe the deforestation caused by tobacco production is especially serious (Geist 1999).

#### **2.2.4 Oil crops and its environmental impact**

The environmental impact associated with the production of oil crops varies according to the type of oil crop under consideration and the way it is produced. Clearing tropical forests to establish large mono-crop plantations causes serious losses in biodiversity and natural habitat and throughout much of the world is the main environmental impact associated with palm oil.

"In Africa oil palm has been a subsistence crop for generations. As such it tends to be an Agro-forestry crop that is inter-planted with other cash and subsistence crops. In most cases, this type of production does not have a large impact on biodiversity. More recently the establishment of vast mono-crop oil palm plantations in Asia and Latin America, as well as in West Africa itself threatens vast tracts of tropical forest with high conservation value" (Clay 2003, p. 218).

## **2.3 Agricultural activities in south Sudan**

The resumption of a peaceful environment in South Sudan has encouraged many projects especially in agriculture to come up in Bor County, Jonglei state and South Sudan in general. Among these include the following:

### **2.3.1 Norwegian People's Aid Project**

Norwegian People's Aid began agriculture activities with USAID support in the mid 1990s. NPA began working on the East Bank of the river Nile in conjunction with the Relief Food Distribution Project but as government asked NPA to concentrate on the West Bank from 1997 so the agriculture activities followed to ensure shared infrastructure could be used (NPA 2004).

The Agriculture Project was part of the overall Food Security (and Rural Livelihoods) Program and fell under the overall goal of "contributing to the right of the rural poor communities of South Sudan in order to have improved livelihoods." For the period 2000 - 2007, the project was able to manage an integrated package of appropriate interventions ranging from provision of relief food to targeted communities, basic agriculture support and rural livelihood development in order to lead towards achievement of this goal.

The objective for the Agricultural Project during this period was increased agricultural production for targeted households through adoption of improved techniques and technologies.

The results expected for this objective were;

- Targeted households have received agreed agricultural inputs in good time for cultivation seasons and use appropriately.

- Targeted farmers trained on basic crop husbandry and on own farm.
- Ox plough technology is transferred and adopted by targeted farmers.
- Improved varieties of seeds from Kenya/Uganda and local regions are available and utilized in operational areas.
- All local seeds required for purchase and distribution across the program are available from seed multiplication contact farmers and groups.
- Staff and partners at County level are trained in sustainable agriculture to certificate level.

The agriculture project reached a peak in 2006/7 by working in 13 Counties across Central Equatorial state, Western Equatorial state, Lakes and Jonglei with a range of interventions from provision of inputs to advanced training. Through regular presence of agriculture and monitoring staff on the ground, a complete picture of the agriculture production of targeted households is built up, noting area cultivated, factors affecting crop growth and yield expected. The level of the targeted households' access to adequate seeds in order to cultivate an area sufficient to produce enough food in the coming season is also estimated and inputs provided accordingly to enable them to increase production to a food secure level. The concurrent training and other interventions build on this basic approach and further enable the targeted households and communities to produce a surplus for marketing and as a provision against any future shocks.

### **2.3.2 FARM-Africa Project**

Agricultural rehabilitation project under FARM-Africa has been going on since 1995 in Southern Sudan. FARM-Africa is providing people

returning to the area with the support and investment they need to effectively farm the land.

Now that Southern Sudan is a more peaceful area, FARM-Africa wants to continue to help families returning to the area to build and develop rural livelihoods such as rearing livestock and small-scale farming. In the long term we aim to reduce the area's reliance on food aid.

- It will further develop a model of post-conflict livelihoods support and widen our work to cover new areas. This model we are developing will also form a basis for livelihood development in other remote areas characterized by severe underdevelopment.
- FARM-Africa will continue to develop working partnerships with government staff and research institutions in Southern Sudan. This way we can impact policy development and the long-term quality of life for returnees.
- In 2011 a referendum to determine the political future of Southern Sudan will be held. This will influence the development of the next phase of the project work. If the funding and political situation allows, the project plans to develop a new project closer to Juba, the capital in 2011.

### **2.3.3 The Jonglei diversion canal**

The Jonglei canal scheme was first studied by the government of Egypt in 1946 and plans were developed in 1954-59. Construction work on the canal began in 1978 but the outbreak of political instability in Sudan has held up work for many years. By 1984 when the Southern Sudanese rebels (SPLA) brought the works to a halt, 240 km of the canal of a total of 360 km had been excavated. However, in 2008- Sudan and Egypt agreed to restart the project and finish the canal after 24 years, something that would most likely damage the local environment.



Because of the Sudd swamp, the water from the southwestern tributaries (the E3ahr el Ghazal system) for all practical purposes does not reach the main river and is lost through evaporation and transpiration. Hydro geologists in the early part of the 20th century proposed digging a canal east of the Sudd which would divert water from the Bahr al Jabal above the Sudd to a point farther down the White Nile, bypassing the swamps and carrying the White Nile's water's directly to the main channel of the river.

It is estimated that the Jonglei canal project would produce  $4.8 \times 10^9 \text{ m}^3$  of water per year (equal to a mean annual discharge of  $152 \text{ m}^3/\text{s}$  ( $5,368 \text{ ft}^3/\text{s}$ ). There are however, complex environmental and social issues involved which may limit the scope of the project in practical terms.

## **2.4 Environmental Ecosystems**

The Boma-Jonglei is the largest most intact savanna ecosystem in East Africa, home to some of the world's greatest land mammal migrations and a WCS initiative to protect species such as the oryx.

Located in Southern Sudan, this landscape encompasses Boma National Park, the proposed Bandinualo National Park, broad pasturelands, floodplains and the Sudd, a vast area of swamp and seasonally flooded grasslands rich in wildlife including the Zeraf Reserve. Containing expansive grasslands the size of Kenya and Uganda combined, the region supports an abundance of iconic African wildlife, including elephants, giraffe, eland, lions, wild dog, buffalo, and antelopes (locally called -tiang").

Boma-Jonglei is now East Africa's largest, most intact savannah ecosystem. The landscape hosts one of the world's greatest mammal

migrations, the seasonal movement of white-eared kob and other antelope species. Some of the facts about this region include;

- The size of the landscape which is about 77,220-square-miles
- Around 1.3 million antelopes migrate across the Boma-Jonglei Landscape taking advantage of seasonal changes in water and food supplies.
- Among the world's most important bird areas. The Sudd Swamp is a stopover site for birds migrating between Africa and Eurasia.

## **2.5 Threats and Challenges to environmental conservation**

Since the signing of the peace accord in 2005, the government of Southern Sudan and champions of conservation have faced many challenges in protecting the habitats and the natural environment of the region. These challenges include:

- Increased security has paved the way for renewed activity by oil companies to explore a large section of Boma-Jonglei and safari hunters looking to identify concessions.
- Internally- Displaced Persons (IDPs) and refugees have returned and are building settlements and towns and seeking grazing and agricultural lands.
- It is not uncommon for local residents to own automatic rifles, which are often used for hunting.
- Road construction and water diversion projects place additional stress on the natural environment.
- Like all protected areas in Sudan. Boma National Park, Bandingalo Park, and Zeraf reserve were neglected for years during the long period of civil war, and so there is an urgent need to better protect these wildlife reserves and improve management of natural resources.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.0 Introduction**

This chapter deals with the research methodology to the study. It discusses aspects of the geographical area in which the research was conducted, the research design, the study population, sampling techniques, the sample size, the study instruments, sources of data, data analysis methods and data process methods respectively.

#### **3.1 Research Design**

The study was both qualitative and quantitative. The quantitative data was obtained using structured questionnaires from different categories of people such as local leaders, politicians, NGOs operating on the ground, religious and cultural leaders, while the qualitative data was obtained from key informants, interviews and observations.

#### **3.2 Population of the study**

Bor County has a population of approximately 10470 people (according to the 2008 Polio eradication campaign data source). About 31% of these are men, about 34% are women and the rest are children. It was not possible for the researcher to get information from all these people and that is why the researcher had to draw a study sample, whose information was treated as representative of all the people in the entire state.

#### **3.3 Sample size**

Due to the time and financial limitations, the researcher was not able to get information from all the people in the state. Therefore a sample was

drawn to represent the entire population. This sample consisted of 60 respondents all chosen from among the local residents, and local leaders, cultural and political leaders and environmental conservation activists.

### **3.4 Sampling Procedure**

A total of 60 respondents were used as a sample for the study. These were randomly selected from the communities in the state. They included local residents, local leaders, cultural and political leaders, and environmental conservation activists. A list of the counties, Payams and Bomas was obtained from the state and local authorities and the respondents were chosen in relation to their responsibility in the community.

### **3.5 Methods/Tools of Data Collection**

The main methods of data collection were questionnaires, interviews, observation and literature search. Structured questionnaires for qualitative research and interview guide of key informants were employed. Also observation guidelines were prepared specifically to record first hand information during interview.

### **3.6 Data control and Measurement**

The data obtained were tested for authenticity by the researcher. This was done by carrying out additional search and applying other methods like observation and literature check. The information got from all these sources was put together and measured to determine its correctness and accuracy to ensure consistency of the data obtained.

### **3.7 Data Processing and Analysis**

In analyzing the data, the quantitative data was edited, coded and tabulated manually by the researcher, while the qualitative data included key informative interviews and literature search.

### **3.8 Ethical procedures of Data analysis**

The use of questionnaire and interview guides was applied by the researcher to the various respondents. The same questions were informally given to different people and the answers from these people were useful in minimizing chances of biasness.

The researcher also physically participated in literature search on the effects of agricultural practices on the livelihoods of farming communities. With the use of guiding check lists the researcher recorded the correct impressions that were provided by the first hand information.

For purposes of confidence building among the respondents, the researcher explained the reasons for carrying out the study and that was to investigate the effects that agricultural activities have on the arable land and how it affects sustainable environmental conservation. The researcher also endeavored to guarantee anonymity for respondents who wished to be protected from exposure.

### **3.9 Study Limitations**

In the course of carrying out this study, the researcher anticipated and indeed encountered several constraints which did, in one way or the other, limit the findings of the research. They included among others the following;

- There was limited access to confidential information which was necessary in the research. Therefore the researcher tried to assure the respondents that the information obtained shall be treated with a high level of confidentiality.
- The researcher was also constrained by financial and the time inadequacies. It was not possible for the researcher to interview all people of Bor County in Jonglei State, Southern Sudan.
- There was a problem with getting information from the residents who appeared cautious and did not want to speak freely with strangers. Local people who till the land in this case, were the hardest to get information from due to suspicion that they are being investigated.

## **CHAPTER FOUR**

### **FINDINGS**

#### **4.1 Agricultural activities in Bor County**

The agricultural activities carried out in Bor County include the following;

##### **Livestocks**

The livestock reared extensively in this area are cattle, goats and sheep. The livestock are mainly kept for food, economic income and prestige for paying Dowry. In Bor County, the livestock sector is undergoing a complex process of technical and geographical change. Production is shifting from countryside to urban and peri-urban areas, and towards sources of animals feed. Owing to this shift, livestock are entering into direct competition for scarce land, water and other natural resources.

**Fig 1: Cattle rearing at the Nile in Bor County**



**Source: Researcher in the field**

In the past, nomadic herdsman in Bor maintained the delicate balance between livestock numbers and the carrying capacity of pasture. But this balance recently has been disturbed, through the expansion of dry farming in traditional grazing lands and an increase in livestock populations. Apart from the degradation of natural vegetation cover, overgrazing results in a decrease in the quality of the pasture. In these areas of the County, most of the palatable grasses have been replaced by various weeds species are not palatable for livestock has therefore lead to expansion of pastures to fresh arable land.

### **Veterinary services**

The Jonglei states veterinary services under state ministry of agriculture and animals resources in Bor County, constantly guards against the introduction of animals diseases from outside. The most deadly animal disease in Bor County in the last two years is east coast fever. Due to combined effort of food and agriculture organization and state ministry of agriculture and animals resources the disease is combated. Also surveillance systems are in place to ensure that all animal products entering and leaving the County are disease free, or offer a negligible risk and therefore pose little risk to the animal diseases status of the County and are also safe for human consumption. These improvements in veterinary services in the County have encouraged the farmers to invest in livestock industry. This has lead to increase in animal population which therefore need more arable land for grazing, hence desertification and habitats destruction in the County as a result of overgrazing.

### **Extensive cultivation**

Rain fed agriculture plays a very important role in Bor County offering food supply stability and providing a large share of staple foods such as sorghum, maize, groundnut and sesame, vegetables such as Okra,



pumpkin, Sukuma wiki, egg plants and cabbages are grown along the Nile rivers bank swamps in Bor town during dry seasons. Although in most payams of this County rain fed agriculture has the capability for substantial horizontal and vertical expansion of potential resources at low cost, a rapid increase of human and animals population necessitates a corresponding expansion of cultivated areas, leading to land over-utilization and thus causing land degradation.

Shifting cultivation is common practice in Bor County. It involves the preparation of cultivated land by tree logging and clearing of weeds, securing soil moisture for the crops. This is repeated year after year, resulting in destruction of vegetation cover, and ultimately in soil deterioration and reduced productivity. The most widespread reaction to a dry year is to increase the area of cultivation by taking in arable lands, fallow lands and pastures wherever possible.

### **Aforestation and Reforestation**

The aforestation and reforestation programme in Bor County are under Ministry of state ministry of agriculture and animals resources. In Jalle Payam in Bor County the programme activities are finance and practices by youth associations through project funded by abroad donors and members contribution. Aforestation which is planting trees provides vegetation cover, so as to reduce the speed of running water and wind in this semi arid areas and grassland Bor County. Trees have been cut by farmers to acquire land for cultivation, timber, firewood, pastures and also as the results of frequent flooding that wipe out most of vegetation cover in Jalle, hence there is demand for reforestation. However, these programs have not shown any success to reverse affected arable land to be productive since it is the recent ideas.

### **Fishing**

Fishing is an activity in Bor County, under the departments of fisheries and water resources in Jonglei state ministry of agriculture and animal resources it is mainly carried out in the fresh water of the river Nile and its tributaries that have formed the complex swamp systems known as “Sudd”. This complexity is associated to existence of varieties of aquatic flora and fauna. Food and Agriculture Organization (FAO) has recently distributed fishing equipment such as fishing nets and hooks as the strategies to alleviate food insecurity in the County, which has increased the number of fishermen, hence destruction of the ecological and arable land degradation by activities of the fishing industry. The fishing community has destroyed large hectares of reeds and papyrus in the sudd.

### **Poultry keeping**

The poultry activities are carried out mainly in Bor town by women groups and farmers associations. The poultry kept are chickens, ducks, geese and pigeons. This agricultural activity is progressing at the profitable pace. This has encouraged most farmers and local organizations to invest in poultry keeping. This is not only because of high demand for poultry but also the industry is running at low cost at the expenses of environmental resources such as construction materials from the natural forest. This has exacerbated the destruction of the forests hence decreasing the potentiality of the better arable land that can support productive agricultural activities.

### **Mechanized cultivation**

The mechanized agriculture began in late 2008, MDTF (multi donor trust fund) local NGO, fund micro-project benefited in Bor County, with 3 tractors. The implementation was through NPA, these tractors were received late, therefore not effective. After they have plough 4 hectares of

virgin land, which currently left bare after the removal of the roots of big trees and other vegetation cover.

**Fig 2: Agricultural tractor at work in Bor County**



**Source: researcher in the field**

Also in Jalle Payam of Bor County, the senior government officials join to buy 2-3 tractors to plough more than 5 hectares of agricultural field for growing sorghum and maize. This activity has increased the soil erosion in the concerned areas. Since the areas have scattered trees and semi-arid characteristics, the rainfall causes compaction and removal of the top soil in the fields. This has lead to shifting of the same farms to other productive fields around the same areas.

### **Farmer training programs**

There are two farmers' training centers in Bor County ran by NPA and FAO, donation from multi donors trust fund and state ministry of agriculture, fisheries and animals resources. They are located in Baidit and Makuach Payam. Baidit training centre offers short course training in fisheries about 4-5 months, and train farmers on agro forestry,

nursery bed preparation, and agribusiness activities, conduct workshops and orientation to farmers on sustainable farming and crop yield. While Makuach training centre offer training in agro forestry, seed management and distribution, field preparation and distribution of farm tools and equipments such as hoes, pangas, watering cans and axes.

These farmers training programs have reduced the pressure on arable land, because local farmers are applying sustainable agricultural activities. However, it would not be helpful in the future since the training centres are managed on contract basis.

#### **4.2 Environmental resources affected by agriculture**

##### **Forests**

The disappearance of many trees from forested areas in Bor County has contributed significantly to land degradation and deterioration of soil fertility. Forests are constantly cut down for expansion of agricultural fields and shifting cultivation with negligible replanting being carried out. As populations grow and concentrate in farming communities and villages, the treeless areas around these settlements increase and villagers have to travel farther to fetch firewood and different species are increasingly exploited for both fuel and construction as the better ones disappear. The collection of wood ultimately becomes commercialized, with men taking over the work from the women. As the distance from the wood source increases, wood tends to be made into charcoal to facilitate its transportation. This pressure imposed by agriculture on the forest leads to destruction of the arable land that is not supposed to be disturbed by the recent farming population of Bor County. The demands for agricultural fields explains the depletion of trees around Bor County villages which are surrounded by circle woodless land. This absence of



forest results in extensive wind erosion and the micro climate becomes increasingly arid.

### **Wildlife and landscapes**

Agriculture has affected wildlife habitat and natural scenery of the landscapes around most Bor farming villages. Many wildlife species, once abundant, have vanished, and those remaining are endangered, this due to competition with livestock for grazing land and destruction of the flora by overgrazing. The gazelle (gazelle someringi), which was abundant until 1980s, has completely disappeared from this area.

**Fig 3: Antelopes grazing in Bor County wilderness**



**Source: Googleimages/antelopes/sudan**

The population of antelopes (*thiang* in Bor local language), in the area have declined. The addax antelope has not been seen for the last fifteen years and the oryx has not been seen since 1970s. The disappearance of these species is attributed to livestock pressures on arable land, which

causes competition for pastures and spaces, and the results of deforestation caused by agricultural activities in the County.

Overgrazing and deforestation did not only contribute to migration and destruction of wildlife but also have lead to modification landscapes making the natural scenery to appear dull and irregular.

### **Wetlands**

Bor County is situated along the sudd wetlands of the river Nile systems and its tributaries. Sudd is one of the largest tropical wetlands in the world, located in the lower reaches of the Bahrel Jebel, the name given to the White Nile as it flows north wards.

Ecologically the sudd wetland in Bor County encompasses a number of different ecosystems, grading from open water and submerged vegetation, to floating fringe vegetation, seasonably in undegraded woodland rain-fed and river-fed grasslands, floodplain scrubland. These ecosystems provide suitable pasture land for Bor nomadic pastoralists. The pastures are unlocked in the diverse ecosystems by fire, the burning of reeds and papyrus open the penetration of livestock through the sudd islands during the dry seasons. The pressure of the livestock, overgrazing and destruction of habitats of both plants and animals of aquatic and terrestrial ecosystems lead to decline and migration for birds of international and regional conservation importance, such as the great white pelican, the black crowned crane, the white stork and the black tern. The wetland is also inhabited by the vulnerable mongalla gazelle, the African elephants and the shoebill stocks which face competition from the livestock and are hunted down by pastoralists for food and their parts for social and economic values.

**Fig 4: Aerial view of the Sudd wetland in Bor County**



**Source: Google Images/suddsudan**

Sudd also provides water for irrigation and fertile soil for agriculture during the seasons between December to April. The irrigated agricultural fields are used to grow vegetables such as Okra, ladyfinger, sukumawiki, Spanish, cabbages, egg plants, carrots, and onions. Maize is also grown. The produce is used to supply Jonglei states headquarters of Bor town which is located in Bor County along the Nile Sudd wetland. Due to high demand of these agricultural products in the dry seasons, the Sudd wetland suffers great ecological destruction; it has led to proliferation of water hyacinths along these irrigated fields. The cultivation along the Sudd in Bor town leads to direct discharge of the town waste and run off into the Nile via the open fields, hence poor water quality, since the Sudd wetland is the natural filter that controls and normalizes water quality and acts as a giant sponge that stabilizes water flow along the river Nile system.

### **Soil**

Soil erosion is an agricultural problem in Bor County because natural vegetation has been removed by shifting cultivation and expansion of



cultivated land. As a result, surface water and winds carry away topsoil, the surface layer of soil that is rich in nutrients and beneficial micro-organisms. This has a direct effect on habitat quality, making an area barren and unsuitable for plants that were native to that habitat.

**Fig 5: Cultivating on barren land in Bor county**



**Source: Researcher in the field**

Around water points, and especially where people have settled in permanent communities in Bor County, grazing drastically reduces soil cover. This has a tremendous effect on soil degradation and hence desertification coming up. Overgrazing is worse where water points have been sited in close proximity. In such cases, the grazing area around water points overlap. The area of overlap is then heavily overgrazed; this leaves the soil loose making it vulnerable to erosion.



## **CHAPTER FIVE**

### **DISCUSSION AND RECOMMENDATIONS**

#### **5.1 Mitigation measures**

USAID and UNDP have helped to build capacity in the forestry sector in Bor County by training forestry officials in proper management of forests concessions and agro forestry extension aiming at reducing the adverse environmental impacts of agriculture on arable land.

Wildlife officers have been trained in wildlife protection and biodiversity conservation at Boma Wildlife Training Centre, a government facility that was revitalized through NGOs support the training ranked agricultural practices as human activities that effect the conservation of wildlife. Therefore the agricultural conservation practices were to be introduced. The government officials and NGO workers have been trained in environmental sound agricultural practices.

Government, local and international NGOs operating in Bor introduce environmental sound development practices including environmental impact assessment (EIA). EIA is carried out for large scale agricultural practices such as mechanized agriculture which involves conventional tillage that uses tractors.

Beginning in 2009, in Jonglei state where Bor County is located, USAID began to support a landscape-level biodiversity conservation program aimed at protecting southern Sudan's rich wildlife resources while enabling the farming communities to benefit from sustainable natural resource management.

UN agencies such as UNDP, FAO and USAID are helping government of Southern Sudan (GOSS) to develop the land tenure laws and policies through an extensive stakeholders' process, as secure property rights are the basic for sustainable agricultural production and economic growth that threaten arable land in the County. These efforts are helping farmers and pastoralists to secure land rights and reduce conflicts, while improving access to land for sustainable agricultural production.

Diking to isolate Bor County area from annual flooding provides wastes arable land into use. The present dike/road building along the Eastern periphery of Sudd North of Bor County has prevented flooding for the last few years since the construction began. The adverse environmental impacts of floods such as change in wildlife habitats, fisheries resources and agricultural land-use options related to livestock grazing and cropping are current curbed down.

Ratification of Ramsar convention Gross in November, 2006 at Juba denotes the Sudd wetlands in Bor County as the wetlands of international importance. This has regulated agricultural activities along the wetlands to the world Ramsar sites standards and regulations.

## **5.2 Suggestions and Recommendations**

There should be construction of boreholes, in order to reduce the agricultural activities along the Sudd wetlands during dry seasons and minimize on the movement of pastoralists, hence little disturbance on arable land.

The GOSS, Jonglei states government and NGOs in collaboration with Bor County local government should encourage massive education to

farmers on sustainable agriculture and the pastoralist in order to teach the value of conserving the environment and importance of living the settled life. This would reduce the agricultural land use pressure on arable land.

Farmers to be encouraged to voluntarily organize themselves into co-operative societies and associations aimed specifically at County environmental objectives. The agricultural producers should be the main force behind the establishment of the organization in order to provide strategies and environmentally sustainable agriculture issues and forum through which large scale and local producers group can share knowledge, identify course of action and work toward solutions in a coordinated fashion.

NGOs and local government should create awareness and campaign for sustainable and conservation agricultural activities impacts on County Jungles and forests, other vegetation covers.

The existing systems of land ownership should be modified from clan/communal ownership to individual ownership. This will ease provision of services, reduce soil erosion, overgrazing and the spread of pests and diseases across arable land.

Alternatives agricultural practices should be introduced in order to promote conservation of the arable environments. The environmentally friendly agricultural practices such crop rotation, rotational grazing, mulching, strip cropping should be encouraged to replace shifting cultivation and pastoralist.

Aforestation and reforestation programs should be emphasized most by local farmers and NGOs in order to rehabilitate trees that have been cut

to acquire land for cultivation, timber, charcoal and pasture-improvement.

Agro forestry is one of the agricultural practices that deserve to be used by the whole County due to its multipurpose conservational functions. It's used to provide fodder, construction materials, food stuffs, shades and other natural environment related activities that attracts farmers to overuse the natural ecosystems and arable land.

Development of other sectors of the economy such as tourisms, transport and communication among others could reduce number of farmers and reduce local dependence of agriculture as the only income earning activity hence reduce pressure on arable land.

Environmental Impact Assessment should be the best tool for developing sustainable agricultural practices in Bor County either at large scale or small scale level.

There should be mechanisms for preventing fires set by pastoralists for pasture on Sudd wetland reeds and papyrus and savanna grassland of Bor County. If large fires are prevented or fought, limited fire itself is a way of promoting natural forest growth.

Since the arable land in Bor County is large enough when compared to the farming community size, gazzeting other arable land as forests or game reserves would promote conservation of Nature and natural resource management efficiency.

GOSS and State authorities should provide security in the County farming communities to avoid agricultural practices concentration on specific sites.

There is need to register and train fisherman in better methods of fishing. This is essential in creating awareness among fishermen by opening up training institutions near landing sites such as Bor town in order to enable them to practice sustainable fishing methods in the Sudd wetlands.

Research should be encouraged in the County to promote sustainable agricultural projects. The research should evaluate farming systems designed to maximize use of the marginal land that many small scale farmers should be obliged to cultivate. It should also investigate the use of alternative farming practices such as integrated pest management and agro forestry on arable land.

Government, International organizations, UN agencies such as UNEP, IUCN and local authorities should invest in remote sensing and geographic information systems (GIS) to monitor and evaluate agricultural activities and enhance knowledge and database of the sensitive areas of the Sudd wetlands on the river Nile.

### **5.3 Conclusions**

Agriculture and society in Bor County are facing tough tradeoffs in that arable lands have become incredibly useful in producing food, but these increased yields have environmental costs that cannot be ignored, especially if the rates of deforestation and Sudd wetland destruction double.

The tradition of agriculture in Bor County has always been to maximize production and minimize the cost of food with little regard to impacts on the environment and the services it provides to society.

The current trends of traditional agricultural practices in Bor County will be relatively unstable that it will make arable land susceptible to invasion by weedy species and high incidences of pests and diseases.

The future of the livestock environment interface in Bor County will be shaped by how farming population resolve the balance for animals, food production and environmental services. Since the natural resources base and arable are finite, the huge expansion of the livestock sector required to meet expanding demand must be accomplished while substantially reducing its environmental impact.

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## **APPENDIX I**

### **Questionnaires for selected residents, local leaders and politicians in Bor County, Jongtei state, Southern Sudan**

Dear Respondent,

This questionnaire is designed to seek information from you on the effects that agricultural activities have on sustainable environmental conservation. It is carried as a partial fulfillment of the requirements for the award of a Bachelors Degree of Environmental management of Kampala International University. Your contribution, opinions and experience will be highly appreciated.

Thanks for your cooperation.

#### **Agricultural dependence:**

1. How widespread is the dependence on agriculture in your community?
2. What is the tenure on land ownership in this community?
3. On average, how much land does each household have'?
4. What crops are most cultivated in this region?

#### **Environmental effects of agriculture:**

5. Does the cultivation of these crops have any effect on the environment?
6. I f so, what effects are they?
7. What challenges do you face in a bid to utilize the natural environment for survival?
8. Do you think there are any farming practices carried out in this region which affect the environment?
9. I f so, what are they?



Mitigation strategies:

10. How are you addressing these problems? .
11. How do you think the government and NGOs can help?

## APPENDIX II

### **Interview Guide for selected government officials and environmental conservationists in Bor County, Jonglei state, southern Sudan.**

Dear Respondent,

This interview guide is designed to seek information from you on the effects that agricultural activities have on sustainable environmental conservation. It is carried as a partial fulfillment of the requirements for the award of a Bachelors Degree of Environmental management of Kampala International University. Your contribution, opinions and experience will be highly appreciated.

Thanks for your cooperation.

1. What is your name, age and sex?

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2. How long have you stayed in this County?

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.....  
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3. What is your observation concerning the state of the environment in this County?

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4. Is there any way in which agricultural activities affect the environment?

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5. If so, what ways'

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6. According to you, what can be done to reverse the environmental threat caused by uncontrolled agricultural practices in this County's arable land?

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