THE IMPACT OF IRRIGATED SCHEMES ON RURAL DEVELOPMENT IN NORTHERN UPPER NILE STATE, SUDAN

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Dedication

This study is dedicated to low-income and poor smallholder farmers, nomads, fishermen, landless and agricultural workers who are making their development sustainable in all rural areas.

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ABBREVIATIONS

CAADP : Comprehensive Africa Agricultural Development Programme.

CIA : Central Intelligent Agency of United States.

CPA : Comprehensive Peace Agreement.

FAO : Food and Agriculture Organization of United Nations.

IFAD : International Fund for Agricultural Development.

IMF : International Monetary Fund of United Nations.

IPTRID : International Programme Training Research for Irrigation and Drainage

GDP : Growth Domestic Product.

GOSS : Government of Southern Sudan.

USAID : United States Agency International Development.

WCAARD : World Conference on Agricultural Reform and Rural Development

WCED : World Conference for Environmental Development.

WFP : World Food Programme.

WFD : World Food Day

WFS : World Food Summit.

ABSTRACT

The recent global financial and food crises, the changing climate with rainfall fluctuation and adequacy have created awareness and much concern among governments, experts and farmers about irrigated agriculture as powerful instrument to make agriculture more productive to attain food security for the growing population, increase farmers' income and improve their living standards in rural areas.

The Northern Upper Nile Irrigated Schemes with good potentials can play a major role in achieving these goals as alternative to rain fed schemes for crops production.

This study was conducted to evaluate the impact of irrigated schemes on rural development with focus on socio-economic aspects of farmer, food security and social services in the study area.

A multistage stratified random sampling procedure was used. Six locations were predetermined and selected namely Geiger, Abu Khadira, Fewar North and Latbior on the eastern bank of White Nile River. Bushara and Wadakona on the Western bank. 20 farmers were randomly selected from each locality to have 120 samples. Primary data was collected through questionnaire by means of direct interviewing of respondents in the year 2008. Secondary data were obtained from various relevant sources.

Different statistical techniques were used in data analysis including frequency distribution and chi-square test analysis.

The study revealed that illiteracy among farmers was very high and the impacts of the schemes were positive on food security, farmers' incomes, education and health services while no significant change on drinking water and availability of diseases in the study area.

The study recommend the rehabilitation of the schemes, by

reallocation of the existing resources and changing farm size and crop structure from simple three course to four course rotation for more intensification and diversification by adding new cash, food and fodder crops to increase farmers incomes, improve livestock production and food situation since the area is enjoying good recharge of irrigation water. The study also suggests a gradual reform of vast fertile but at the same time unexploited or unsustainably used rain fed schemes in Northern Upper Nile into large long term irrigated projects by reducing size of these schemes from 1,000 to 500 feddans for each farm to be divided into four Hawashas of 125 feddans each. This could be financed by agricultural and Commercial Banks for cultivation of cotton, sunflower, sesame, sugarcane, guar and groundnut as cash crops. Sorghum, maize, millet, rice and vegetables as food crops in four course rotation to make this area ‘food basket’ for southern and western States of Sudan.

الخـــلاصة

الازمة المالية والغذائية العالمية، المناخ المتغير مع تذبذب الامطار وعدم كفايتها خلقت وعياً والكثير من الاهتمام بين الحكومات, والخبراء والمزارعين بخصوص الزراعة المروية كأداة فاعلة لجعل الزراعة أكثر انتاجية للحصول على الامن الغذائى للجموع المتكاثرة من السكان، ولزيادة دخل المزارعين وتحسين معدلات معيشتهم فى المناطق الريفية.

مخططات رى منطقة شمال أعالى النيل مع أمكانيات جيدة يمكنها أن تلعب دوراً كبيراً فى تحقيق هذه الأهداف كخيار بديل لمخططات الرى المطري لإنتاج المحاصيل.

أجريت هذه الدراسه لتقييم تأثير مخططات الري على تطور المناطق الريفية مع التركيز على الجوانب الاقتصادية – الاجتماعية بالنسبة للمزارع, والامن الغذائى والخدمات الاجتماعية فى منطقة الدراسة.

تم استخدام طريقة العينة العشوائية الطبقية المرحلية. ستة مناطق تم تحديدها مسبقاً واختيارها, تحديداً هي القيقر وأبوخضرة، فيوارشمال، ولاتبيور علي الضفة الشرقية للنيل الابيض. ومناطق بشارة وود دكونا علي الضفة الغربية. عشرون مزارعاً تم اختيارهم عشوائياً من كل منطقة للحصول على 120عينة. البيانات الأساسية تم تجميعها من خلال استبيان بطريقة المقابلة المباشرة فى عام 2008م.البيانات الثانوية تم الحصول عليها من مصادر متنوعة ذات صلة بموضوع الدراسة. وقد تم استخدام اساليب احصائية مختلفة فى تحليل البيانات شمل ذلك التوزيع والنسب التكرارية, والتحليل الاختبارى بمربع"كاي".

كشفت الدراسة أن نسبة الأمية بين المزارعين كانت عالية جداً وأن تأثيرالمخططات كان معنويا على الأمن الغذائى, دخل المزارع, وخدمات التعليم والصحة بينما لم يكن هناك تغيير معنوي على ماء الشرب وتكاثر الأمراض فى منطقة الدراسة.

توصي الدراسة بإعادة تأهيل المخططات عن طريق تخصيص الموارد الحالية، وتغيير حجم المزرعة وتركيبة المحاصيل من ثلاثية بسيطة الى دورة رباعية لمزيد من التكثيف والتنويع باضافة محاصيل نقدية، علفية أوغذائية جديدة لزيادة دخل المزارعين وتحسين انتاج ماشيتهم والموقف الغذائى، لأن المنطقة تتمتع بمياه رى متجددة وجيدة.

تقترح الدراسة كذلك اصلاحاً تدريجياً لمخططات الزراعة المطرية الخصبة وغير المستقلة بصورة مستديمة فى آنٍ واحد فى منطقة شمال اعالى النيل وتحويلها الى مشاريع مروية ضخمة طويلة الأمد بتخفيض حجم هذه المخططات من1000فدان لكل مزارع الى 500 فدان على أن يتم تقسيمها إلى أربعة حواشات من 125 فدان لكل واحدة. ويمكن أن تقوم البنوك الزراعية والتجارية بتمويلها لزراعة القطن وزهرة الشمس والسمسم وقصب السكر, القوار والفول السودانى كمحاصيل نقدية. الدخن والذرة الرفيعة والذره الشامي والارز والخضروات كمحاصيل غذائية فى أربعة فترات دورية لجعل هذه المنطقة سلة الغذاء بالنسبة للولايات الجنوبية والغربية فى السودان.

CHAPTER ONE

1. INTRODUCTION

1.1Background

Agriculture has been and will continue to be a sector with multiple functions which gives it powers as unique fundamental instrument for development and reduction of poverty in developing countries. These countries have looked at it as a way of solving some of their own development problems in many dimensions of ill being like poverty, inequality of conditions and chances, vulnerability to stocks, sustainability during resources use and access to basic human needs such as health, education, citizenship and social peace (World Bank,2008). The changing climate with rainfall fluctuation and inadequacy, rapid population rate growth and the recent global financial and food crisis effecting more than 21 countries, where half of them are in Sub-Sahara Africa, which are particularly vulnerable and this number can double if the global growth of financing conditions deteriorates further. After hitting the advanced economies and then emerging economies such as China and India, the third wave from global financial crises is now hitting the World poorest and most vulnerable countries putting at risk the major achievements at higher growth, lower poverty and greater political stability that many low income countries have made over the past decade (Khahn, 2009).

All these crises are placing more challenges for both governments and farmers in every developing country to adopt irrigated farming systems to make agriculture more productive as a key to attain food security, increase farmer's incomes and improve living standards of their rural poor.

Sudan as largest African country has good agricultural potential,

which include variety of climate from desert regions in the north to equatorial zone in the south. This makes the Sudan favorable environment for all activities of integrated agricultural investment from production to processing industrials (Jalal, 1997). Sudan population now is 39.2 million (Sudan Census 2009). Most of the population lives along the Nile and it tributaries. Some live around water points scattered around the country.78 of the population have access to improved drinking water. (FAO, 2004). Sudan has a large modern irrigated agricultural sector totaling more than 2.4 million feddans out of about 209 million feddans that are potentially arable. About 93 percent of irrigated area was in government projects, the remaining 7 percent belonged to private cooperation (CIA, 1991).

The Northern Upper Nile irrigated schemes are extension of White Nile Schemes and were administered from White Nile State (Kosti) before the establishment of Upper Irrigated Project in the year 2000. The total arable area covered by these schemes is about 300 thousand fedddans in 21 locations in east and west bank of White Nile River (Map: 1). The main crop grown is cotton an export cash crop .Dura, groundnut, sunflower and vegetables are also cultivated. The area is rich with forest, animals, land and water resources .The evergreen and deciduous trees are the dominant in the area but forest land diminished rapidly in the pace of fast growing agricultural land expansion. At the present the remaining forest-suffered from animals movement looking for grazing land and water during dry season and return back when rains start. Most of animals in Northern Upper Nile are of local breed no improvement programmes carried out except vaccination which is done as animal care by NGOs.

The area enjoys a good amount of rainfall which is considered one of the main sources of water irrigating big agricultural schemes.

The position of Northern Upper Nile as transitional area between the south and the north makes it an ideal marketing center and transverse point for supplying many regions with different agricultural products not only in the south but also the north (Haroun, 2007). It is considered the biggest production centre for crops such as cereals, oil fiber, gum Arabic and animal wealth in southern Sudan. This choice of Northern Upper Nile as a centre for crops production in the south was in response to development plans in early seventies for the following reasons:-

1. Availability of vast fertile land.
2. Favorable climate conditions.
3. Availability of cheap labor.
4. Flexibility of means of transportation (Haruon, 2007).

1.2Problem Statement

The irrigated schemes in Northern Upper Nile experienced decline in both productivity and cultivated area due to lack of funds, wrong policies and weak infrastructures causing shortages in food, low incomes, spread of diseases due to poor health services, increasing poverty and instability in the area .Farmers found

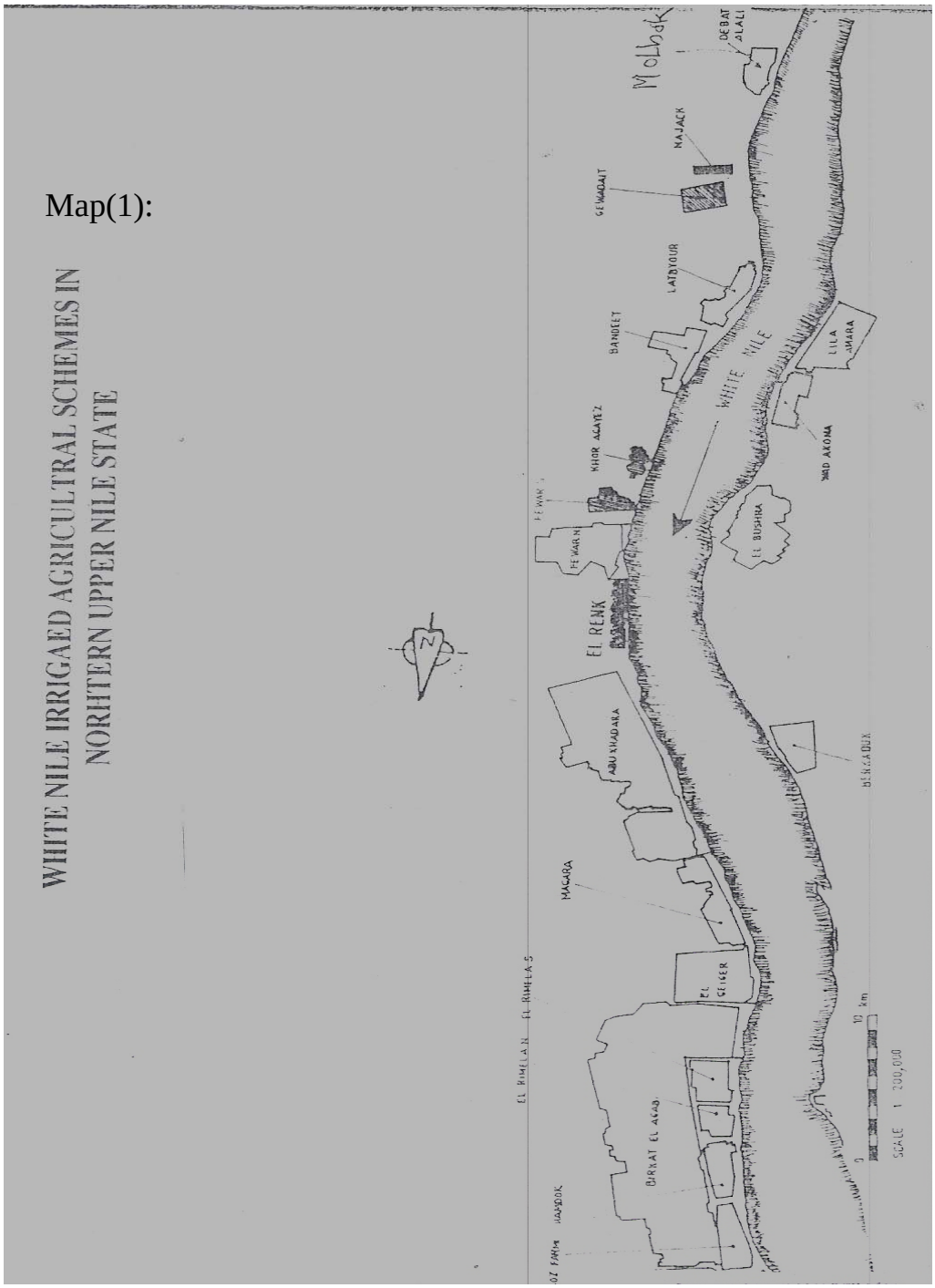
it difficult to get alternative means for their livelihood other than internal migration to urban centers, quitted their schemes and villages and engaging in marginal activities such as cutting of trees for wood and charcoal creating even more damage to the forest resources . The mechanized rain fed agriculture in the area has led to confestication of local farmers lands and transformed them from farmers to labors instead of improving their standard of living.

1.3 Research Objectives

This research concentrates on economic and social impact of the irrigated schemes in Northern Upper Nile State however the specific objectives are:

1. To assess the impact of irrigated schemes on food security in Northern Upper Nile State.
2. To investigate the changes in farmers incomes caused by irrigated schemes in the area.
3. To study the impact of the schemes on social services (health, education, water, sanitation).
4. To suggest recommendations for improving irrigated schemes for the achievement of sustainable rural development in Northern Upper Nile State.

Map(1):



Map 1: White Nile Irrigated Agricultural Schemes in Northern Upper Nile State

1.4Research Hypothesis

1. There is food shortage in the area.
2. There is poverty in the area because of farmer's low incomes.
3. Farmer's incomes are low due to low crops yields.
4. There are diseases in the area due to poor health services.
5. Illiteracy is high among the farmers.
6. There is lack of clean drinking water and sanitation in the area.

1.5 Research Questions

1 .What is the situation before and after the introduction of irrigated schemes in Northern Upper Nile State.

2. Which is profitable for the farmers to concentrate on cotton production as cash crop or food crops?

3. What are the main factors influencing the crop production and farmers incomes in these schemes.

4. What are the appropriate solutions to improve irrigated schemes in Northern Upper Nile State which will lead to rural development?

1.6 Research Organization

The research is organized in five chapters. Chapter one deals with the general introduction about Sudan agricultural potentials in terms of land and water resources and its place in Sub-Sahara Africa regarding irrigated agriculture and the importance and potentials of Northern Upper Nile as productive centre in the whole Southern Sudan .The chapter also includes the problem statement, research objectives, hypothesis of the study and research questions.

Chapter two is a literature review about the concept of development, rural development, agricultural development and concept of irrigation,

irrigated schemes in Sudan and southern Sudan. Some African irrigated schemes are included.

Chapter three introduces the research methodology followed. Chapter four is devoted to the research results and discussion of the impact of irrigated schemes on food security, social services and farmer's incomes. Finally, chapter five is the conclusion and recommendations of the study

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Concept of Development

The term development has been used by many scholars, writers, researchers and decision-makers to mean different things to different people. Sinah (1963) suggested that “development and under-development terms are not free from ambiguity and do not enable us to make rigid classification of the different countries of the World. Yet they broadly indicate the status of countries. The words developed, un-developed, underdeveloped and less developed are often use to denote the social and economic conditions of the people in a given country or region (George, 1979). The concept of development is elusive: it is perceived not only as a condition of life but also as goal to be attained and as the capacity to grow, change and develop. Chairman (1978) stated that these ideas of development are bound together in efforts to understand and deal with the phenomenon of development. According to African Development Group, (1978) development is defined as recite (In: Suliman, 2002): “a process in which man is liberated from realism of freedom to create, to produce to enjoy and to consume”.

This definition necessitates the freedom of people in the development process to enable them choose, be creative and participate in their development programmes and be agents for change and transformation.

Dixon, (1978) indicated that the development broader concept include progressive reduction and eventual elimination of malnutrition, diseases, illiteracy, unemployment. In the same context, Koker, (1973) defined development as:

"A general improvement in the level of livings, together with decreasing inequality of income distribution an capacity to sustain continues improvement overtime" (In: Dixon, R.1978). To measure these development components tailored to local conditions and general improvement in level of living include not only the reduction of malnutrition , disease , illiteracy and unemployment but also it needs increase in regularly amount and purchasing power of income in kind or cash in land ownership or access to it.

Todaro, (1985) viewed development as programs directed at the promotion of socioeconomic conditions prevailing in rural areas. Such programs aim to enhance the efficiency of agricultural production and adjunct services together with the provision of social services conductive to production. Development is dynamic concepts, which suggests change in moment away from the previous and present situation to a situation where people can accomplish things they could not do before. Gabriel, (1991) indicated that learning an applying information, attitudes, values and skills previously unavailable to the bad learning as one aspect of development requires capital investment and technical process. Since development process involves the use and development of resources, it must also contain elements of political activity, Politics after all is based upon differing and often conflicting views of resources uses so that development choices must be understood in part at least as political choices. Development is about types of economic and social changes and human choices and values regarding those changes.

According to various studies conducted on experience of the third world which indicates that the process of development could take different forms and different objectives. Okley, (1985) indicated three forms of concepts of development as follows:

1- Development involves introduction of new ideas in the social system in order to produce higher per capita income and improve level of living standards through modern production methods and to promote changes.
2- Implies total transformation of traditional or pre-modern society to types of technology and associated social organizations of advance staple nations of Western world.
3- Building up people .It is and experience of freedom in deciding and choosing.

Kabirn (1994) stated five criteria of development, these are:

1- A property or attribute which is a basic prerequisite and criteria of development is capacity of the given society increasingly to use it on resources of land, minerals and manpower to feed its own people even in the situation of population growth, more direct and in that sense unsatisfactory empirical indicators could deal with results of food sufficiency or insufficiency such as the status of health of the population or levels of child mortality which could be assumed to be correlated with food availability or without however, being able to indicate the extent to which health status is due to internal production to another property require for satisfying the concept of development is that a given country is capable increasingly to produce to make available farmers the basic tools needed in food production or in countries with lack of arable land the tools needed in other production necessary for importation of food.
2- To speak out development also implies that there is emerges through struggle, a set of share transaction rules regulating relationships between the main actors involve in the economic or other important

social activities and accepted by the majority as legally or morally binding.

3- Without indigenous interpreters and labors there should not be development. The existence of labor and indigenous entrepreneurial and innovative activities to manage labor and other resources in the production and sale not only of agricultural products and tools but other products are necessary elements identifying the very process of development.

4- Development of export-import relationships but with reasonably balance transaction of this trade so as to avoid too much of unequal exchange is one criterion. This could be perhaps considered as an effect of development or in some theories as a precondition for development rather than criterion to be used in defining development.

2.2 Sustainable Development

Sustainable development will be a key issue for the next decades (FAO, 1989). Babiker (1994) defined sustainable development as the management and conservation of natural resources base and the orientation of the technological and institutional changes in such manner as to ensure the attainment and continued satisfaction of human needs for present and future generation. According to David Peare (1999), such sustainable, which conserve water, land, plant and animal genetic resources environmentally man degrading, technically appropriate economically viable and socially acceptable.

Sustainable development is a development strategy that manages all assets, natural resources; human resources as well as financial and physical assets for increasing long term wealth and well being. Sustainable development as a goal rejects policies and practices that support current

living standard by depleting the productive base including natural resources and that leave future generation with poorer prospects and greater risk than our own (WSSD, 1987). Sustainable development is a process which uses world resources in a way sustainable in the long-run. Bruntland Commission memorally defined Sustainable Development as: "Development which meets the needs of the present without compromising the ability future generation to meet their own needs" (Bruntland Commission, 1987).

This definition is now universally accepted as a starting point for looking at sustainable development, a policy that implies tackling problems with foresight and one that most nations wholly embraced. It also brought together the so called "there's", environment, economy, equity where the World Summit on Sustainable Development (WSSD), 1987 built on these pillars. The report rendered by Bruntland Commission 1987 "our common future" and the report by Brandt Commission 1980 strongly influenced the international policies on environment and development and established a complex relationship between environmental degradation, population growth and social inequalities. Degradation of natural resources is harbinger of poverty such as over fishing and deforestation for which deplete the very resources on which the poor depend. The report of Bruntland Commission (1987) was one of the major incentives for the World Summit in Rio-de-Janeiro 1992 knowing as the Earth Summit which adopted comprehensive action programme to achieve sustainable development in the 21st century. The conventions which were put in the place at the Earth Summit have provided a framework for ongoing negotiation and major progress on issues like climate change, biodiversity and desertification. Although the Earth Summit was at a time of optimism and hope but after ten years from the Summit, deals were far from the sustainable development because the World

faces endemic poverty, environmental degradation and unsustainable lifestyles and the global inequalities have increased.

Some writers have attempted to define sustainable development as a process of changes in which exploitation of resources, the direction of investment, the orientation of technological and institutional changes are all in harmony and enhance both current and future potential to meet human need and aspiration. El-Shiekh, (1993) gave a similar definition in which sustainable development is the development that meets the needs of the present without compromising the ability of the future generation to meet their own needs.

Recently there is strong tendency among the scholars, writers and development experts to consider sustainable agriculture as the most relevant approach to achievement sustainable development in the third world countries.

Sustainable agriculture is based on the idea of farming in harmony with nature of carefully using nature's riches rather than nearly exploiting them. It means promotion of natural conditions where possible. Ali , (1997) stated that sustainable agriculture refers to agriculture where production methods are being used to maintain or improve the productive resources such as (soil, plants, animals, human labor and skills, social economic system and services and infrastructure) as well as non productive natural and cultural resources. Thus search is for alternative that are environ-mentally sound, economically efficient, socially more just and politically more participatory. Sustainable agricultural methods are politically desirable because they will create more employment, they are better suited to the poorer farmers since they are labor intensive are required only low cash inputs. The Policy of sustainable agriculture means more small farmers and

many of the poor rural people can make a living from and contribution to the country's agriculture (Ali, 1997).

2.3 Rural Development

By the late 1960s, planners and decision- makers recognized the fact that to faster development in less developing countries, introduction of new models of development are needed. Such approaches should aim at the provision of basic needs for the majority of the population residing in the traditional sector and making the process of their development self sustained. Rural development has become a growing concern for many governments in the third world as well as for the international aid-organizations since the United Nations Second Development Decade 1970.

Bello, (1998) viewed rural development as application of policies, approaches and practices by national governments and NGOs as well as the international agencies in the traditional societies. It is therefore aim at improving the standard of living of the mss population residing in the rural areas .It is associated with the introduction of different-subprojects and activities in different communities. Such attempts usually focus on poverty alleviation and inequality (Suliman. 2002).

As stated by Bello (1998) the term rural development is used to refer to the process of transformation and changes in the total system of relation of production. Transformation is associated with environmental and technical changes as well as the economic and Scio-cultural aspects.

World Bank (1975) defined rural development as: "A strategy designed to improve the economic, social life of specific group of people of rural poor. It involves extending the benefits of development to poorest among those who seek a livelihood in rural areas. The group includes small scale farmers, tenants and landless" (In: Chambers, 1983).

This definition views development as strategy to help the rural people of different class's, age group and occupation to plan for their needs and to be able participate and look forwards to their future development.

According to Lel, (1975) rural development is defined as: "Improving living standards of the mass of the low-income population residing in the rural areas, making the process of their development self-sustaining" (Lele,1975).

This definition indicates three important features:

- Improving the standard of living for subsistence's population, where there are mobilization and allocation of resources, so as to reach desirable balance over time between the welfare and productive services available to sustain rural development programmes.
- Mass participation requires resources mobilization and allocation to low-income regions or groups.
- Making the process self sustaining which means the development programmes should be built on sustainability through development of appropriate skills of target group and institutional building at local, regional and national levels to serve the process of rural development.

Mubarak (1997) defined rural development as: "extended efforts towards improvement of standards of living of rural people with participation in integrated manners at all different sectors" (In : Mustafa, *et al*, 2002).

In the above mentioned definition, community participation refers to as action process whereby the people influence the direction and execution of development project. It requires an active involvement in decision

making, implementation, benefits, monitoring and evaluation of activities (FAO, 1989). The community participation is important because it facilitates the immediate fulfillment of the community needs. It enhances the sense of initiative and dependence among the local inhabitants. According to Bello, A, (1994) this participation or bottom –up approach requires that the beneficiaries participate in all stages of project activities, project identification , implementation, execution aimed at creating sustainable rural development which can be extended and carried out by the community in the future through its participatory institutions that will be built during the project life

3.1 Objectives of Rural Development

The main objectives of mural development is to achieve socio-economic development, is a balance process among the rural people. Okley, P. (1983) indicated that the objectives of rural development include the following:

Increase of agricultural out put per capita income.

- Provision of social services (health, education, water supply, sanitation).
- Generating new employment opportunities for rural people.
- Obtaining greater opportunities of income distribution.
- A much greater opportunity for rural population to realize full potential for their belief through training and learning.

Rural development is crucial in developing counties, where more than 80% of population in these countries lives in rural areas and in Southern Sudan this percentage is higher as Garang. (1981) indicated that the rural of Sudan is even truer of the Southern Region where more than 90% of population live and subsist in rural areas.

In the reference to development there is no national development without rural development. Okley, (1983) stated six principles to be considered when providing basic rural development programmes they are:

1- Access tries to ensure that programmes and their benefits are related to those who are in need.
2- Dependence: The development programmes should be designed to help and support the rural people, but they do not make them or their livelihood depend upon the programmes.
3- Sustainability: To ensure that these programmes plans and solutions are relevant to the local economic social and administrative solutions. Short-term solutions may yield quick results but long term may be suitable to local environment and have greater success.
4- Going forwards: Technical aspects of rural development programmes should help rural people to take the next step in the development and not demand o to take huge technical leaps.
5- Participation: By means of consulting rural people, seeking out their ideas and involving them as much as possible in the development programmes.
6- Effectiveness: Rural development programmes should be based on active use of resources and not necessarily of their most efficient use.

These broad principles are important not for checking up the types of planning or implementation but they are ways of designing rural development programmes to ensure sustainability and to achieve their objectives.

The World Conference on Agricultural Reform and Rural Development (WCARRD) which was organized in Rom 1979 classified objectives of rural development into primary and contributory objectives. The primary objectives include eradication of poverty, hunger and malnutrition while contributory objectives include growth with equity. National self reliance in food security production, ecological harmony, conservation of natural resources, social, economic structure and inter group relationship in rural societies.

2.5 Agricultural Development

Agricultural development both in terms of plant and animal production is considered the foundation of national economy in it's entirely and the development of other sectors is closely linked to agricultural expansion. Studies showed a correlation between population growth and agricultural production in both developed and the developing nations as well as between he rural and the urban societies, but the gap widened sharply after the World War II.

During the 1960s a new potential for the rapid increase in the grain production in the developing countries by the economists who increasingly shifted their attention to economy that did not solve the problem of nations which are characterized by static agricultural technology, rapid increase demands for farm products in response to population and income growth beside the growth of urban centers. There is agreement among economists in regard to an ideal package by which rapid productivity and out put growth can be attained in agricultural sector.

Schultz, (1964) suggested that a significant growth in productivity can not be brought about by the relation of resources in traditional agricultural systems. Significant opportunities for growth will become available through

changes in technology of husbandry, better seed varieties, more efficient sources of power and cheaper plant nutrients. Schultz's theory of agricultural development is consistent with more generalized perspectives advanced theory of Simon (1966). The basic hypothesis for achievement rapid growth in agricultural productivity urges the capacity to generate ecological adapted, economically viable, socially acceptable agricultural technology. However, achieving a continuous success in agricultural growth over time involves dynamic process of adjustment to the original agricultural development. It also involves an adapted response in the part of cultural, political and economical institutions.

In the pre-modern times agriculture was characterized by continuous relative slow development of agriculture tools, machines, plants, animals and husbandry practices. The rate of development was influenced by long run pattern of population growth and price fluctuation.

The sustained rate of growth in agricultural out put was in the range of 1% per year in many pre-industrial nations, but with the industrialization, potentials for the growth of agricultural output became in the range of 1.5-2.5% per year (Ester, 1981).

After the industrial revolution, growth rate developed over time in the Western Europe, North of America and Japan. During the mid of 20th century the growth again shifted upward to over 4% per year (Ester 1981). Sustained growth rate of similar range has been observed in newly developed economies like Mexico, Brazil, Taiwan and Israel (Yujiro, 1985).

Viewing, the history, the problem of agricultural development is not transforming a static agricultural sector into a modern dynamic, but of accelerating the rate of growth of agricultural out put and productivity consistent with the growth of other sectors of modernized economy which

was ranging from those in which output growing was at the rate of 1% or less to those in which agricultural output growing was at annual rate of 4% per year or more (Jerry, 1981).

According to Haroun, (2007), the literature on agricultural development has been characterized by six approaches as follows :

[1] Resources exploitation: Expansion of the cultivated area is being one of the main principles mean of increasing agricultural production that laid down by the Western nations who opened the new continents (North and South America, Australia and Africa).

[2] Conservation: Young (1961) stated that the conservation model of Agricultural development evolves from advances in crop and livestock husbandry associated with the English Agricultural Revolution based on the concept of soil exhaustion and theory of fertility by Liebig (1873).

[3] Location: This model was formulated to explain geographical variations in the location and intensity of agricultural production in industrialized economy. Johann *et al*. (1850) tried to determine both the optimal intensity and cultivation and the optimal farm organization, or combination of crop and animal enterprises. They generalized the Recardian theory of net (1817) which shows how urbanization determines the location of agricultural commodities and influences the techniques and intensity cultivation.

[4] Diffusion: Pavlov, (1969) explained that the diffusion of better husbandry practices of crop and livestock has been a major source of productivity growth in agriculture. Others said the source of diffusion approach in agricultural development was drawn from the observation of sustainable differences in land or labor productivity among farmers in any region, from the most advanced to the most back-ward. However the view

reflects more effective dissemination of technical knowledge and narrowing of dispersion in productivity among individual farmers and regions.

[5] High pay-off input model: Poor policies based on the diffusion model led in 1960s to re-examination of the assumption regarding the availability of a body of agricultural technology that could be readily diffused from the high productivity to low productivity countries and the existence of significant disequilibria in the allocation of resources among progressive and lagging farmers in the developing countries, but the model remained incomplete as a theory of agricultural development. The mechanism by which the resources are allocated among education, research, and other alternative public and private sectors of economic activities is not fully incorporated into the model. Schultz (1964) has stressed the need for direct research towards the analysis of this process. Generally, the model does treat investment in research as a source of new high-pay off input technique. Also it does not explain how economic conditions induce development and adaptation of ancient set of technologies for a particular society, nor does it attempt to specify the process by which factor product-price relationships induced investment in research in particular direction. Moreover, the high payoff input model does not explain how the economic conditions induce the development of new institutions like publicly supported agricultural experimental stations to enable both individual and society to take fuller advantage of new technical opport-unities, nor dose it attempt to specify the process by which farmers organize collective action for creation of public infrastructure such as irrigation and drainage systems. However, the model remains incomplete unless the process is specified by which collective action from the local community to the central government level is organized for the supply of

public goods including technical knowledge beside the institutional arrangements in response to changes in economic conditions.

In Schultz's opinion (1964), the key to transforming a traditional agricultural sector into a productive source of economic growth is investment to make modern high-pay off inputs available to farmers in poor countries.

[6] Induced innovation model (The theory of technical and institutional change**):** The model attempts to incorporate changes in both technology and institutions as endogenous to economic system as directed by conditions of factor supply and product demand. Also it incorporates interaction between technical and institutional changes and how both are Influenced by cultural endowment specific to each society current thought on the role of agriculture on the economic development is strongly influenced by the dynamic classical school of Adam Smith 1771 and Recardo 1817 who agreed on:

a- Capital accumulation was a fundamental source of agricultural growth.

b- Possibility for productive growth in agriculture opened up division of labor (In Haroun, 2007).

The dynamic of Recardo (1817) is considered the most rigorously developed classical model that can illustrated by tracing the effect of an increase in the production resulting from a new invention, discovery of new land or new raw materials. Obviously Recardo (1817) was pessimistic about potential of technology process in agriculture and this model predicted that the share of the land and the national income has declined in the process of economic development. In contrast, empirical studies for the developed countries indicated that the total factor of the productivity in agriculture has

risen in the process of economic development (Schultz, 1964).

Marxian system(1918) described that economic developed through certain stages (primitive communism, ancient slavery, medieval feadalism, industrial capitalism and socialism) derived by the force generated by struggle between two classes, one controlling the means of production combined with labor, and the other possessing no means of production but labor “Despite of the unrealistic assumption of two socioeconomic classes with the mutually inconsistent interest engaged in continuous struggle over division of income, yet it is the only genuinely evolutionary economic theory that the period produced. Marx (1918) considered the growth of agricultural productivity as precondition to emergence of industrial capitalism in contrast to the classical economists. He was impressed by the efficiency of large-scale farming in England and he regarded it as structural changes leading to the elimination of peasant farming as an essential step in agricultural development.

Heeman (1967) indicated that the theory of agricultural development include three inter related parts. These are:

- The role of agriculture in development.
- The economic nature of traditional agriculture.
- The economic process of modernization of agriculture.

According to that theory agriculture is the dominant sector of resources and generation of income. Consequent interdependence of agriculture and non- agricultural sectors limits the full development of either in isolation from others, because agriculture is an industry of major proportions at the start of economic development. Its development is a process of modernization rather than creation of new industry (ILACOB, 1981).

In 1960s agricultural development was seen as the result of the correct application of technical know-how and capital in the production process, yielding higher output and consequently, higher incomes. Research aimed at new varieties and methods. Much capital was invested in irrigation and drainage, the extension services were established especially in developing countries in order to provide the farmer with know-how inputs. This approach to agricultural development is sometimes described as centralistic, capital intensive and large scale. Attention to these programmes caused an increase in agricultural production. They also gave a rise to increasing inequality and disguised or open unemployment. It would be easy as well as cheap to discard this vision with the benefit of high sight, as naive. Although a new marked by terms such as self-reliance basic needs, preferential support of the poorest. A manual on how these goals can be reached is not yet available.

The new view on agricultural development is based on the desire to lessen or prevent future introduction of extreme socio-economic differences which are the result of non-guided entry into the market economy. This will require the involvement of groups in agrarian production to direct and control their own development themselves much more than was formerly the case (Zareba, 2000). This only possible when they are organized in one way or another, they participate in the decision-making at higher levels where it concerns their own development.

2.5.1 Concept of Irrigation

Irrigation is an old aged art as old as civilization. History of old civilization indicated that irrigation was found on the Nile basin during 6000 years before the birth of the Christ (BC) followed by the Tigris and Euphrates basin during 4000 years (BC). Wells were used for irrigation in

Indies during 2500 years before the birth of Christ (Beda, 2004).

Development of irrigated agriculture started in the 18th century. Amer (1998) mentioned that expansion and development in agricultural sector enhanced water utilization for irrigation. Irrigation accordingly is considered as great consumer of water amounting to 2/3 of water from river, lakes and underground water (World Food Day, 1994).

Beda (2004) defined irrigation as: "a concentrated process directed and managed with respect to when and how much water should be applied to the crops" (In: Galuak, W.2008). According to Michael, N. (1998) irrigation is the artificial application of water for the purpose of crop production. Water is supplied to supplement the water available from the rainfall. FAO, (1986) stated that irrigation refers to the application of water supplementary to that supplied by precipitation for the production of crops.

The definitions indicate that water is applied to supplement the existing rain water and that it should be controlled managed properly when applying it to the crop or soil.

According to Hansen (1979), irrigation is the science of artificial application of water to the land in accordance with crop requirement throughout its growing season. However, a broad and inclusive definition is that irrigation is the application of water to the soil to satisfy one of the following purposes:

1- To add water to the soil to supply the moisture essential for plant growth.
2- To provide crop insurance against short duration droughts.
3- To cool the soil and atmosphere thereby making more favorable environment for plant growth.
4- To reduce hazard of frost.

5- To washout or dilute salts in soil.

6- To reduce hazard of soil piping.

7- To soften tillage pans.

8- To delay bud formation by evaporation (In: Amin, W. 2002).

The frequent increase in the world population couples with industrial and agricultural development lead to growing demand for land and against limited resources of water. Irrigation is considered to be the first essential step in development of dry regions and a powerful tool for progress even where rain fed cropping is possible.

Ali, (1997) indicated that the main importance of irrigation in semi-arid areas is to make possible a more intensive successive of crops, greater variety production and higher yield levels.

Development of irrigation also has an impact on the development of non-agricultural sectors of economic such commerce, services and transportation. It contributes to the balance of payment and provides a market for industrial production of agricultural equipments and supplies. Irrigated agriculture can be the most productive form of farming but it would be a great fallacy to assume that irrigation as much as equivalent to intensive agriculture and capable of increasing productivity and raising the living standard when applied in primitive conditions because of its high capital and operating costs Amin, (2002). Irrigated agriculture must be intensive. Successful irrigated agriculture implying more than applying water to the land. It becomes an effective tool for increasing production only when applied in accordance with up-date cultural practices.

According to Garang (1981) irrigation is one method of modernizing agriculture when he stated that: "Modern agriculture is characterized by modern irrigated methods, mechanization, cash cropping and heavy

government involvement in all aspects of farming".

One of the key challenges we face is to ensure food security for the increasing global population. Many estimates showed that with more efficient irrigation, we can produce 40% more food that will be needed with 15-20% more water consumed (Cosqrove, 2002). Some feel that, these estimates are too low. Other point out that, in some regions water drawls for agriculture and poor agricultural practices have already caused serious harm to the environment. According to (IFAD, 2003) irrigation systems need to be expanded in marginal areas with low rainfall. It also felt that rural poor would be better served by irrigation systems that require limited labor and capital input. The Sustainable agriculture could not be attained in isolation from other income generating activities which supplement food security such as fisheries, forestry, wildlife products. It is essential to prevent further environmental destruction from land degradation, deforestation to protect watersheds and catchments (IFAD, 2000).

Irrigated agriculture remains a source that many want and will ask for. It remains a vital activity in livelihood of many small producers who value the security it provides. It can also be a vehicle to provide basic needs for and reduce the vulnerability of poor people. People in irrigated areas can benefit directly by increased and more stable incomes from increase cropping intensities, improve yields, new farm enterprise, technology-mixes and the appreciation of value of land with access to irrigation. Indirectly, they benefit from a more even spread of, and increase in farm incomes, wages, lower food prices, better nutrition and more water for domestic uses that can improve health.

Irrigated agriculture provides 40% of world food production on only 17% of total cultivated land (IPRID, 1999). The World Food Summit in

1996 estimated that 60% of the extra food required to sustain the World in the future must come from irrigated agriculture .Much of this must come from improvements of the existing schemes, as well as new sites for development are scarce. Three quarters of the total irrigated area of 260 million hectares is in developing countries where smallholder agriculture still predominant. The bulk of improvements in food supply in irrigation are expected to come from changes in a sector still dominated by small producers. The rural poor are not simply people deserving help and justice. Small scale irrigation is and will continue to be vital part of future world food security (IPTRD 1999). They indicated that irrigation benefits apply to the whole population but can be targeted at the poor by:

1- Employment-intensive construction, operation and maintenance practices.

2- Approaches that allow greater access to water particularly in times of scarcity (owning irrigation systems –selling water for profit , water rights , allocations of irrigable land and accessing small or marginal quality supplies).

To increase benefits of irrigated agriculture to the poor it is critical to understand the real social and economic benefits of irrigation development, the water environment where poor live, their production preference and what designs can allow poor people and smallholders to make the most of their opportunities.

Irrigated agriculture can be defined as agriculture where the supply of water is increased by artificial means, involving the use of water control technology and including drainage to dispose of excess water (IPTRID 1999).

Analysis of information from Asia shows that yields per area for most crops have increased by between 100-400 % as a result of irrigation (FAO, 1996). This has contributed to a reduction of food prices. These reductions on food prices have had a positive impact on the real incomes of the urban and rural poor. Irrigation brings a range of benefits to individuals and households that economists sometimes distinguish between primary and spillover effects (Shah, 1993). These primary effects are:

1- Increased and more stable flow of income from farming made possible by increase intensity of cropping, improved yields and new farm enterprises or technology mixes.
2- Appreciation of the value of land with access to water for irrigation spill-over effects.
3- Increased and more evenly spread farm labor opportunities and improved wage rates.
4- Reduced out- migration and increased return migration.
5- Improved security against impoverishment.
6- Lower food prices and better nutrition throughout the year.
7- Growth in non-farm employment.
8- Greater urban rural contact and social network.
9- More water for non-agriculture uses including domestic uses that improve health.

Development of irrigated agriculture benefits land owning household in first instance by increasing their incomes from gains in productivity. One challenge in promoting irrigation for poverty reduction is to specially target the land poor who include those who neither own nor operate land or those whose major source of income is derived from agricultural wage employment even they own or rent small amount of land.

Irrigation development brings a range of potential benefits at regional and national levels. It contributes to economic growth by generating export crops, reducing imports and thus saving foreign exchange and increasing home food supplies which can lead to lower prices and more secure supply of food at reasonable prices. In many countries, Irrigation development has played major role in eliminating food insecurity nationwide.

Altaf, (1994) suggested that one of the biggest constraints to increase food output and rural development is limited uptake of new technologies by risk averse small farmers. Higher productivity is associated with greater inputs and initial capital expenditure. In such circumstances failure of a single harvest can cause a farmer to lose his land to moneylenders. Poor farmers especially women, are usually unable to obtain credit from commercial banks for lack collateral (IPTRID, 1999).

Irrigated schemes often function as a development pole in rural areas where increase output and population concentrations attract additional services and infrastructure. Irrigated agriculture contributes to increase incomes from production and employment, so that families can gain access to schooling, health, and welfare services which are more likely to be present. Irrigation also satisfies important political objectives in nation building. It opens remote or under populated areas through new settlement schemes and this facilitates closer political links with rural population. It can reduce migration or discourage unsustainable land use practices such as pastoralism and shifting cultivation. Irrigated schemes facilitate closer links between the rural population and local government although large development may displace people (IPTRID, 1999).

Irrigation of any size can benefit the poor, though it is more usual to target poverty by developing small- scale irrigation using the following

sources:

1- Lift irrigation to pump water from groundwater, river, lakes or dams. This is successful in the areas of good recharge potential; however, care is needed to avoid aquifer with lower recharge as small farmers are unable to afford deeper wells and more powerful pumps.
2- Water storage structures or small dams to distribute water or promote recharge for subsequent use by crops.
3- Small system taking water from river or springs by gravity.
4- Small wetland developments where water levels are controlled through layout of canals and cultivation beds.

The relationship between the irrigation system and its catchments is also of growing importance as water became scarce. Understanding this physical interaction will support institutions that help local people plan and maintain the use of their water resources.

Irrigation brings a range potential change in agricultural production. It can give more assured cropping and more secure food supply for basic needs. This is often priority of the smallholder subsistence producers. Irrigation can change the cropping timetable to take advantage of food weather conditions or avoid periods of hazards like hail or heavy rainfall.

Reducing or eliminating water deficits increases crop yields and crops are even possible in drought years, providing the water source is not completely eliminated. Irrigation can also provide a more secure supply of fodder for livestock and the quality of soil can be improved through leaching and drainage. Many of these options need to be given attention in agricultural research and irrigation planning.

Irrigation can also increase out put and value through intensification of cropping and innovation in crop choice which is often the objective for

development programmes. Such programmes increase production and therefore justify the higher production costs. Irrigation can extend the cropping season to allow multiple cropping, improve the quality of produce and permit new commercial crops and varieties to be grown. With irrigation the effects of fertilizers on yields of new or existing crop varieties are enhanced and multiple farm enterprises with livestock, crops and agro-processing can be developed (IPTRID, 1999).

Irrigation can make a significant contribution to reducing poverty and increasing crop production. As a social goal, irrigated agriculture is a vehicle for provision of basic needs and the reduction of vulnerability to food insecurity. It is and will remain a vital activity in the livelihoods of many small producers who value the security it's provides.

The challenge will be to make the technology affordable and easy to maintain and ensure that irrigation systems can operate effectively and equitably under adverse hydrological regimes. Appropriate low-cost irrigation technology including low-cost pumps, hose and drip systems and simplified drip systems, require further investigation and promotion (IPTRID, 1999). Kofi Anan, 2000 stressed the need for effective efficient use and management of water as follows: 'we need a Blue Revolution in agriculture that focuses on increasing productivity per unit of water more crops per drop'.

Getting more crop per drop means that growing more food with less water alleviates scarcity, contributes to achieving food security by freeing up more water for nature.

2.5.2 Irrigated Agriculture in Africa

The Commission for Africa indicated the importance of development in Sub-Sahara as "Sub-Sahara Africa is highly complex Region of 47

countries with 7 distinctly different colonial histories. It is also highly diverse with more than 700 million people of at least 1000 different ethnic groups. The region is a critical development priority. It has some of the World's poorest countries and during the past two decades the number of the poor in the region has doubled to 300 million-more than 40% of the Regions' population" (World Bank, 2008).

Over the past 35 years, the international consensus on the importance of agriculture in economic development has varied from vary high until 1980s to very low since 1990s to the current middling (Hazell, 2006). Asia was fortunate enough to launch its agriculture and economic evolution at a time when interest in agriculture was still high. Africa was less fortunate and now strapped in food crises, poverty and economic stagnation. However even though agriculture is back on the agenda for Africa, the level commitment amongst key donors and government is mixed and the emerging strategy is very different from that of the past. Africa total GDP is currently about 350 billion dollar per year which is not large by Western standards but is enough to provide 700 million Africans with average annual income of 500 US dollar each. To make serious dent in Africa poverty, it is necessary to think about doubling or trebling this income while also achieving a better distribution. This will require another 350 million dollar per year and growth in a large sector like agriculture which is accounts for about 30% of growth domestic production (GDP) for Africa as a whole.

Among the challenges facing accelerating food production in Africa are poorly developed markets, lack of investment and poor infrastructure in rural areas. Despite this, here exist opportunities that can be stepped to help end chronic hunger and food problems in "bread basket areas" FAO (2008). Areas to rapidly improve food production, food security and rural incomes

where careful environmental monitoring and conserving biodiversity, water and land will be given high priority in areas with relatively good rainfall, soil, infrastructure and markets.

Productivity from irrigated land is approximately three times higher than from rain fed land. Investment in irrigation development provides insurance against erratic rainfall and stabilizes agricultural output, boosting crop productivity and allowing farmers to diversify. This translates into increased and less volatile farm incomes. In turn, predicable and stable production system has a positive effect on services providers to the sector, increasing the non-farm multiplier the value of the land. Small scale water collection, irrigation and drainage works implemented with local labor are economically viable and once the basic infrastructure has been put in place with public funding further investment also become viable. Additional direct effects investing in water development include improved nutrition through out the year, a more active market in rural labor, reduced out migration and reduced agricultural pressure on marginal land.

Sustainable social and economic development in Africa is necessarily based on the development of its agricultural sector on which some 70% of its population and 80% of its poor depend only 7% of Africa arable land is irrigated down to 4% in Sub-Sahara Africa. In contrast, irrigated land accounts for 38% of arable land in Asia. As a result Sub- Sahara Africa uses less than 3% of its water resources compare to 20% in Asia. One-third of the population of Sub-Sahara Africa is undernourished and its current population of 700 million is expected to reach 1-2 billion in 2030, the opportunities to improve the livelihoods of rural communities through water control are clear (FAO 2004).

The CAADP has estimated that as part of a wider set of measures to

promote agricultural and rural development as annual investment of around US 2 billion US dollar would be needed to boost irrigated agriculture in Africa. Aberra , (2004) stated that: "The hope for boosting agricultural output in areas where rainfall inadequacy and variability is a major environmental limiting factor depended for a long time on the development of large capital intensive irrigated schemes".

The inadequacy and ineffectiveness of large scale externally imposed and high technology initiatives have been under scrutiny by critics of rural development in Sub-Sahara (Adams, 1994). The major reasons given for the failures of the major irrigated schemes in Sub- Sahara Africa are related to cost, institutional problems, policy environment, design issues, cultural factors and environmental problems (Barghouti and Le Moigne, 1990). In fact the cost of large scale-irrigated schemes has been much higher in Africa than else where in the World due to reliance on imported materials, equipments and expertise (Vaishnov, 1994). Other problems that are believed to have undermined the importance of large scale projects in Africa are over-optimism about the benefits, insufficient account being taken of indigenous systems, lack of practical and management skills, attitudes of national staff and under provisioning for operation and maintenance (Carter, 1989).

During 1980s the awareness of failure of large-scale projects increased the interest in and the tendency to promote small scale-irrigation (Smout, 1994). Turner (1994) defined small-scale irrigation as:

"It is irrigation on small plots where farmers have the majority control, using technologies which they can effectively operate and maintain"

According to the above definition the reference small scale schemes is based on the perceived easy adaptability of the systems to local

environmental and socio-economic conditions. Moreover, unlike large scale schemes, they are not influenced by national and international strategies and power (Underhill, 1993). This is another probably more important reason for the popularity of small scale irrigation than the poor performance of large scale schemes. This is the recent shift in the development paradigm to development from the below, an approach subsumed under. Irrigated farming system under irrigated farming system (2 percent land area-7 percent agriculture population in Middle East and North Africa, 1 percent land area, 2 percent agriculture population in Sub-Sahara Africa). Hazell, 2006 extressed the important economics of small farms in Africa as follow :

1- They are more efficient producers in labor surplus economies (because family workers are less costly and more motivated than hired workers and small farms likely to use labor rather than capital intensive technologies).
2- They help contain poverty by providing an affordable home platform from which poor households can experiment with ways to imporove their livelihoods
3- They help prevent premature urban migration and explosive growth of large cities
4- They also ensure degree of food security in rural areas where high transport and marketing costs can drive up food prices, while at the national level their higher land productivity has the potential to help poor countries attain greater self –sufficiency in staple such as cereals, tubes and even livestock.

Large scale irrigation schemes have linked primarily to perennial surface water resources notably in Egypt, Nigeria, Mali, Mauritania and

Senegal. However, since the 1960s, the rise of drilling and pumping technology has permitted the development of large ground water-dependent schemes. They are found across all zones and including high value cash and export cropping and intensive vegetable and fruit cropping. Pattern of water use vary greatly but often it is not used efficiently. If Africa used more water to irrigate its agriculture, then it might be richer (FAO, 2004). As the World struggles to feed a burgeoning population, Africa's use of water resources for agriculture is a small fraction of its potential and must be expanded to address poverty in the continent. The United Nations food production agency stated that: "We therefore still have a great potential and opportunity to address the needs of Africa in food, poverty reduction and ecosystems, "(UN, 2004). They went on to say that Africa must continue to invest in unlocking the potential of its diversified agricultural systems in rain fed agriculture, irrigation and mixed systems. According to World Bank (2006) irrigated farms are less sensitive to climate where water is available. Irrigation is a practical adaptation to climate change in Africa where revenue rises for irrigated crops which are located in relatively cool parts of Africa.

Small scale irrigated schemes occur in many places across the region. They are a significant element in the survival of people in dry areas. Such schemes systems develop along small perennial streams and at oases or are built where flood and spate irrigation is feasible as well as around boreholes.

The major crops are mixed cereals and vegetables. These locations where water available always provide focal point for socio-economic activity but intense local competition for limited water resources between livestock owners and farmers is becoming increasingly evident.

2.5.3 Irrigated Agriculture in Sudan

Sudan the Africa's largest nation has vast arable land. It is a paradise for agriculture, more importantly no shortage of water. Sudan is distinguished by the Nile valley that traverses the country from south to the north and constitutes one of the major supporters of the livestock's and livelihood of its people. This valley is composed of Blue and White Niles and their tributaries. The total volume of the river water is estimated at 84 billion cubic meters while the portion received by the Sudan from total output is 20.35 billion cubic meters. The total annual rainfall is about 1093 million cubic meters with an annual average of rainfall ranging from 150 mm in the north to 1600 mm in the south while the under groundwater is about 260 billion cubic meters and it is used for domestic purposes and limitedly for irrigation agriculture due to the fact that it exist at very deep aquifer (FAO, 2004). The surface water in Sudan comprises the River Nile (Nilotic water) and other non-nilotic streams. 64 percent of the Nile Basin lies within Sudan and the local rainfall is the main source of the non-nilotic streams and of Bahr El Ghazal basin, where as rainfall over the Central African Plateau (Equatorial-lakes) and over Ethiopia-Eritrean highlands is the main source of the Nile River and other trans-boundary seasonal streams such as Gash and Baraka.

According to FAO, 2005 Sudan shares parts of the following basins with neighboring countries:

- The Nile Basin which is about 1978506 km (79 percent of the area of country).
- The Northern Interior Basins covering 313365km in the northwest part of the country (12.5 percent).
- The Lake Chad Basin in the West of the country along the border

with Chad and the Central African Republic covering 101048km (4.0 percent).

- Northeast Coast Basin representing a strip along the Red Sea Coast of the country covering 96450 km (3.8 percent).
- Rift Valley Basin in the Southeast part of the country at the border with Ethiopia and Kenya covering 16441km (0.7 percent).

The Nile system in the Sudan comprises of the following:

1- The Blue Nile, Sobat and Atbara Rivers originating in Ethiopia highland.

2- The White Nile system: Upstream of Sobat River originating on the lakes plateau.

3- The Bahr El Gahazal Basin: An internal basin in southwest Sudan.

The Sudan has a total area of 6oo million feddans and the sizeable arable cultivable land is accounting **to** about 209 million feddans being used at the present time and distributed among different sectors as indicated bellow:

Sector	**Area in million feddans**
-Irrigated agriculture	4½
-Mechanized rainfed agriculture	12
-Traditional rainfed agriculture	23
-Natural rangeland	215
-Forest	64
-Others	52½

Source :(Ahmed, S.S.2008).

The area being utilized for crop production is about 39.5 million feddans and the area covered by irrigated agriculture is putting the Sudan to be the largest country with largest irrigated area in Sub-Sahara Africa. This

irrigated area is comprises of Gezira, New Halfa, El Rahad, Blue Nile and White Nile cotton and sugarcane schemes, Toker and Gash deltas as well as Northern State . More than 95%of exported cotton is grown in this area but other crops are cultivated such as wheat, groundnuts, sorghum, maize, sunflower, vegetables, fruits, sugarcane and dates (Ahmed, 2008).

Based on these potentialities, Sudan has comparatively clear advantage in agriculture as the backbone of its economy and social development. The GDP of the Sudan was 17.8 million US dolor in 2003 the agriculture sector is the most dominant in the country's economy, even though it share has declined recently because of decreased agricultural production and increase exploitation and export of mineral oil in 2002. The sector contributed over 39% to GDP and employed 57% of total economically active population in 2004. It contributed about 9% of Sudan non-oil export earning (Ahmed, 2008).

Sudan's agro-ecological zones support a variety of food, cash and industrial crops. Vast natural pasture and forests support land herds of livestock including cattle, sheep and goats. The main exported crops are cotton, gum Arabic, sesame, groundnuts, fruits and vegetables. Livestock is also important for export. Within the agricultural sector, crop production accounts for 53% of agricultural output, livestock for 38% and forestry and fisheries for 9% (FAO, 2005).

The majority of Sudan is rich with underground water. The Nile River and its tributaries, the White and Blue Niles which emerge in the capital of Khartoum, have also long contribution to the irrigation of crops (UW, 2006). According to IFAD, (2001) the Sudan with its large areas of arable land, has a predominantly agricultural economy. Agriculture contributed about 39% of Gross domestic product in 2001and continued to be a major export sector.

About 70% o the population is rural and depends on agriculture for food and income. Nomadic herders and smallholder farmers co-exist alongside recently established mechanized farms about 60% of all crops production depends on irrigation and 33% is rain fed.

. The Nile and its tributaries were the source of water for 93 percent of agriculture and for this the Blue Nile accounts for about 67 percent. Gravity flow was the main form of irrigation but one third of irrigated area was served by pumps.

The water of the Nile in Sudan has been used for centuries for traditional irrigation taking advantage of the annual Nile flood. Some use of this method still continued in the early 1990 and the traditional shaduf (a device to raise water) and water wheel were also used to lift water to fields in local irrigated projects but were rapidly being replaced by more efficient mechanized pump systems.

Among the first efforts to employ irrigation for modern commercial cropping was the use of the floodwaters of the Qash River and Baraka River (both of which originate from Ethiopia) in eastern Sudan to grow cotton on their deltas. This project was started in late 860s by Egyptian governor and continued until interrupted by the turbulent period of the 1880s leading to the consequent of the country by the British 1899. Cultivation was resumed 1896 in Baraka delta in Thwaker area, but in the Qash delta it only resumed after the world war I. between 1924 and 1926 canals were built in the lates delta to control flood, sandstorms made the canals unfeasible in the Baraka. Between 1940s and 1970s various projects were developed to irrigate land. In 1982 both deltas yielded only one crop a year watered by the flood. Adequate ground waters, however suffered the eventual possibility of using pump irrigation from local wells for additional cropping or for

supplementing flood shortages.

The country largest irrigation projects had been developed on the land between the blue and White Nile Rivers south of their influence at Khartoum. This area is generally flat with gentle slope to the north and west permitting natural gravity irrigation and its soils are fertile cracking clays well suited to irrigation. The project originated in 1911 when a private British enterprise, Sudan Plantation syndicate, found cotton suited to the area and embarked on what in the 1920s becomes the Gezira scheme intended to principally feverish cotton to the British textile industry. Backed by a loan from the British government, the syndicate began a dam on the Blue Nile at Sennar in 1913 but work was interrupted by World War I and the dam was not completed until 1925. By 1929 agreement between Sudan and Egypt that restricted amount of water Sudan could use during the dry season. By 1931 the project had expanded to 450.000 hectares the maximum that then could be irrigated by the available water. The project was nationalized in 1950s and operated by the Gezira Board as government enterprise.

Wallah, (1988) stated that new projects have been undertaken, which include 400.000 feddans at New Halfa, 300.000 feddans of the Rahad scheme on the right bank of Blue Nile opposite to the Gezira scheme. There schemes were hugely important to the economy of Sudan since the opening of the initial 300.000 feddans of the Gezira in late 1920s, cotton has provided most of the export earnings for the country. The New Halfa was established to resettle Nubians displaced by Lake Nuba (Lake Nasser in Egypt) which was formed by the construction of the Aswan high dam in Egypt. To provide farm land for the Nubians, the government constructed the Khashm El-Girbah Dam on the Atbara River and established the new

Halfa project located west of Kassala to irrigate about 164.000 hectares.

The multi-purpose Roserises dam was built in 1966 and power generating facilities were installed in 1971. Both the water and the power were needed to implement the Rahad River irrigation project located east of the Rahad River, a tributary of the Blue Nile.(CIA,1991)

In 1920s private irrigation projects using diesel pumps also had begun to appear in el Khartoum province mainly along the White Nile River to provide vegetables, fruits and other floods.

In 1937 a dam was built by Anglo-Egyptian condominium up streams from Khartoum on the White Nile at Jebel Awliya to regulate the supply of water to Egypt during the August to April period of declining flow. Grazing and cultivated land along the river was flooded for almost 300 kilometers (CIA, 1991). In 1958, most half of the country's irrigated cotton was grown under irrigation.

Sine 1950 the government constructed a number of large pump projects. Mostly on the Blue Nile these included the Gunied project on the right bank of the Blue Nile east of Gezira scheme. This project went to operation 1955 with irrigated area of 36.000 hectares to provide alternative livelihood for nomadic pastoralists in the area. It produced cotton until 1960 then 8.400 hectares were devoted to raising sugarcane.(CIA,1991)

Several small Blue Nile projects added more than 80.000 additional hectares to Sudan's overall irrigated area during 1970s.

In the 1970s the consumption and import of Sugar grew rapidly, domestic production became a priority and two major pump irrigated sugar plantation were established on the White Nile in Kosti area. The Hajar Asalaya Sugar project begun 1957, had an irrigated area of about 7.500 hectares. The Kennana sugar project which has almost 16.200 hectares under

irrigation in 1981 and had a future potential of over 33.000 hectares was one of the world largest sugar milling and refining operations (CIA, 1991). The Kennana sugar project unlike the countries four other government owned projects, was a private venture among the governments of Sudan, Kuwait, Saudi Arabia and the Arab investment company. Recently new irrigated projects have been established such as Sundos Agricultural project south of Khartoum and While Nile sugar cane project in While Nile State. In addition to construction of Merawi Dam in the Northern state all these efforts will make Sudan to be the "World Bread Basket" as contribution to the world food crises. All the irrigated schemes in Sudan practice crop rotation as indicated in Table 2.1

2.5.5 Irrigated Agriculture in Southern Sudan

Southern Sudan though known to be rich in natural resources floating over huge oil reserve of million of barrels and has bountiful natural resources and the potential to be a major producer of a wide range of agricultural commodities. Largely untapped livestock, fishery and forestry resources adequate rainfall, fertile land and water availability all point to agricultural potential of Southern Sudan but still remains one of the poorest and grossly undeveloped regions in the World. Although it has received large amount from the oil revenue after CPA as indicated in Table 2.2. However, the development of agricultural sector has been shifted by the long civil war and resulting economic isolation of this region (USAID, 2005).

It is slowly recovering after 21 years of bloody war which has devastated Southern Sudanese where three million people have died and nearly five million people are internally displaced to Northern Sudan while nearly one million are refugees mainly in neighboring countries and around the World (Malual, 2005).

Table 2.1: Crop Rotation in Main Irrigated Schemes in Sudan

Scheme	Type of rotation	Crop-sequence
Gezira	5 course	Cotton, wheat, groundnut, sorghum, fallow
Blue Nile	3 course	Cotton, sorghum, fallow
Suki	3 course	Cotton, sorghum, sunflower, wheat, G/nuts
Rahad	4 course	Cotton, wheat, G/nuts, sorghum
New Halfa	3 course	Cotton, sorghum G/nuts
Sugar of Halfa	4 course	Cane crop, 1st rotation, 2nd rotation, fallow
White Nile	3 course	Cotton, wheat, sorghum, fallow
Northern Upper Nile	3 course	Cotton, sorghum, G/nuts, vegetables, fallow

Source: Designed by the Researcher, (2008).

Table 2.2: The shares and Transfers to Goss and Relevant States from Net Oil Revenue (2005-2008) (in US Dollars)

Year	Goss (50%)	Unity State	Upper Nile State
2005	798.40	32.59	-
2006	953.30	38.14	0.77
2007	1457.83	37.19	22.31
2008	2888.11	45.05	60.02
	6097.63	152.97	83.1

Grand Total 6333.7 US Dollars

Source: The Joint Technical Committee GONU/GOSS for monitoring Net Oil Revenues (2008).

This civil war has led to stopping of big development projects in Southern Sudan such as Mangala Sugar Project, Melut Sugar Project, Tong Project, Jonglei Canal Project, Tea and Coffee Project and Mechanized Schemes in Berh El Ghazal.

The total area suitable for cultivation is 17.4 million feddans and only 1.4 million feddans under use for crop production mainly in Northern Upper Nile where the Irrigated Agriculture accounts for 300 feddans. The constraints of agricultural production and marketing in Southern Sudan include poor infrastructure, lack of access to capital and low-level agricultural technical efficiency and skills in production, marketing and business management (USAID, 2005).

According to Biar, 1985 irrigated agriculture in Southern Sudan was extended to semi-arid areas of Northern Upper Nile Province. The first installation was in Malakal, 1950 for experimentations purposes under the supervision of Sudan Plantation Syndicate.

Galuak, 2008 indicated that the real establishment took place during the period of (1950-1960) to more extend in early seventies in western side of the Nile. The establishment of pump schemes was between Kuek in the North and midway between Wadakona and Kaka in the South on the West bank of the White Nile River while on the Eastern side, the pump schemes were concentrated between Joda in the North down to Jelhak in South with Melut and Malakal furthers South. He stated that the development of Irrigated Agriculture in Southern Sudan should be given top priority along the Nile River and its tributaries in toiches and surface water.

Till 1960 the schemes were being supervised by Agricultural Development Committee and in 1975 the White Nile agricultural Corporation took over (El Faki, 1987). In between there was Kosti-Renk Agricultural

Corporation under the umbrella of Agricultural Reform Corporation (ARC) which late got dissolved.

In 1991 the White Nile Agricultural Corporation based in Kosti was dissolved because of great losses. In 2000 the Upper Nile Government established what is known as Upper Nile Irrigated Project after the report of technical committee Study (Haroun, A.2000). The task of this committee was to lay down immediate objectives and development objectives and as well as giving the significance of the study.

The vast cultivated land under rain fed agriculture can be transformed to a big strategic irrigated schemes where agro-industrial projects can be established and irrigation water can be provided directly from White Nile water pumps as alternative to rain fed farming in Northern Upper Nile because rain fed agriculture development is accomplished by many serious social, economic and environmental problems such as environmental disintegration, poor economy, poverty, hunger malnutrition, illness and migration.

Although it is difficult and costly to reform such a situation which may take long time but according to (Haroun, 2007) the establishment of such irrigated schemes will have the following advantages:

1- Attain food security.

2- Avail permanent and seasonal job opportunities.

3- Increase incomes and improve living standards.

4- Provision of services (education-health-roads-water-etc).

5- Access to pasture, reduce animal movements and minimize conflicts between farmers and nomads.

6- Strengthening the economic structure.

7- Establishment of agro-forest and agro-industrial bases.

8- Minimizing rural-urban migrations.

9- Poverty alleviation and political instability.

Galuak, (2008) indicated that irrigation in Southern Sudan can secure self-independence through the production of an adequate amount of crops; fiber and feed are essential elements of food security and supplying fiber from crops such as cotton to textile industry and food production for the dairy, meat and poultry industries. He added that water demand for agriculture will increase in the future to the intensification of agriculture needed to keep face with the growing population and the increasing food demand.

Lupai, (2007) indicated that the digging of Jonglei Canal in Southern Sudan is considered one of the most important irrigated projects between Sudan and Egypt. It was seen as the development of modern irrigation and drainage facilities that would put the end to agriculture being tied to annual flooding and drought in the countries with the primary objective of ensuring the flow of 4.7 billion cubic meters of the Nile water annually to be distributed between Sudan and Egypt. The Nile which runs for thousands kilometers through the Southern Sudanese territory so well endowed with others sources of waters from many small and big rivers and lakes that are tributaries to the Nile and very high annual rainfall from400mm in the north and 1600mm in south. Malual,(2005) Indicated that Southern Sudanese were always oblivious to the importance of the Nile but obtain fish from other rivers than the Nile, to graze their animals in other greater pasture and grow crops for subsistent existence and did not bother to make any claim for the share of the River Nile and its waters. He suggested that the Nile waters will be shared by all people who live along it for the development and social development.

Others irrigated schemes in Southern Sudan were badly affected by the civil war. These schemes include Pengkow Rice Pilot Project in Jonglei State, Malakal Rice Scheme and Melut Sugarcane Scheme in Upper Nile State, Awiel Rice Scheme in Northern Bahr El Gazal State, Western Equatoria Cotton Scheme in Western Equatoria State, and Mangala Sugarcane Scheme in Central Equatoria State.

The truism is that the only existing irrigated schemes not affected by war are the Northern Upper Nile Schemes in the whole Southern Sudan.

2.5.6 Irrigated Schemes in Northern Upper Nile

2.5.6.1 General Information

The Northern Upper Nile irrigated schemes cover the areas east and west of White Nile River with total area of 300000 fed.The actual area under cultivation 77355 feddans The schemes are extension of White Nile pump schemes which started 100km south of Jebel Awlia Dam down up to Joda on the border of White Nile and Upper Nile States. They were known as Kosti-Renk Agricultural Corpor-ation in 1970s with their headquarter in Kosti. In 1990 the National Salvation Government dissolved most of the non-profit public corporations including the White Nile Corporation. The White Nile Irrigation Project was established in 2002 for the irrigated schemes lying in the Northern Upper Nile. Accordingly, in the season 2002/2003, 28 medium size pumps from China were installed through the Federal Ministry of agriculture and Forestry while at the same time maintaining the old machines and water pumps. In 2006, the Ministry of Agriculture and Forestry and Ministry of Water Resources and Irrigation of the Government of Southern Sudan (GOSS) took over the general administration of the pump schemes in Northern Upper Nile under the Food Security Project. The crop rotation introduced is three courses as indicted in Table (2.3_a).

Table 2.3$_a$: The existing crop rotation in Northern Upper Nile irrigated schemes

Crops	Crops	Crops	Year
5 feddans G/ nut or fallow	5 feddans sorghum	5 feddans cotton	1st year
5 feddans Cotton	5feddans fallow	5 feddans sorghum	2nd year
Sorghum or vegetables	5 feddans cotton	5 feddans fallow	3rd year

Source: Irrigated Pump Schemes in Northern Upper Nile (Haroun, A. 2007)

Galuak, 2008 proposed that crop rotation in Northern Upper Nile to be changed by introduction of maize to the existing rotation (Table 2.3$_b$).

Table 2.3$_b$: The Crop Rotation in Northern Upper Nile Pump Schemes Proposed by Galuak, 2008

Crop rotation	Crop rotation	Crop rotation	Year
5 feddans G/nuts Or fallows	5 feddans 3.0 feddans maize 1.5 feddans dura 0. feddans veget.	5 feddans cotton	1st year
5 feddans cotton	5 feddans G/nuts or fallow	5 feddans, 3 feddans maize 1.5 feddans dura 0.5 feddans veget.	2nd year
5 feddans; 3.0 maize; 1.5 dura; 0.5 veget.	5 feddans cotton	5 feddans ground nuts Or fallow	3rd year

Source: Galuak, W. (2008).

2.5.6.2 Physical Features of the Area

2.5.6.2.1 Location

Northern Upper Nile geographically lies between latitude 9 30 and 12 15 degrees north and longitude 23 25 and 33 45 degrees east .Its total area is 32000 square km (Haroun, A .2007). It shares border with six states, namely, the Blue Nile, White Nile, Sennar, Unity, Southern Kordofan. It is composed of five localities which include Renk, Maban, Melut and Mywod on the eastern bank of the White Nile while Fashoda locality is on the western bank.

2.5.6.2.2 Population and Ethnic Structure

The population is estimated at 450000 persons with annual growth rate of 3% (Haroun, 2007). Numerous tribes of different ethnic groups are living together in the area. The local tribes are Dinka, Shilluk, Nuer and Burun. They selected to live in their homelands in relative isolation from each others free to develop their own cultural values. Only when forced to move from their traditional habitats by reasons of ecological degradation or political coercion did they have to confront alien cultures and people. According to Haroun,(2007) these points of contact between strong ethnic identities, whether Arab or Africa were also the causes of friction and political for low and high intensity conflict .

2.5.6.2.3 Climate

Climatically the area lies in the Savanna region. The period from March to June is well known for its extreme heat, which could reach up to 44.8 degree Celsius in May. When rains start, gradual drop of temperature is obvious, also it begins to decrease from the mid of November and could reach to 16 degree Celsius in January (Table 2.4).

Table 2.4: Daily maximum and minimum and average temperature (°C) in Northern Upper Nile-Renk 1988-2008

Month	Daily max. (20 years)		Daily min. (20 years)		Average
	Average	Highest	Average	Highest	
January	32.8	40.6	15.1	9.7	23.9
February	35.1	43.3	16.5	8.6	25.8
March	38.6	44.8	19.7	11.7	29.1
April	40.0	44.3	22.3	13.8	31.1
May	44.8	43.4	24.1	17.4	31.5
June	35.5	43.1	33.0	16.3	29.3
July	32.5	40.2	22.1	16.3	27.3
August	31.4	37.5	21.6	15.1	26.5
September	32.8	39.1	21.6	17.0	27.1
October	35.5	41.7	21.9	12.9	28.2
November	35.9	41.4	18.0	11.0	27.4
December	33.1	40.4	16.2	7.6	24.7

Source: Department of Meteorology, Northern Upper Nile, Renk 2008.

It starts raining in July and ends at the end of October. The climatologically normal showed high rainfall variability in time and space. The average annual precipitation is between 400and 650 mm (Table 2.4).

2.5.6.2.4 Soil

Harrison and Jackson (1958) indicated that the soil of Northern Upper Nile is dark cracking clay known as cotton soil. It is alluvial origin transported by the White and Blue Niles. The Soil Survey Department at Wad Medani (1962) distinguished two groups of soil in the area, the dark clay order vertisol, family montmorillonite which was developed on the White Nile alluvium , feature by non calcareous low nitrogen, low caption exchangeable capacity (CEC), adequate potassium and phosphate content. There is Azaza (reddish coarse texture) soil formed from the river alluvium with sand from the local environment.

2.5.6.2.5 Vegetation

The vegetation in the area as described by Wickens, (1981) is comprises of Thorn Savanna and shrubs. According to Harrison and Jackson (1958) the Northern Upper Nile lies within group (III) A where *Acacia Seyal* alternates with grass areas . The *Acacia* species grow in dark cracking clays which can not absorb water that exceeds 700mm rainfall, therefore, when flood occurs trees vanish or are replaced with open grass except at high ground that can only flood to shallow depth where *Acacia Seyal* remains. This was observed in Benjella area in the Southern part of Northern Upper Nile where trees completely disappeared and only tall grasses remained in the area (Haroun, 2007) However, the forest woodland and grassland which constitute a reserve genetic diversity had under gone a serious devastation by the mechanized rain fed farming from one side and the overgrazing from the other side.

Table: 2.5 Irrigated Schemes in Northern Upper Nile- Renk (Review)

No.	Name of the Scheme	Area (Feddan)	Number of Farmers	Population of the area
1	Geiger	3150	210	7000
2	Berka El Agab	28000	1600	17000
3	Tayba	2250	150	250
4	Taisha	1650	110	700
5	Magara	4500	160	500
6	Helaka	2250	150	850
7	Remala North	600	40	300
8	Remala South	2265	150	950
9	Abu Khadira	9000	600	7000
10	Fewar North	3000	200	500
11	Fewar South	600	20	35
12	Khor Agaziz	600	20	35
13	Bandiet	1050	70	55
14	Juandiet	600	20	20
15	Latbior	3000	200	300
16	Majak	840	56	2000
17	Melbuk	3000	200	7000
18	Lelo Amara	1500	100	200
19	Wadakona	2500	166	5500
20	Bushara	2500	166	2500
21	Ber Kodok	4500	300	75
	Total	77355	4688	59770

Source : Department of Irrigation, Northern Upper Nile – Renk (2008).

Table 2.6: Rainfall in (mm) Northern Upper Nile Rank for the period (1989/1990- 2007/2008)

Year	Months										
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Total	Average
1989/1990	0.0	0.0	0.0	85	262	116.4	70.0	0.0	0.0	533.4	133.35
1990/1991	0.0	0.0	0.0	23.5	130.2	208.4	41.7	0.0	0.0	403.4	100.95
1991/1992	0.0	0.0	35.7	0.0	201.3	158.0	37.0	0.0	0.0	432.0	108.00
1992/1993	0.0	0.0	11.5	59.5	184	41.5	80.4	0.0	0.0	376.9	75.38
1993/1994	0.0	18.9	65.0	84	76.5	149.0	52.5	18.0	0.0	464.8	66.4
1994/1995	0.0	0.0	34.0	8.0	16.5	156.5	203.0	0.0	0.0	418.0	83.60
1995/1996	0.0	0.0	18.0	92.5	31.5	93.5	28.5	0.0	0.0	261.0	52.80
1996/1997	0.0	0.0	24.5	114.5	169	93.5	118	7.0	0.0	526.5	87.75
1997/1998	0.0	0.0	7.0	95.0	157	124.0	38.0	74.5	0.0	523.5	74.79
1998/1999	0.0	0.0	14.0	18.5	247.5	180.0	244.5	117	28.0	821.5	136.92
1999/2000	0.0	11	65.0	35.0	58.5	306.5	64.0	146	0.0	627.5	89.75
2000/2001	0.0	2.0	26.3	36.3	214	125.0	85.5	76.5	0.0	802.3	114.61
2001/2002	0.0	0.0	25.5	44.0	113.5	119.0	145	21.0	0.0	468.0	78.00
2002/2003	0.0	0.0	27.5	50.0	103	151.0	125	20.5	0.0	477.0	79.50
2003/2004	0.0	10	20.1	34.0	13.1	110.0	150	65.0	0.0	516.0	73.71
2004/2005	0.0	1.1	17.5	22.0	53.5	135.5	149	58.0	0.0	436.6	62.37
2005/2006	0.0	0.0	7.0	149.5	104.5	122.5	155	57.5	0.0	441.0	73.50
2006/2007	0.0	0.0	28.5	51.3	168.3	172.5	74.5	36.0	0.0	531.1	88.52
2007/2008	0.0	0.0	11.5	143.5	244.5	132.5	134	0.0	0.0	537.0	107.40

Source: Meteorology Department, Renk 2008.

2.5.6.2.6 Topography

The area is a vast plain sloping from an attitude of 390 meters above the sea level in the south east to 330 meters above the sea level in north. Some seasonal streams (Khors) are found they include khor el sheer khor Umdelwis Khor Abu Khadra Khor Adar Khor el Karao Khor Yabos and Khor Neela .Some scattered plateaus are found in area like Jebel Ahamed Agaa and Jebel Jongdied in addition to some mountains in Maban County like Jebel Abu Gaya and Jebel Tombik.

2.5.6.2.7 Agricultural Activities

Based on great potentialities which favor farming and grazing, three kids of agricultural activities are recognized in the area. First the irrigated agriculture practiced along the White Nile River using water pumps for growing cotton as main cash crop. Also dura and vegetables are cultivated beside limited areas devoted for horticultural crops such as citrus, mango and guava.

The second agricultural activity is mechanized rain fed agriculture. The Northern Upper Nile is considered the second productive area after Gadarif in the Sudan. About 3.624000 fed. are under mechanized rain fed farming but despite of this huge area ,the schemes have no notable impact on the development and welfare of the local people in Northern Upper Nile because when the schemes were distributed the native people were marginalized and only few were given schemes and many became landless because their traditional farms were demarcated, confesticated and allotted to other people and even those who were allotted schemes some of them used to hire their schemes or sold them due to lack of funds (Haroun, 2007). This situation forced the local people who are mainly rural deserted their old villages to settle in towns and became seasonal labors and practicing

marginal works which means that the introduction of mechanized rain fed schemes has transformed the local people from farmers to labors.

Another shortcoming of this type of agriculture is that there is a relative unpredictability with high risk attached to it which is why planners in the Sudan always tend to concentrate their efforts on irrigated schemes of which Sudan is reliant. This success could be extended to Southern Sudan because there are already schemes in place like rice scheme in Aweil. Sorghum in Lakes State, cotton in Western Equatoria, sugarcane in Mangala and the very successful sorghum schemes in Northern Upper Nile-Renk (Costa, 2008).

The third agricultural activity in this area as in many other parts of Southern Sudan is traditional agricultural consists of unorganized and fragmented livestock herding and traditional cultivation characterized by settled nomadic or transhumant modes of livelihood for the inhabitants and backward forms of irrigation and rain fed cultivation methods using simple hand tools invariably, low cultivated area per family, low yields per unit of area and low labor effort and productivity. The primary objective of the herder is to maximize the number of animals in his herder not the production of milk, meat and the number of animals sold. The large herd size is necessary for insurance against many natural calamities or for social status and transactions such as marriages (Garang, 1981). He indicated that Infrastructural resources and basic services such as credit, marketing arrangements, transportation, education, health and water supply are nonexistent or abysmal inadequate in many areas of Southern Sudan including Northern Upper Nile.

CHAPTER THREE

3. METHODOLOGY

3.1 The Study Area

The study covered irrigated schemes in Northern Upper Nile from Wontaw north of Renk county extending southward to Melut County about 72 km from Renk on the eastern bank of the White Nile River. On the western bank, the schemes cover the area from Kuek north of Wadakona which is about 300 thousand feddans owned by both private and public sectors using water pumps for irrigation at 21 localities along the White Nile River (Map:1).

3.2 Sample Size

The total sample size was 120 both male and female from the schemes area. It was calculated statistically as follows:

$$n = \frac{z^2 (pq)}{d^2}$$

Where:

n = target sample size

z = standard normal variable

p = proportional of target group to the total population

q = 1-p, probability of fail

d = margin of error

3. 3 Sample Selection

Multi-stratified random sampling was adopted from 16villages on the eastern bank, six locations were predetermined and selected namely Geiger, Abu Khadira, Fewar North and Latbior, and from 5 villages on the western bank Bushara and Wadakona were randomly selected. Then 20 farmers from each locality were randomly selected to have 120 samples.

3.4 Data Collection

The primary data was collected through the use of questionnaire (Appendix1:). Field visits were carried out to both sites of the schemes on the eastern and western banks of the White Nile River. The first visit made by the researcher to the area was during July and August 2008 at the time of cultivation for general field observation on the schemes, social services, irrigation systems, economic activities and available resources while the second visit was carried out in November and December 2008 at the time of harvest of crops except cotton and sunflower to interview the farmers, local leaders and the scheme authorities.

3.3 Data Analysis

Descriptive and analytical methods were used in this study relying on both primary and secondary data. Questionnaires were coded and statistical techniques were applied to derive frequencies, percentages and the results were summarized in tables and histogram. Chi-square test was used for some selected variables.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Age Structure

The study showed that 8.3% of farmers are in the age group of 31-40 years 54.2% are in the age group of 41-50 years while 4.2% are above 7o years of age. Age structure patterns are considered to be the most important factors in determining the level trends of socio-economic and demographic changes. It is a decisive factor in determining the size of supply in the labour markets as well as the economic burden, consumption patterns and other factors. The study showed that majority farmers were in the productive age of 30-50 years (Table 4-1**)**.

Table 4-1: Distribution of respondents according to age

Age groups	No. of farmers	%
20-30	-	-
31-40	10	8.3
41-50	65	54.2
51-60	32	26.6
61-70	8	6.7
More than 70	5	4.2
Total	**120**	**100%**

Source: Field survey, 2008.

4.2 Gender and Marital Status of the Farmer

The study indicated that 89.3% of respondents were male and married while 1.7% were divorced female (Tables 4-2 and 4-3).

Table 4-2: Distribution of respondents according to gender

Gender	No. of farmers	%
Male	118	98.3
Female	2	1.7
Total	**120**	**100%**

Source: Field survey, 2008.

Table 4-3: Distribution of respondents according to marital status

Marital status	No. of farmers	%
Married	118	98.3
Single	-	-
Divorced	2	1.7
Total	**120**	**100%**

Source: Field survey, 2008.

4.3 Land Use

Traditional land use by man before the project was pastoral nomadic with some crop growing both on rain lands and along the White Nile River in small size ranging from 1 to 10 feddans. Whilst the irrigated schemes farm size were reorganized and extended along the Nile (Map: 1). Increase of human and animals were slowly having an effect upon the ecological balance leading to crises by the run of drier years beginning in 1968 but the situation began to improve by 1973 where much current concern has been paid among farmers, administrators and agricultural experts about the future of rain land which led to establishment of irrigated schemes in the area.(Haruon,2007)

4.4 Farm Size

The land is owned by the government and the farmer pays rent for the land every year. The area allotted to each farmer is 15 feddans to be used for crops cultivation in rotation. Farm size before the establishment of the schemes from 1 to10 feddans but the introduction of cash crops such as cotton and groundnuts after the schemes was a caused of increasing farm size to 15 feddans for each farmer(Table 4.4).

Table 4.4: Distribution of respondents according to farm size

Area in feddan	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
1-5	81	67.5	-	-
6-10	39	32.5	37	30.8
11-15	-	-	83	69.2
Total	**120**	**100%**	**120**	**100%**

Source: Field survey, 2008.

4.5 Animals Ownership

As shown in Table (4-5), the average number of goats per household after the establishment of the irrigated schemes was 7.7 heads compared to 1.9 before the schemes. The average number of sheep and cattle was 4.6and 4.3 heads after the schemes compared to 1.3and 0.7heads before the schemes respectively while the average number for donkey was 0.5 and 0.3 heads after and before the scheme.

Goats, sheep and cattle are raised for milk beside social prestige and wealth while the donkeys are means of transportation. The increase of number of animals was most probably due to availability of pasture provided by the schemes after crops harvest.

Table 4-5: Animals ownership

Types of animals	Before the project		After the project	
	No. of animals	Average	No. of animals	Average
Goat	227	1.9	925	7.7
Sheep	159	1.3	556	4.6
Cattle	85	0.7	526	4.3
Donkey	3	0.3	64	0.5

Source: Field survey, 2008.

4.6 Source of Agricultural Inputs

In the past the local varieties which were available in farmers stocks or provided by local merchants were used by all farmers, but the establishment of the irrigated schemes has enable the Ministry of Agriculture to provide these improved inputs through agricultural companies or directly by the Irrigation Administration the responsible institution for these schemes (Table 4-6).

Table 4-6: Distribution of respondents according to sources of agric. inputs

Source	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Farmers own store	99	82.5	-	-
Local merchants	21	17.5	-	-
Agric. Bank	-	-	66	55.0
Ministry of Agric.	-	-	14	11.7
Agric. Companies	-	-	40	33.3
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

4.7 Crops Grown

The main crops grown on these schemes are cotton, sorghum, groundnut and vegetables in simple rotation which does not allow more intensification and diversification. The crop rotation proposed by Galuak, (2008) has not changed the existing crop structure but added maize by reducing the area devoted for sorghum.

Other crops such as maize, millet and sunflower are also grown at small scale outside the crop rotation (Table 4.7).

Table 4.7: Main food crops

Main food crops	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Sorghum	37	46.2	45	37.5
Maize	21	26.3	15	12.5
Millet	15	18.7	31	25.8
Vegetables	7	8.8	29	24.2
Total	**80**	**100%**	**120**	**100%**

Source: Field survey, 2008.

Pearson chi-square	X^2	df	Aysmp-sig.2-sided
	28.41	3	0.068*

According to the respondent main food crops include sorghum 37.5%, maize 12.5%, millet25.8%, vegetables24.2% after the project while before the schemes main food crops sorghum 46.2% , maize 26.3%, millet 18.7% and vegetables 8.8% .

4.7 Agricultural Operations:

Table (4-8) demonstrates that all agricultural operations before the project were carried out manually by the members of the family for all the crops grown. No chance for any labour use outside the family. With irrigated schemes agricultural practices are organized at the pump schemes. For cotton, the first operation is dry ploughing by tractor in April or May followed by leveling and a second ploughing begins with rains from June or July then grasses start to grow and a third ploughing is in late August or early September followed by a periodic hand weeding. For sorghum and sunflower ploughing is done after the first rains followed by manual weeding. For vegetables the main operation is ploughing followed by leveling then hand sowing and weeding.

Adequate irrigation and weeding is required to ensure a reasonable yield for all these crops. After the harvest animals are allowed to graze on

the crop residues and this help clearing the land and also provides natural 4fertilizers. Before the rains start the cotton and sunflower stems are pulled out, collected and burnt then the land is left until the next season.

Table 4.8: Distribution of respondents according to crop husbandry practice

Practice	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Manual	120	100	35	29.2
Mechanical	-	-	85	70.8
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

4.9 The Irrigation System

Table 4.9 indicated that before the project the farmers in the area depended wholly on rains to irrigate their traditional small size farms to grow traditional crops for subsistence. In the project area lift irrigation to pump water from distance to a large concrete basin which leads into big canal. The irrigation water is then flown into the field through Abu XX and then to Abu XI direct to Hawasha by gravitation after the Hawasha is divided into angaya (strips separated by ridges). The water distribution system of canals in all the schemes lack annual maintenance. As a result, more silt and weed mats are decreasing and slowing down both the capacity and flow of water into the fields. Moreover, canals banks are partly damaged by animal herds in the schemes areas. Water control gates are either damaged or totally absent in most of the schemes.

Table 4-9: Distribution of respondents according to type of irrigation

Type of irrigation	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Rainfall	120	100	-	-
Water pumps	-	-	120	100
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

Source: Study of Northern Upper Nile Irrigated Schemes (2000).

The water requirements for crops irrigation in Northern Upper Nile is less than in Kosti and Dewiem irrigated schemes because of adequate rainfall in the area (Table 4-10).

Table 4.10: Crops Water Requirements in Square Meters/Season

Crop	Dawiem	Kosti	Renk
Cotton	5418	4740	3686
Cotton	3755	3052	2127
Sorghum	2410	1222	469
G/nuts	3000	2267	1516
Beans	4219	4605	2164

Labour Supply

Results of Table (4-11) showed that both family and hired labour were used for agricultural operations in the area. Before the project the source of labour was the family but the introduction of cotton by the project as new cash crop needs certain techniques which were sometimes not available at the level of the family. Also the areas cultivated within the project were large for the members of the family consequently cotton pickers were brought from Western Sudan by the help of the schemes authorities in the term of January to April.

Table 4-11: Distribution of respondents according to type of labor used

Type of Labor	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Family labor	120	100	40	33.3
Hired labor	-	-	80	66.7
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

4.11 Source of Credit

Access to credit sources before the project did not exist as a result 85% of farmers depended on either self- finance or local merchants. After the schemes 45.8% of farmers have access to Agricultural Bank loans and 20% receive loans from Ministry of Agriculture in addition to self-finance (Table 4-12).

Table 4-12: Distribution of respondents according to source of agric. credit

Source of credit	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Agric. Bank	-	-	55	45.8
Merchants	85	70.8	11	9.2
Government Ministry	-	-	24	20.0
Self-finance	35	29.2	30	25.0
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

4.12 Transportation and Marketing Price Policy

Local markets including Renk town were the main channels for crop marketing before the project but the establishment of the irrigated schemes has enabled farmers to have access to markets outside the project area

especially for cash crops. Kosti and Renk are the main centers for marketing of cash crops and to some extend Khartoum, especially after the construction of El- Salam Road between Rebek and Renk (Table 4-13).

Table 4-13: Distribution of respondents according to marketing area

Area	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Renk	120	100	22	18.3
Kosti	-	-	98	81.7
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

4.13 Farmers Income

Table (4-14), Reflected that family monthly income from farm crops were at 50-300sp before the schemes compared to 300-500sp after the schemes, while seasonal farm incomes has increased from 1000-1500sp before the schemes to 1500-3500sp after the schemes. The study showed that farmers have other sources of off-farm incomes which include labour wages 37.5% fishing 22.5% Arabic gum 17.5% local trade 8.3%.The off-farm incomes have contributed in improving the food situation and family expenditure for purchasing basic needs from the markets with affordable prices.

Table 4-14$_a$: Distribution of respondents according to monthly farm income

Income level (SP)	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
50-100	90	75.0	-	-
101-200	18	15.0	20	16.7
201-300	12	10.0	33	27.4
301-400	-	-	47	39.2
401-500	-	-	20	16.7
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

Table 4-14$_b$: Distribution of respondents according to off-farm seasonal income

Source of income	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Charcoal	10	8.3	23	19.2
Labor wages	-	-	45	37.5
Fishing	10	8.3	27	22.5
Arabic gum	-	-	15	12.5
Trade	5	4.2	10	8.3
Total	**25**	**-**	**120**	**100**

Source: Field survey, 2008.

4.14 Food Security Situation

The Study revealed that sorghum, maize and millet were the main food crops before the Project also NGOs resorted to food distribution to local people to fill the gap of any food shortages. After the schemes the food quality has improved due to introduction of new varieties of sorghum and vegetables beside animal products and purchased food items from the markets which were affordable to farmers due to increase in their incomes.

Based on the results of this study, no significant differences before and after the project in term of respondents' receive of relief items (Table 4-15).

Table 4.15$_a$: Distribution of respondents according to receiving of relief items from NGOs

Relief items	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Receive	115	95.8	15	12.5
Not receive	5	4.2	105	87.5
Total	**120**	**100%**	120	100%

Source: Field survey, 2008.

Pearson chi-square	X^2	df	Aysmp-sig.2-sided
	2.18	4	0.847NS

Table 4.15$_b$:Distribution of respondents according to food items purchased from market

Food items	Before the project		After the project	
	No.	%	No.	%
Sugar	10	8.3	110	91.7
Onion	8	6.7	112	93.3
Coffee	21	17.5	119	99.2
Tea	21	17.5	119	99.2
Salt	40	33.3	80	66.7

Source: Field survey, 2008.

Table 4.15$_c$: Distribution of respondents according to food shortage

Food shortage	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Yes	78	65.0	42	35.0
No	42	35.0	78	78.0
Total	**120**	**100%**	**120**	**100%**

Source: Field survey, 2008.

4.16 Social Services

4.16.1 Education

The study indicated that the number of schools has increased as a result of irrigated schemes. Khalwa from 5.6% to 22.2% basic schools from 11.1% to 33.2% secondary schools from 5.6 to 16.7% (Table 4.16). The lack of schools were reported as main problems before the schemes and lack of books and trained teachers are the main problems after the project as reported by the respondants in the area. The respondents assured that most of the school were built from the social funds allocated by the schemes administration and farmers one dividing the shares of cotton income. Beside the schools, police stations, social, cultural, sports and religion clubs were also built from the social funds.

Table 4.16: Education services

Education services	Before the project		After the project	
	No.	%	No.	%
Khalwa	1	5.6	4	22.2
Basic schools	2	11.1	6	33.2
Secondary schools	1	5.6	3	16.7
College	-	-	1	5.6

Pearson chi-square	x^2	df	Aysmp-sig.2-sided
	49.90	3	0.066*

4.16.2 Health Services

The study indicted that the number of health centers has increased form 10% to 40% after the schemes and dispensaries from 10% to 40% (fig.4.1). Although there is significant increase in the number of health centers and dispensaries caused by the project but lack of drugs and trained staff are still the main problems. Child services are completely lacking. The situation is unchanged regarding the availability of diseases such as malaria, cholera, etc.

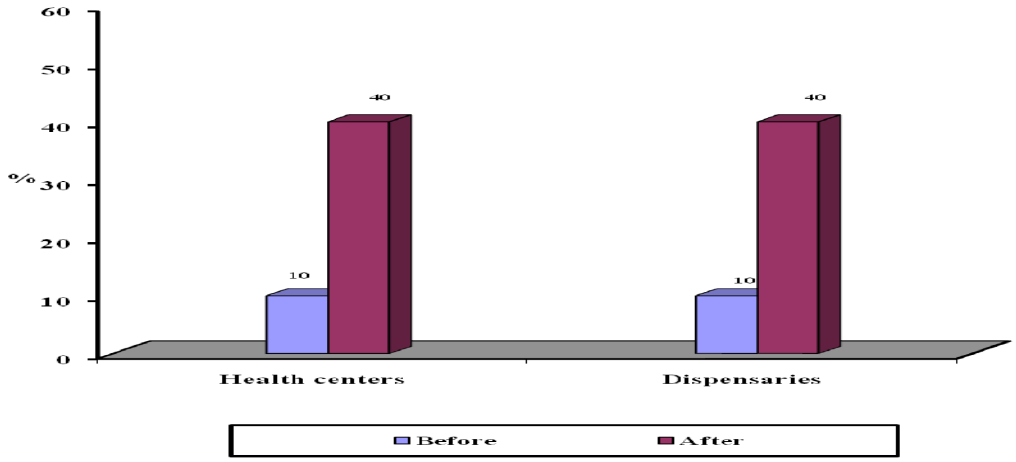


Fig. (4–1): Shows the availability of health services in the study area before and after the project

4.16.3 Water Supply and Sanitation

The study showed that most farmers' source of drinking water is either

direct river or scheme canals. Only 10.8% of farmers have access to safe and clean water (Table 4-17). No technological methods to purify water at the household resulting in poor quality of water and sanitation leading to spread of water borne diseases.

The poor sanitation situation before the project has notably improved as a result of irrigated schemes where appropriate designed household latrines and institutional latrines at schools and health centers which have eliminated the rate of the disease of the poor such as cholera, malaria and diarrhea.

Table 4-17$_a$: Distribution of respondents according to problems of drinking water

Problems	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Water not clean	81	67.5	80	66.7
Source is far	29	24.2	25	20.8
Water is charged	-	-	15	12.5
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

Table 4-17$_b$: Sanitation situation

Sanitation situation	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Bad	87	72.5	20	16.7
Good	33	27.5	100	83.3
Total	**120**	**100%**	**120**	**100%**

Source: Field survey, 2008.

Table 4-17$_c$: Distribution of respondents according to main diseases

Disease	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Malaria	80	66.7	100	83.3
Diarrhoea	40	33.3	20	16.7
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

4.17 Agricultural Extension Services

Table (4-18) illustrates the availability of extension services within the project to assist the famers to increase crops production and improve their incomes through education and technical advice to adopt new practices by using appropriate extension methods. These services were completely lacking before the schemes.

Table 4-18: Distribution of respondents according to availability of extension services

Availability	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Available	-	-	120	100
Not available	120	100	-	-
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2008.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the results of the study, the following conclusions can be drawn:

1. The majority of farmers in the study area were in productive age.
2. Farm size had increased as a result of irrigated schemes where simple three course crop rotation was adopted with cotton as main cash crop and sorghum as a food crop. No intensification and diversification of crops, and crop yields were low and cultivated area suffered from gradual decline.
3. Some irrigated pumps were old and lack spare-parts in the present markets and the process of removal of silt and weed from irrigated canals was inefficient.
4. Infrastructure in terms of roads and transportation within and outside the schemes area had been improved by the construction of El Salam Road between Rebek and Renk.
5. Most farmers were illiterate. The lack of books and trained teachers ranged among the problems of education though there was an increase in the number of schools after the schemes.
6. Safe and clean drinking water was accessible to few farmers in the study area. Moreover the technological methods to purify water at the household level were lacking.
7. No food shortages before and after the schemes because NGOs resorted to distribute food items to farmers to bridge any gap of food shortages before the schemes. The establishment of irrigated schemes has caused increase in farmer's incomes so they were able to purchase

basic needs from markets with affordable prices.

8. The animals owned by the household are kept for social prestige rather than production of milk and meat.
9. There was a significant increase in health services and improvement of sanitation but lack of drugs and trained health staffs were the main health problems.
10. Availability of extension services within the project has positive effect on increasing farmers' incomes through education and technical advice to farmers to adopt new practices by using appropriate extension methods.

5.2 Recommendations

1. The research recommends rehabilitation of the irrigation schemes in Northern Upper Nile State by reallocation of the existing resources and changing the old irrigated pump as well as farm size(from 15-20 feddans) and crop structure from simple three course to four course rotation for more intensification and diversification by encouraging the introduction of new cash, food and fodder crops to increase farmers incomes. Improve livestock production and food situation. The scheme should support and promote the use of improved seeds and planting materials through sourcing, procurement and demonstration of improved seeds and practices for all crops within the crop rotation.

2- Both State and schemes authorities should improve market infrastructure and identify needs and opportunities to market needs information for crop and livestock products and training entrepreneurs individually or in group in business practices, management and finance for more income generation in the study area beside encouraging agricultural

companies to set up input shops

for farmers and pastoralists to ensure reliability and avoid exploitation by merchants.

3- Improving the local livestock breed and training farmers in improving milk production, processing and marketing with emphasis to hygiene with provision and improving veterinary services.

4- Provision of clean drinking water at household level through filters and training households in filter management and basic hygiene.

5- Rehabilitation of old schools, health centers,water points, latrines, and construction of new ones through identification of local labour and materials and other inputs needed for the construction and rehabilitation, then recruitment of trained teachers and health workers through organization of community resources.

6-The vast fertile unexploited or unsustainably used rain fed schemes in the area to be reformed and transformed gradually into large long term irrigated projects by reducing size of these schemes from 1000 to 500 feddans for each farmer to be divided into four hawashas of 125 feddans each, and be financed by Agricultural and Commercial Bankes for cultivation of cotton, sunflower, sesame , sugarcane, guar and groundnut as cash crops. Sorghum , maize, millet, rice, and vegetables as food corps in four course rotation to make this area “bread basket” for Southern and Western States of the Sudan.

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APPENDICES

Appendix 1: Questionnaire

1.Location of the scheme ……
2.Name of the farmer ……..
3.Age of the farmer ……...
4.Gender of the farmer ……
5.Marital status ……
6.Education …….. Illiterate……
Literate……. Primary…….
Intermediate……
Secondary…….
Diploma ……
University…….
Others……
7. Farm size :
Before the scheme…….....
After the scheme…
8. Types of crops grown:
Before the scheme…….
After the scheme……
9. Animals owned or kept :

Kind	No.	before	after
Goat			
Cattle			
Cheap			
Camel			
Donkey			

10. Source of family food
Before the scheme…….
After the scheme……..……
11. Main food crops :
Before the scheme…….. ……..
After the scheme…….
12. No. of meals per day :

Before the scheme ……
After the scheme……
13. Food items purchased from the market :
Before the scheme…….
After the scheme…….
14. Do you receive relief food items : Yes No
Before the scheme……..
After the scheme……..
From whom ?…….
15. Do you have food shortages: Yes No
Before the scheme …… ……
After the scheme …… …….
16. Source of Agricultural inputs :
Before the scheme…….. ……..
After the scheme…….
17. How agricultural practices are carried out?
Mechanical Manual
Before the scheme ……. ……..
After the scheme …… …….
18. Do you apply crop rotation - Yes No
Before the scheme …… ……..
After the scheme …… ……..
19. Type of crops rotation applied?
Before the scheme…….
After the scheme……....
20. Labor Used :
Before the scheme……...
After the scheme…….
21. Source of markets :
Before the scheme ……
After the scheme ……
22. Means of transportation of crops to the markets :
Before the scheme……
After the scheme……
23. Farmer monthly income :
Before the scheme ……
After the scheme……..
24. Farmer income from the crops per season :
Before the scheme ……
After the scheme……

25. Farmer other sources of income :
Before the scheme…….
After the scheme……
26 .Source of credit : Before the scheme After the scheme
Agricultural bank …… …….
Commercial banks …… ……..
Government Ministry ……. ……..
Merchants ……. …….
Cooperatives ……. ……..
Self finance. ……. ……
27.Types of health services Before the sch. After the sch.
Health centers ……..... …….
Health units ……. …….
Dispensaries ……. …….
28. The main diseases in area :
Before the scheme ……..
After the scheme ……..
29. Sanitation Situation :
Before the scheme ……..
After the scheme ……..
30. Types of schools available: Before the sch. After the sche,
Khalwa ……. ……
Basic …… ……..
Intermediate …….. ……
Secondary …… ……..
Total …… ……..
31. The main education problems in the area :
Before the scheme …….
After the scheme ……
32. Types of irrigations used :
Before the scheme……
After the scheme……
33.Who is responsible for supplying irrigation water ?
Before the scheme ……
After the scheme …….
34. Source of drinking water :
Before the scheme ……..
After the scheme ……
35. The main problems of drinking water :
Before the scheme…….

After the scheme ……
36.Availability of agricultural extension services
Before the scheme…….
After the scheme …….....
37. Committees available in the area :
Before the scheme…….
After the scheme……...
38.Main cash crops :
Before the scheme…….
After the scheme……
FAO : Food and Agricultural Organization
UN : United Nations.
IFAD: International Funds for Agricultural Development.

Appendix 2: Distribution of respondents according to main cash crops

Cash crops	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Cotton	-	-	85	70.8
Sunflower	-	-	15	12.5
Groundnuts	-	-	20	16.7
Guar	-	-	-	-
Others	-	-	-	-
Total	-	-	120	100

Appendix 3: Distribution of respondents according to educational level

Educational level	No. of farmers	%
Literate	84	70.0
Khalwa	5	4.2
Basic	15	12.5
Intermediate	9	7.5
Secondary	6	5.0
College	1	0.8
Total	120	100%

Appendix 4: Distribution of respondents according to crops grown

Cultivated crops	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Sorghum	67	55.8	20	16.7
Maize	33	27.5	20	16.7
Cotton	-	-	50	41.6
Groundnut	15	12.5	15	12.5
Sunflower	-	-	10	8.3
Vegetables	5	4.2	5	4.2
Total	120	100%	120	100%

Appendix 5: Distribution of respondents according to number of meals/day

Cultivated crops	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Once	24	20.0	-	-
Twice	96	80.0	120	100
3 times a day	-	-	-	-
Total	120	100%	120	100

Appendix 6: Distribution of respondents according to means of transportation of crops

Transportation method	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Donkeys	120	100	18	15.0
Vehicles	-	-	92	85.0
Total	120	100	120	100

Appendix 7: Distribution of respondents according to availability of committees in the area

Availability	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Available	-	-	120	100
Not available	120	100	-	-
Total	120	100	120	100

Appendix 8: Food shortage in the study area

Source of family food	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Crop products	41	34.2	62	51.7
Animal products	12	10.0	25	20.8
Fish	17	14.1	18	15.0
Wild plants	15	12.5	-	-
Relief	35	29.2	15	12.5
Total	120	100%	120	100%

Pearson chi-square	x^2	df	Aysmp-sig.2-sided
	52.04	4	0.061*

Appendix 9: Health services

Health services situation	Before the project		After the project	
	No.	%	No.	%
Health centers	1	10.0	4	40.0
Dispensaries	1	10.0	4	40.0
Total	2	20%	8	80

Pearson chi-square	x^2	df	Aysmp-sig.2-sided
	39.14	1	0.051**

Appendix 10: Main education problems

Problems	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Lack of schools	94	78.3	-	-
Lack of teachers	18	15.0	38	31.7
Lack of books	8	6.7	82	68.3
Total	120	100%	120	100%

Pearson chi-square	x^2	df	Aysmp-sig.2-sided
	31.72	2	0.0626*

Appendix 11: Sources of drinking water

Sources	Before the project		After the project	
	No. of farmers	%	No. of farmers	%
Direct from river	120	100.0	97	80.9
Direct from canals	-	-	10	8.3
Direct from water pipes	-	-	13	10.8
Total	120	100%	120	100%

Pearson chi-square	x^2	df	Aysmp-sig.2-sided
	29.55	2	0.071*