SOCIO-ECONOMIC EFFECTS OF REHABLITATED DESERTIFIED AGRICULTURAL TENANCIES OF NORTH WESTERN PARTS OF THE GEZIRA SCHEME

BY

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B.Sc (Agric.) Honors

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2002

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A thesis submitted to the University of Khartoum in partial fulfillment of the requirements for the degree of Master of Science in Desertification

Desertification and Desert Cultivation Studies Institute (DADCSI)

University of Khartoum

June 2006

DEDICATION

To my family

To my friends

With love

I dedicate this work

Rabea

ACKNOWLEDGMENT

I would like to express my deep thanks and my special gratitude to my supervisor Dr. Ali Abdelaziz Salih for his valuable criticism and constructive suggestion.

Iam grateful to Prof. Hassan Mohamed Fadul and Dr. Nawal Khider Nasr Al-amin for their helpful suggestions and guidance. My thanks are also due to my friend Dr. Mohamed El-Amin Ahmed and every one who helped me in completing this work.

Finally, I would like to express my thanks to the staff and members of Desertification and Desert Cultivation Studies Institute and all my friends for their help and cooperation.

ABSTRACT

This study aimed at evaluating the impacts of removal of sand and growing of Seheimab shelterbelt on irrigation canals of northwestern parts of the Gezira Scheme. The study targeted Abu Guta and Begigea blocks, eighty tenancies were randomly selected out of five villages adjacent to northwestern parts of the Gezira Scheme. Those tenancies were divided into two groups: the first one whose tenancies were previously affected by desertification then rehabilitated and the other group was for those tenancies that were not rehabilitated. The evaluation was relevant to level of agricultural productivity as they live in the same geographical area.

Descriptive statistic indicated that most of the tenancies shared the same social characteristics. It also indicated that the tenancies on rehabilitated land had higher annual income, which reflected their stability of crops cultivated areas. The effort for establishment of shelterbelts led to protection of some canals and restored some irrigation area from sand encroachment for the rehabilitated tenancies. For non-rehabilitated tenancies, productivity was directly affected by desertification.
Tenancies of rehabilitated fields owned more animals than the tenancies of non-rehabilitated fields because of their ability to keep animals and sell them when market price was high. However the non-rehabilitated tenancies were compelled to sell their animals at lower prices to satisfy urgent consumption need to compensate for their low income from other sources.

When comparing rehabilitated and non affected tenancies in the block of Abu Guta using the official records for cotton, to confident the stability of crops cultivated areas found that the average yield for rehabilitated tenancies was less than the yield obtained by those in non affected areas. This was attributed to the decline in the quality of the soil being affected by sand after rehabilitation.

The study concluded that restoring of the irrigation capacity, soil quality and establishing shelterbelts (to some extent) helped in increasing income of the tenancies in desert prone areas in Gezira Scheme.

خلاصة الأطروحة

هدفت هذه الدراسة الى تقييم آثار إعادة حفر القنوات وإستزراع حزام السحيماب الواقى من التصحر بالمناطق الشمالية الغربية لمشروع الجزيرة.

شملت الدراسة تفتيشى أبوقوتة وبجيجة حيث تم اختيار 80 مزارعاً عشوائيا من 5 قرى متاخمة لمشروع الجزيرة لتمثيل المناطق الشمالية الغربية للمشروع، وقد كانت المقارنة على اساس الانتاجية بعد تصنيفهم الى شريحتين: متاثرين بالتصحر وتمت إعادة تاهيل مزارعهم داخل المشروع ومتاثرين بالتصحر ولم يشملهم التاهيل على الرغم من تواجدهم بنفس تلك القرى.

أوضح الوصف الاحصائى أن العينة الكلية لها نفس السمات الاجتماعية، كما أوضحت الدراسة أن هناك زيادة فى مستوى الدخل السنوى للمزارعين الذين تمت إعادة تاهيل مناطقهم وهذا نتيجة للإستقرار فى مساحة المحاصيل المزروعة بعد المجهودات المبذولة لاعادة حفر القنوات وإستزراع حزام السحيماب ومنه إعادة بعض المزارعين للإنتاج. أما بالنسبة للمزارعين الذين لم تتم إعادة تاهيل مزارعهم فقد تاثروا مباشرة بالتصحر.

فيما يخص الثروة الحيوانية نجد ان أعداد الحيوانات المختلفة المملوكة بواسطة المزارعين المتاثرين بالتصحر وتمت إعادة تاهيل مناطقهم أكبر منها للمزارعين المتاثرين بالتصحر، ويظهر هذا الفرق لمقدرة المزارعين الذين تمت إعادة تاهيل مناطقهم على الاحتفاظ بالحيوانات وبيعها عند ارتفاع أسعارها بالاسواق مقارنة بالمزارعين المتاثرين بالتصحر والذين يبيعون حيواناتهم حسب الحاجة لقلة دخلهم مما يؤدى الى تدنى أسعارها بالأسواق.

عند مقارنة متوسط إنتاجية القطن بين المناطق إلى تمت إعادة تأهيلها والمناطق المنتجة خارج نطاق التصحر, وذلك لتأكيد ثبات إنتاجية المناطق التي تمت إعادة تأهيلها وجد أن متوسط الإنتاجية للمناطق التي تمت إعادة تأهيلها أقل من متوسط الإنتاجية للمناطق المنتجة خارج نطاق التصحر، ويعزى تراجع إنتاجية المزارعين الذين تمت إعادة تأهيل مزارعهم لتدنى جودة التربة بعد تعرضها للتصحر.

خلصت هذه الدراسة الى أن إعادة سعة الرى وتحسين نوعية التربة مع حمايتها بواسطة الاحزمة ساعد الى حد ما على زيادة دخل المزارعين فى المناطق المتاثرة بالتصحر داخل مشروع الجزيرة.

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INTRODUCTION

1.1 General

Desertification problem has universal impacts and cause, which extend beyond the dry lands most immediately affected.

Desertification has a considerable bearing on overall economic performance and prospects in the majority of African countries because these countries rely heavily on their dry lands as their main resource base. Sudan is one of these countries lying within the desertification high risk prone zone, where desertification had threatened the irrigation sector, mechanized crop production schemes and traditional rain-fed agriculture. The area affected by drought and desertification in Sudan covered the semi-desert, arid and semi arid ecological regions which include most of the Northern, Northern Kordufan and Darfur States and some parts of the Gezira and Eastern States (Salih, 1993).

In the western Gezira Scheme of the Gezira State, human activities exposed that part to sand encroachment. The hazard to the scheme infrastructure included filling of irrigation canals by sand, changing of topography of the field, leading farmers to move out of production. In other situations, many villages were deserted and covered by sand because of the destroyed natural vegetation by deforestation for supply of fire wood and building materials.

1.2 Socio-economic aspects

The total number of villages suffering from sand invasion in the study area was about 28 in El-hasahessa province (UNEP and LAS, 1995).

Poverty is the main factor that shapes the vulnerability of the human communities in the study area, their response and adaptation to desertification, and the efforts they exerted to combat desertification. Indicatives are the high rate of illiteracy and, therefore, lack of skill for high earning jobs. Accordingly they have low income and limited resources (Al-amin, 1999).

This study aims at assessing and comparing the socio-economic impacts on tenancies previously affected by sand encroachment then rehabilitated with non rehabilitated tenancies, as they live in the same geographical areas, also to study the effects of sand encroachment on their villages in the area.

1.3 Statement of the Problem

The north western part of the Gezira scheme ling in the arid climate of the Sahel zone, is recently facing serious thereat of sand encroachment covering fields and irrigation canals. Many villages were buried by sand dunes. The rehabilitation activities of Saheimab canal and the Eucalyptus microthica (Ban trees) of Saheimab and Eltahmeid shelterbelts (36km length with 40meter width and 12km length with width 200m respectively) were established to some extent to protect the scheme from sand encroachment. Up till now, the hazards threaten the socio- economic condition of the people in the non rehabilitated areas of the scheme and put them out of production

1.4 Objectives of the Study

The main objective of this study is to evaluate the socio-economic status of tenancies affected by sand encroachment then rehabilitated compared to those non rehabilitated tenancies.

The specific objectives of the study were as follows:

1. To Assess the socio-economic effects of desertification:
    - On livestock population and production.
    - On migration by number of migrants, type of migration and reasons for migration.
2. To assess the impact of desert encroachment:
    - On crop production pattern.
    - On crop productivity.
    - On crop income to tenants.
3. To evaluate the extent of environmental awareness among people in affected and not affected areas helping in reducing the effects of environmental hazards caused by the moving sands.

CHAPTER TWO
LITERATURE REVIEW

Recently, the issue of desertification in both developed and developing countries has received much attention worldwide because it is considered as one of the major socio-economic and environmental problems in the world.

This chapter is concerned with giving a general review on aspects that are related to desertification, or assumed to have direct or indirect effects on socio-economic status of people.

2.1 Desertification

Desertification is the result of a complex interaction of a number of factors. One of these factors is the effect of man. This effect has been a result of population growth and resource mismanagement. The other factor is that of climate change, which is important in effecting the severity and the rate of desertification. This change made drought one of the major causes of desertification since with each drought cycle, dry land degradation increases.

2.2 Definitions of desertification

The definition of desertification has been developed through time. As early as 1949, the scientist Aubreville thought of desertification in tropical Africa, where he worked, as the changing of productive land into a desert as the result of ruination of land by man-induced soil erosion. Aubreville was quite clear in his conclusion that desertification in tropical Africa was due to man's activity, and that there had been no significant

climatic change during the past thousand or more years. Most of that destructive activity has occurred within recent historic time by the action of agricultural populations (Dergne, 1986). The later definitions, by the UN agencies and others introduced the behavior of man and his attitude towards managing the natural resource base around him.

The latest agreed upon definitions were those that combined the effect of both the climate change and the mismanagement of human beings of their environment.

For assessment purposes, a simple recent definition was given by UNCOD in (1977) as:

“A process leading to reduced biological productivity, with consequent reduction in plant biomass, in the lands carrying capacity for livestock, in crop yields and human well being leading to the intensification or extension of desert conditions".

In this concept, the reduction of potential resources or a combination of processes such as physical or chemo-physical process induced by biological or biophysical mechanisms that reduce plant cover and productivity leading to conditions unusual for man.

In 1986, Dergne emphasized that droughts related to man’s activities were the main causes of desertification and described the phenomenon as:

"The process of impoverishment of ecosystems under the impacts of man".

The process of deterioration in these ecosystems can be measured by reduced productivity of desirable plants, undesirable alterations in the biomass and the diversity of the micro and macro fauna and flora, accelerated soil deterioration, and increased hazards for human occupancy.

United Nation Conference on Environment and Development (UNCED) held at Rio D-Janeiro of the Earth Summit (1992) proposed a new definition for desertification as follows:

"A process of land degradation in arid, semi-arid and dry sub humid areas resulting from various factors including climatic variation and human activities".

This definition emphasized the relationship between climatic factors and the socio-economic conditions of populations. Most of the definitions highlighted the symptoms of the problem as indicated by deterioration in biological potentials of the land and low crop yield. This definition also mentioned the main causes for desertification as triggered by mans activities and misuse of natural resources.

Most of the recent studies prefer the use of the term desertification because it implies the effect of human activities and mismanagement of resources associated with climatic change.

In conclusion the last definition of desertification by UNCED (1992) may be an appropriate definition because desertification is considered as the product of interaction of climate change with irrational utilization of resources base by man. The climate change is closely linked to desertification because it intensifies and accelerates the process. Hence, human activities and climate change are two processes that overlap.

2.3 Causes of desertification

The causes and consequences of desertification are largely rooted in socio-economic factors, as it is concerned, primarily with its direct and indirect impact on the welfare of human population. Hence, the complexity and diversity of the causes of desertification make it difficult to evaluate its magnitude.

The Sudanese Desert Encroachment Control and Rehabilitation Program (DECARP) in 1976 concluded, that no one single factor causes desertification. Obviously, it is a combination of factors, involving fragile ecosystems, developed under cruel and fluctuating climate, and man's activities, some of which are increased in permanent magnitude by weather fluctuation, especially periodic droughts.

The following processes are important because they are more wide spread and they have large impact of desertification leading to low productivity in agriculture.

2.3.1 Over grazing

DECARP, (1976) stated that over-grazing had broken down the dynamic equilibrium that once existed between livestock and the natural resources, causing desert or range land domination. The grazing condition in Agadez, Niger, on the south side of the Sahara, gives an example of accelerated desertification in recent decades under 100-350 mm rainfall zone (Bernus, 1977). Glantz, (1986) stated that over grazing causes soil compaction and reduces infiltration of rain water into the soil and increases surfaces runoff. As a result, soil fertility decreases, water erosions increases, and the vegetation suffers from moisture shortages. In India, UNDP, (1986) described grazing lands as causes of soils and vegetation degradation as the result of the excessive pressure of cattle herds.

2.3.2 Deforestation

According to the World Commission on Forests and Sustainable Development1 (WCFSD), (1999), about 14 million hectares of tropical forests had been lost each year since 1980 as a result of changes in land use from forest to agriculture. In Sudan large areas of arid zone had turned into

desert. Illegal and unregulated deforestation resulted from over cutting of national forests to meet Sudan energy needs, of which about 80% was provided as biomass in the form of fire wood and charcoal (Bashir, 2001). Reports on the State of the World's Forests and world's Forests Resources Assessment (2000) released in 2001 by FAO showed that an annual deforestation was 0.96 million hectares in the Sudan during 1990-2000 (FNC, 2004). The severe over cutting of natural forests east of White Nile which act in part as a barrier to moving sands, allowed the encroachment of sand to reach the Gezira Scheme and covered the canals and villages over there (FAO, 1986).

In forest areas, the major causes of land degradation were illegal commercial logging, conversion of forest land into agriculture associated with infrastructure and/or human settlements. The loss of forest or woodland puts the survival and income of communities that depend on forest at risk (GEF, 2003).

2.3.3 Over cultivation

Over cultivation has been mentioned as a major cause of desertification. In Sudan, Mensching and Ibrahim (1976) stated that "Field study has firmly convinced us that transgression over the potential, (climatically controlled border of millet cultivation) has been the major factor in the process of desertification in Northern Darfur. This assumes that the desert creeps southwards with the advance of north-eastern trade winds. The sand creep continued, originated from the Qoz-belt, by the expansion of crop cultivation. UNEP (1991) stated that frequent agricultural expansion to marginal lands resulted in rapid land degradation with a subsequent decline in production. Hunger for land often causes agricultural encroachment by marginalized farmers into marginal dry lands.

Bashir (2001) estimated that about 50%-83% of the monthly fire wood supplies to the capital cities originated from northern Upper Nile State. The bulk was produced in areas already under marked land clearance for mechanized agriculture.

In conclusion, desertification often originates on land cleared for cultivation or left fallow. Removal of the original vegetation cover exposes the soil to accelerated wind and water erosion.

2.3.4 Wind erosion

Wind erosion removes soil and natural vegetation and causes dryness and deterioration of soil structure leading to desertification.

Blowing soil or soil erosion by wind is a complex process. It involves detachment, transport, sorting, abrasion, avalanching, and deposition of soil particles (James and Croissant, 1994). In Sudan, wind erosion is the main desertification process as it affected about 27 million hectares out of 64 million hectares of degraded soils. Most of it in the hyper arid and arid zone (Ayoub, 1998). Desertification in western Sudan is an example of exposed land to wind and water erosion. In El- Odaya region, natural sandy soils have been increasingly affected by wind and water erosion. Soil erosion has been especially manifested around animal watering points and areas of intensive agricultural production. A general decline in soil fertility due to the reduction of fallow periods has also occurred. Continued population growth, livestock rising and increasing demand for agricultural land were expected to intensify land degradation process (UNEP, 1992).

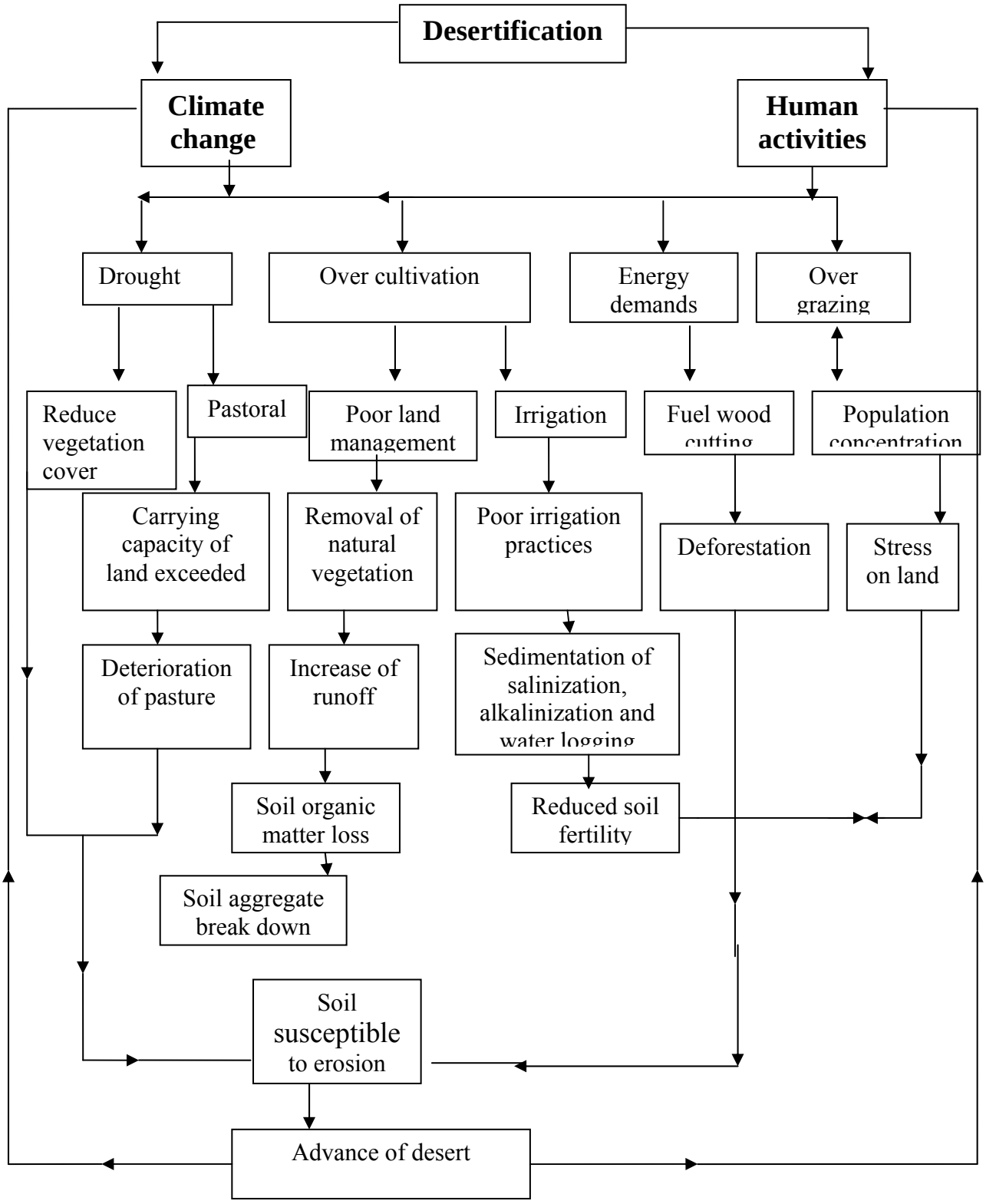
Winds rooted sand dunes and encroach it to move from site to other site guided to desertification, wind direction and the amount of available sand affected sand dunes size and shape (Tsoar, 2002). Modern techniques,

such as aerial photography and satellite images, have been used to classify dunes based on their characteristics. Sand dunes are classified according to their characteristics that rally round their form under winds blow from one or different directions. However, to assess their shape, height, size and mobility help in rehabilitating desertification process.

Figure (2.1) shows a hypothetical of the causes and mechanisms of desertification. These causes deemed to occur with long-term interaction between physical, topographical and human components. Mechanism (1) is caused by human activities such as stress on land through over cultivation, severe fire-wood cutting for energy demand, over grazing which leads to the loss of vegetation cover and may cause water and wind erosion. Mechanism (2) also affected by human activities, which comes as the result of poor irrigation practices, increased sedimentation, salinization and alkalinization and water logging resulting in reduced soil fertility. These will lead to poor

land management, removal of natural vegetation, and increase of run-off and as a consequence, soil organic matter loss, and result in a surface more susceptible to erosion.

Fig. 2.1 The causes and development of desertification



Modified to (R. k. Pachauri and R. k. Rajashree. S. Kanetkar, 1993)

2.4 The effect of desertification in Sudan

One of the most important issues facing Sudan in general today is the threat of continued drought and desertification, resulting in destruction of natural resources and their political and social disturbances.

In 1976, the government of the Sudan formulated DECARP, which described the problem of desertification as a man-made phenomenon caused by intensive misuse of natural resources such as overgrazing, over cultivation, deforestation, uprooting of shrubs for fuel and lowering of water tables due to increased water use, burning of grasslands and forests.

The overall situation in areas affected by desertification particularly in Central Sudan (Kordofan) may be illustrated as concluded by UNEP, (1991) as: "The drought of 1982-1984 resulted in serious dry land degradation in central Sudan (Kordofan). The period was characterized by greatly diminished rainfall, loss of vegetation, crop failures with zero harvest of cereals, soil erosion, famine, suffering and death of people and livestock, and human migration from the region". Some effects of desertification in Sudan are discussed in the following parts:

2.4.1 The effect of desertification on land in Sudan

Deterioration in soil and plant cover has adversely affected the land areas as a result of human mismanagement (UNEP, 1991). According to FAO (1992) the degradation of fragile dry lands threatened the livelihoods of over 900 million people in some 100 countries. The situation was especially serious in Africa where most of the agricultural dry land was already degraded.

Sudan comes within degraded African countries, in the southern edge of the Sahara desert and along the Nile mobile sand dunes threats to the agricultural land, villages, infrastructures and alluvial strip and

depression along the Nile (Ayoub and Musa, 2004). In the desert and semi-desert regions of northern Sudan, deterioration of the vegetative cover as well as the disappearance of wildlife were recognized as the main features of desert encroachment (Hellden,1988).

2.4.2 The effect of desertification on agricultural production in Sudan

Continued agricultural expansion to marginal lands frequently resulted in rapid land degradation, with a subsequent decline in production (UNEP, 1991). Scherr and Yadav (1996) suggested that 5-10 million hectares had been lost annually to severe degradation. If this trend continues, about 1.4%-2.8% of total cropland and forest land would be lost by the year 2020.Declining yields or increasing input requirements to maintain yields would be needed over much larger area.

In western Sudan desertification had shocking effects on the natural environment and led to considerable reduction in food production (Ali, 1991). Ahmed, (1994) pointed out that sand encroachment in the Gezira scheme has resulted in irrigation problems such as coverage of canals with sand which led to reduced productive areas. In fields, sand creeping makes the gravity irrigation difficult for crops. Soil fertility is expected to change depending on the type of the added soil. Finally, all these direct or indirect factors would result in low crop productivity.

2. 5 The effect of desertification on food and food security

Food security exists when all people at all time have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life (USAID, 1995). The relationship between environmental degradation and food insecurity, especially in arid and semi arid areas is indicated by (a) the long term and accumulative environmental

degradation resulting from inappropriate cultivation practices, over grazing, excessive fire- wood cutting, burning and deforestation. (b) the decline and/or collapse of permanent productive systems. These will affect food security and increase poverty (Abedlati, 2002). UN, Secretary General Annan (2003) in the world Day to Combat Desertification and Drought sent the following message reflecting the effect of desertification on poor rural areas threatening food security and triggering humanitarian and economic crises: **"**Desertification and drought cause an ever-increasing global threat. Human activities such as over-cultivation, overgrazing, deforestation and poor irrigation practices, along with climate change, are turning previously fertile soils into unproductive and infertile patches of land. Arable land per person is shrinking throughout the world threatening food security, particularly in poor rural areas."

In general, desertification does not only threaten the agricultural base of production but also the existence of the livelihood of the people and the social structure of the communities. It also causes loss of biodiversity and ultimately put food security at risk (Alwakeel, 2004).

2.6 The effect of desertification on poverty

Our common future as underlined by the report of the World Commotion on Environment and Development (WCED) in 1987 connected between poverty, international policy and environmental degradation. The report emphasized that poverty itself effected the environment; however poorest hungry peoples will often destroy their immediate environment in order to survive. They will cut forests, overgraze grasslands, overuse marginal and then crowd into the congested cities. The accumulative effect of these changes is so far reaching as to make poverty itself a major global scourge. UNEP (1991) stated that land degradation and poverty issues

reflected socio-economic, biological and political problems. Abedelati (2002) affirmed that farmers, being poor, are unable to restore the soil fertility or improve their agricultural technology, or practices. As a result of the degradation, they are forced to move to other areas, expanding further the degraded area and ultimately move to urban centers, causing more degradation.

This following message by Secretary-General Kofi Annan (2003) for the World Day to Combat Desertification and Drought, reflected desertification cause and a consequence of poverty:

"The poor often farm degraded land that is ever more unable to meet their needs, desertification is both a cause and a consequence of poverty. Fighting desertification must, therefore, be an essential part of our efforts to eradicate poverty and verify long-term food security".

2.7 The effect of desertification on migration

When an imbalance develops between population numbers and the carrying capacity of the land, the persons thereby displaced are referred to as environmental refugees. The utilization of the land beyond sustainability leads to land degradation and ultimately desertification.

United Nations (2004) pointed out that the reasons for migration include desertification and drought that affected many areas in Sudan, particularly Western Sudan. Both resulted in famine, the search for better social services such as education and health facilities, employment opportunities, and war in the south and in the Darfur Region. The majority of the war and drought-affected migrant population are employed by the informal sector while the rest are involved in livestock and agricultural activities.

The desertification-poverty-migration phenomenon has been growing in Latin America and the Caribbean. Desertification affected much of the Peruvian coastal areas, where migration from rural areas has been growing rapidly. Haiti had experienced a 20% decline in productive lands and only 2% of its territory remains forested. Many experts believed that rapid population growth in the rural dry land areas could place increased stress on land and water resources, cause greater subdivision of land, reduce farm income and results in greater social fragmentation and migration (NHI, 1997).

2.8 The effect of people on desertification and vice versa

The increase of population and livestock pressure on marginal lands contribute to the expansion of desertification or land degradation processes (Tewari, 1987). Degradation in any one place can be caused by complex mixed different combinations of causes such as over grazing, over cultivation and population pressure (Warren and Agnew, 1988). The incorporation of population in the national development poses considerable socio-economic challenge. This is compounded by the fact that population continues to increase in the low rainfall areas, without a corresponding increase in extra agricultural employment possibilities. Any intervention in the low rainfall areas should, therefore, recognize the relationship and the incorporation of population in the main stream of the national development process (FAO, 1989).

Gorse and Steeds (1987) stated that overall population pressure is determinant to vegetation loss, especially in areas with limited land reserves and energy sources. In the high population density areas of West Africa, for instance, concentration of demand for arable land and fire wood

rest at the root of resource abuse. In these areas patches of desertification are the most visible.

United Nations Population Information Network, (POPIN) in 1995 reported that, population growth among both the Maasai pastorals and the sedentary agricultural population in Kenya led to competition for land between the two groups, which caused degradation and desertification in certain areas.

2.9 Desertification control

Techniques for combating desertification are, in fact, practices to control several desertification processes that, in the aggregate, represent desertification. The major processes are vegetation degradation, water erosion, wind erosion, salinization of soils, and soil compaction (Dregne, 1989).

To reduce and control desertification, a lot of research is carried out and various technologies are known like:

Soil conservation:

Soil conservation is based on covering the soil to protect it from raindrop impact, increasing the infiltration rate to reduce runoff, improving the aggregate stability of the soil and increase surface roughness to reduce the velocity of runoff and wind (Morgan, 1995).

The various conservation techniques can be described under the headings of (i) agronomic measures; by utilizing the role of vegetation to protect the soil against erosion, (ii) soil management; by ways of preparing the soil to promote plant growth and improve its structure, (iii) by manipulating the surface topography; for example: installing terraces to control the flow of water and wind (Morgan, 1995). Mustafa and Saeed (2004) stated that most techniques applied for soil conservation cause water

conservation. For example, mulching to minimize soil erosion, loss of organic matter, and soil fertility, improve soil structure, infiltration rate and thus conserve soil and water.

Water harvesting techniques:

Water harvesting can be defined as collection of runoff for its productive use. Moe precisely, water harvesting is the process of collecting and concentrating rainfall as runoff from large non-cultivated areas to be used in smaller cultivated areas (Leeuwen, 2003).

Ahmed (2003) concluded that water harvesting is the most practical and economical solution to narrow the gap between demand and supply. It is expected that rain water harvesting will play an increasingly important role in enhancing food production in areas on rainfall agriculture, especially, in the dry areas.

Coping strategies besides that people can cope with desertification by changing land use and/or location in several ways. Al-amin, (1999) gaves some examples: (i) temporary or permanent migration to other places (ii) change in the use of land by growing crops adapted to drought and desertification (iii) using more protective methods by applying irrigation, decreasing the number of animals and stopping trees over-cutting.

UNESCO and UNDP (1993) suggested strategies to reduce or prevent the hazards of desertification. These strategies were based on the following principles:

- Participation of all socio-economic groups at all stages;
- Decentralization of resource management of local communities, who are the first beneficiaries and main actors;
- Integrated approaches to long-term improvements while giving special attention to the short-term needs of local communities;

- Iterative approaches to ensure the necessary adjustment of the activities undertaken; and
- Long-term involvement and commitment of all the partners.

Sudan has been responded to the issue and elements of desertification and drought since the late 1940, where the Sudan government formed a commission to investigate desert encroachment on the irrigated lands in the Nile and rainfed areas. It indicated that the desert marginal zone has expanded southwards into the most active economic regions of the Sudan reflected on the productivity of both cultivated land and pastures (Elsanjak, 2000).

The other document prepared by Sudan government entitled DECARP 1976, which included a wide range of projects in agriculture, range-land, wild-life, surface and ground water, forestry and other activities which due with areas affected by desert encroachment (Elsanjak, 2000).

In 1978 National Encroachment and Monitoring Unit was established by Sudan Government and supported by UNESCO in 1980. The efforts were continued until in 1988 the Ministrys of Agriculture prepared the proposed National Plan for Combating Drought and Desertification. In 1991 the Ministry of Agriculture, Natural Resources and Animal Wealth reestablished the unit of National Drought and Desertification Control Coordination and Monitoring Unit (NDDU) which draw the national plan for combating drought and desertification. Recently, in Sudan a Geographic Information System (GIS) unit was installed and compilations of different information were carried out (Salih, 1993). Despite the seriousness of the environmental and socio-economic impact of desertification and drought in the Sudan, few efforts have been made to devise diagnostic and monitoring techniques for appraising the status and trends of desertification.

2.10 Attempted to control desertification

2.10.1 Establishment of forests

The forest has a major role to play in reversing desertification trends and in providing an outstanding long-term investment in the valuable natural resources needed for continued development. In dry zones, the main efforts to wards re-establishment of forest resources have been directed to the artificial forestry production systems, which in lower rainfall areas, are frequently associated with water harvesting and soil and water conservation work (FAO, 1989).

Forests maintain favorable and stable conditions needed for sustained agricultural productivity. Trees prevent soil erosion, enhance soil fertility and maintain soil moisture. Developing countries, particularly those in arid zones, rely on trees to prevent erosion, halt desertification and protect biological diversity, crops, settlements and watersheds. Their rural population depends on trees for fuel, poles for construction and a range of none- wood forests products such as fodder, food and medicines. In those countries there is little potential for producing industrial wood (FAO, 2003).

FAO (1982) suggested that links between population density/growth and land conservation are weak. Other factors such as the development of the overall economy, urbanization, policies, legislation, culture and tradition might have explained a relatively large proportion of the variation in the rate of forest area change among countries (FAO, 2001).

In conclusion sustainability multiple roles and functions of all types of forest lands and wood lands is an international problem. Chapter 11 of Agenda 21 reported by the United Nations Conference on Environment and Development (UNCED,1992) shown that there are major weaknesses in the policies, methods and mechanisms adopted to support and develop

the multiple ecological, economic social and cultural roles of trees, forests and forest lands.

2.10.2 Use of energy

Energy alternatives have been promoted to meet the wood-fuel deficit and conserve the environmental degradation. Gabat-Gas Project prepared by Forests National Corporation (FNC, 2004) aimed at changing consumption attitudes by reducing fire wood and charcoal consumption by 50% in a period ranging between 3 and 5 years. This was to be effects by encouraging the use of other biomass alternatives in order to protect forest and preserve the environment. Distribution of gas cylinders and their accessories was proposed to reach people in the dry areas of the Sudan through establishing permanent gas storehouses in the cities and urban centers together with mobile storehouses in rural areas. It also aims at encouraging the use of brick ovens and traditional bakeries using gas, kerosene and furnace instead of firewood and charcoal.

Shomm and El Waleed (1996) stated that Carbonization of agricultural residues expected saving in natural forests, the most useful candidates for energy purposes are cotton stalk, groundnut shells and bagasse. The produced residue coal briquettes reflected good properties (67% of the wood charcoal heat value) and burning characteristics and their marketing expected that acceptability.

From the environmental point of view if all available promising residues were utilized as energy source the natural forests will be saves annually and the environment positive impact would be great.

2.10.3 Shelterbelts establishment

Shelterbelts are one type of wind breaks composed of a number of tree rows established round vast extended land. They are used to protect land against erosion and provide it with suitable environment. Shelterbelts are, also, established around villages and towns in order to protect them from wind and moving sand.

Hanno (2003) found that Shelterbelts which surrounded El Basheri Oasis in Northern Kordofan State were able to stop sand dunes movement efficiently. They would create microclimates that reduce temperature, wind velocity and contribute to reduced dust storms. In addition, the shelterbelts would create favorable conditions for growth of new plants species, helped in increasing crops productivity, provide forest products, increase livestock production and improve socio-economic status.

Gupta, et al. (1997) reported that in India shelterbelts along the boundaries of crop fields helped to reduce damage to tender seedlings from sand blasting and desiccating winds. Shelterbelts also reduce the loss of moisture from fields. At least 14% higher soil moisture and 70% more grain yield of pearl millet were recorded in the lee of shelters, as compared to that in the areas without shelters.

The Agriculture and Agric-Food of Canada, (2005) found that the prairies crops grown in fields protected by shelterbelts yielded better than those grown in unsheltered fields. This was due to many interacting factors including less soil erosion, lower wind speed and evapo-transpiration and higher temperatures (www.agr.gc.ca/pfra/soil/swork2).

2.10.4 Regeneration of vegetation

Vegetation is most vulnerable to drought and desertification if not properly managed, rehabilitated and improved. These require the actions of

man to restore the degraded land and vegetation. The options for these action decrease with increasing dryness. FAO (1986) detailed measures to restore degraded land and vegetation as follows:

(a) Sand and sand-dune fixation through artificial sowing of plants including trees, shrubs and grass species, (b) Establishment of plantations on degraded lands, especially on irrigated degraded lands, (c) Establishment of trees, shrubs and grass plantations of value to restore the fertility of degraded lands where rain-fed cultivation is practiced, (d) Seeding and planting catchment areas and stock of permanent and seasonal water-courses for regulation of water-flows and erosion control, (e) Use of improved species and varieties and better management and operation systems.

Moreover, Abu Suwar and Darrag (2004) summarized that the study conducted in Bara project among nomadic areas to save wood energy through improving stoves for cooking and using mud in building huts instead of wood showed high success for carbon sequestration and range rehabilitation. The project also focused on implementation of series of pilot projects for reserving and seeding across the Savanna Belt at El Odaya town in Western Kordofan State. They found that the most important of seeding was the rehabilitation of the range degraded areas around permanent water supplies.

2.10.5 Agroforestry

An ultimate goal of agroforestry is conserving the soil and water sources while satisfying the need of rural people for food, fuel and income. Successful agroforestry depends upon the quality and quantity of products that may be produced, but also largely upon the socio-political strategies of a project (FAO, 1989).

Agroforestry is a land management system that combining agricultural production and crops fodder on the same unit of land. The system conserves nutrients and increases the yield of grain, forage, timber, animal products and improves the environments (UNESCO, 2004)

Fadl (1999) found that the use of mesquite (Prosopis juliflora) in agroforestry had a great potential for rural people in a region very vulnerable to drought and famine. Fadl (1999) confirmed the feasibility of agroforestry in Acacia senegal gardens of Kordofan sands however, agroforestry lends itself as the most appropriate for its many virtues, particularly increasing soil fertility and hence crop yields and conserving the environment. Pod production is of paramount importance especially during times of scarcity of fodder and food.

Basic principles for combating desertification can be summarized in several points including: (i) the necessity for planning on long-term basic collaboration and coordination among stakeholders at all levels, (ii) determination of the appropriate use of resources, (iii) establishment of appropriate mechanisms and implementing programs and projects designed for controlling desertification and (iv) mitigating the effects of drought.

CHAPTER THREE
MATERIALS AND METHODS

A general review of the research methodology used in this study will be the subject of this chapter. Two types of data were used namely; primary and secondary data. Secondary data were collected from reports, official records, documents and internet. While the primary data was collected through personal interviews with individuals using structured questionnaire, group discussions and observation. The survey area, data collection methods, sampling design, sample size, and the analytical techniques used will be discussed below:

3.1 Site of the Research

Gezira is a metaphorical island between the White Nile and the Blue Nile. The Gezira is wedge –shaped plain, bordered by the White Nile to the west, the Blue Nile to the east, and the Kosti-Sennar railway line to the south. The Gezira Scheme located on Geziera state whatever, this scheme is important to the Sudan economy with a total area of about 2.2 million feddans which uses a gravity irrigation system. The Scheme is divided into 18 administrative units, each of which is sub divided into further blocks, making 109 in total. This corresponds to 1,055 villages, in which the 112,000 tenancies families live.

Out of the total land under irrigation, about 1.5million feddans per year are cultivated on a crop rotation basis. Crops cultivated in the scheme are cotton, wheat, sorghum, groundnut, and small area of vegetables.

The scheme administration provides the farmers with inputs in form of seeds, chemicals (fertilizers and pesticides) and irrigation water while

channel preparation was carried out by administration office. Farmers have to provide other inputs themselves. Each farmer within the scheme possesses 20 feddans (21 acres) for the main crops: cotton, wheat, sorghum and groundnuts.

The tenancies pay 12% of their gross returns of cotton, which are allocated as follows: 2% for social development, 4%for local government council, 5% Zaka, 1% for the tenant reserve fund. The net proceeds go to tenants. Figure (3.1) shows the land cover map of the study area.

The study selected six villages and was conducted in Abu Guta and Begeiga Blocks in the north-western part of the Gezira Scheme because they were most affected by desertification (see figure 3.2).

3.2 Vegetation cover

Lack of permanent vegetation cover in certain locations within the Gezira Scheme has resulted in areas affected by extensive wind erosion.

The vegetation cover in the Gezira Scheme in Abu Guta area is characterized by a mixture of grasses and herbs with scattered bushes. Plant community distribution is determined by topography (Al-amin, 1999). The vegetation cover in the area was affected by land use pattern particularly rain fed agriculture. The natural vegetation is composed of Acacia thorn on dark cracking clays mainly of dominant tree species of Acacia tortilis (Samr, sarih) mixture of Cappris decidua (Tundub) Ziziphus spina-christi (Sidr) and alternating with grass land mainly of Cymbopogon nervatus (Nal).

Fig (3.1)

Landcover of the Study Area

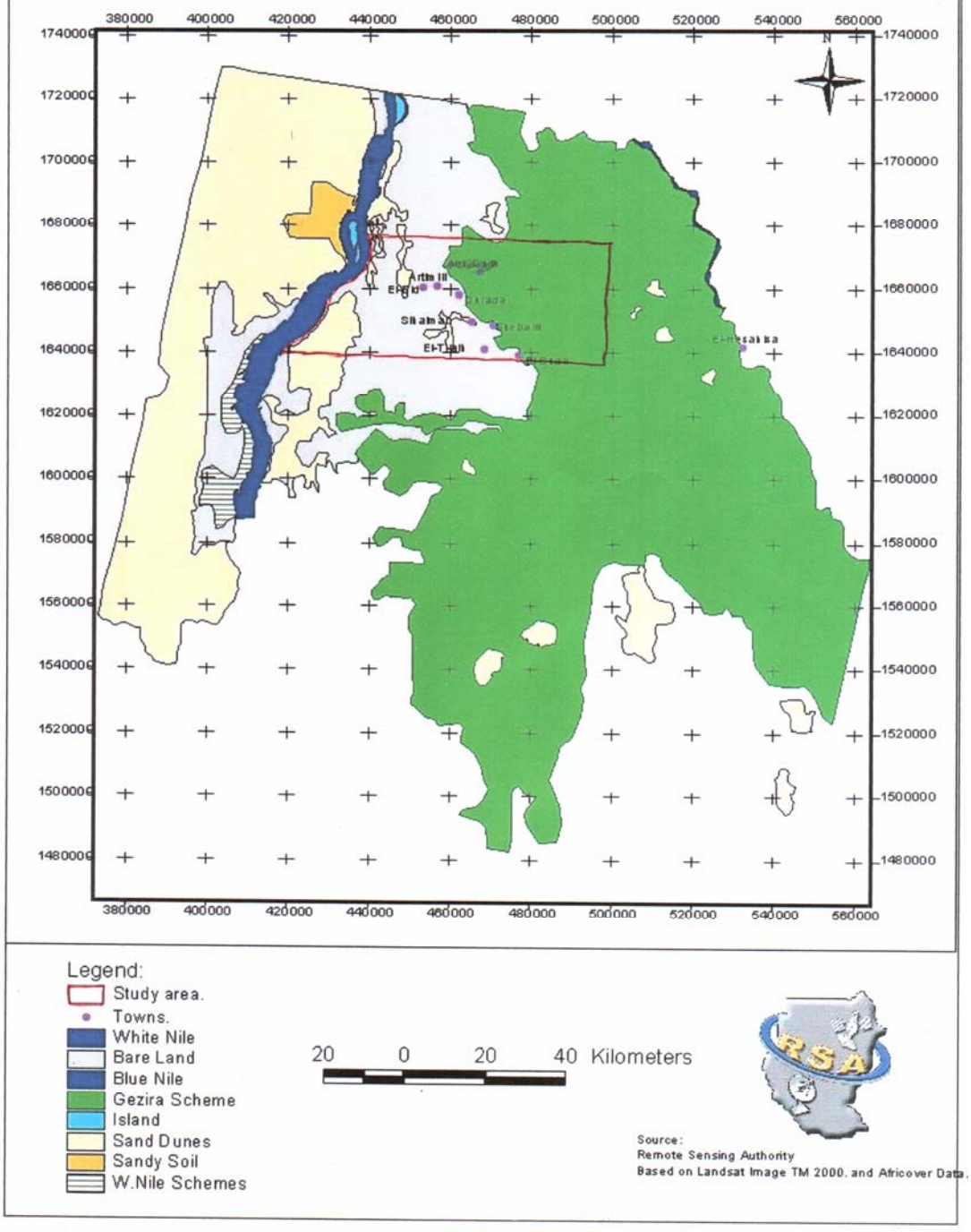
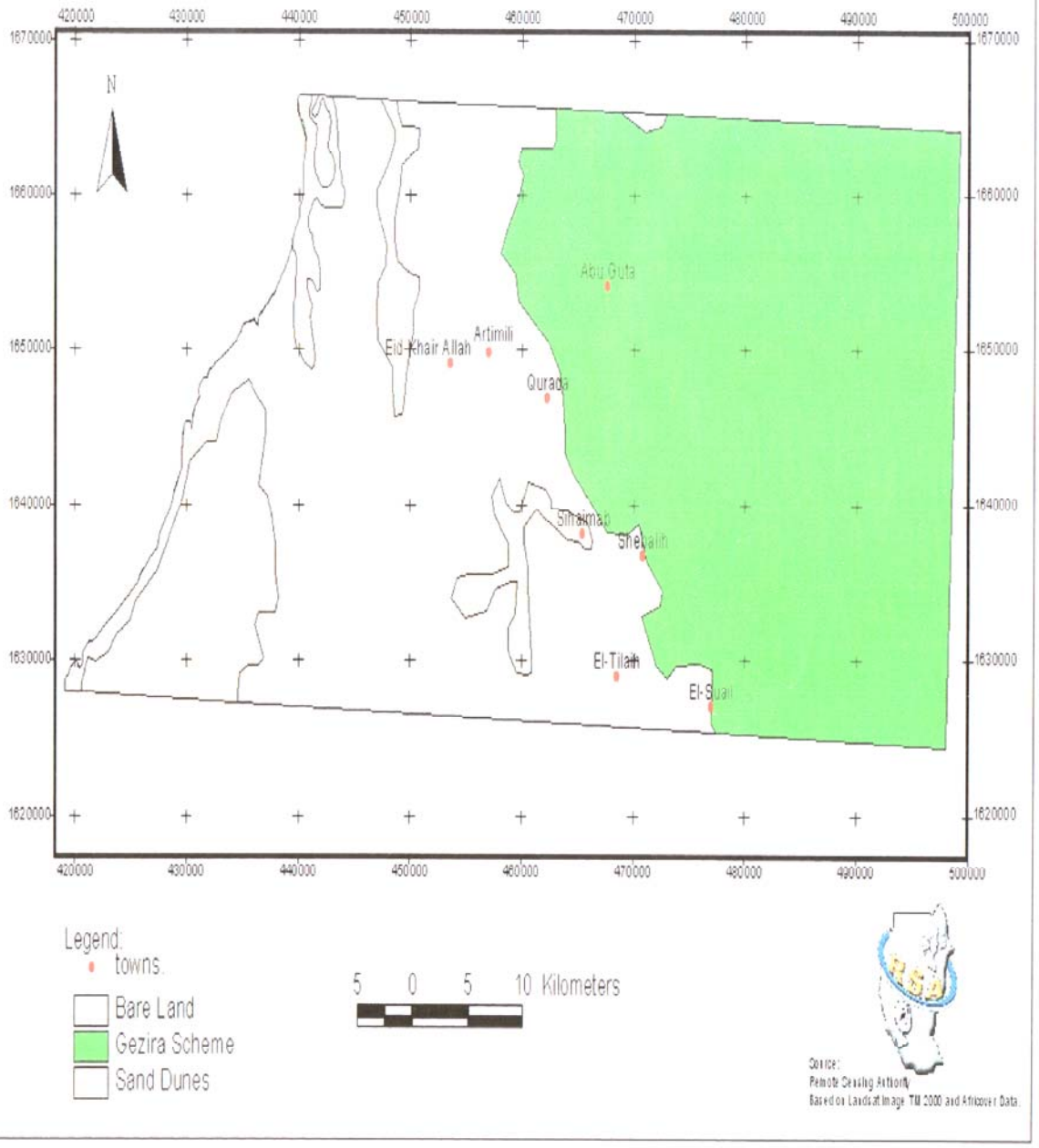


Fig (3.2)

Landcover of the Study Area(Zoom in)



3.3 Climate

The climate of the area is a semi arid zone climate where the potential evaporation exceeds annual rain fall.

Wind is considered the important erosion factor in the area due to its ability to carry the sand particles for the long distances.

The prevailing winds blowing over the area are south western winds and north eastern winds. The south western winds are humid winds from June to September while the north eastern winds are dry winds from November to April-May. These winds have no stable direction during those periods.

The unrestricted advancement of sand dunes hit the scheme in different parts. The study area of Abu Guta and Begeiga area has been affected by sand carried by the south western winds during the summer season, while El-Tahamid area has been affected by sand carried by south-eastern wind during the winter season.

Temperature varies during the year. Maximum temperatures occur in May and in September/October. A relatively low maximum air temperature during July and August is due to the cloudiness during the rainy season.

Rain falls in the period between July to September and its quantity starts from 250 mm in the northern part of the study area and increases southwards to 450 mm in the southern parts. The area has been affected by the droughts that hit the Sudano-Sahelian zone in 1968-72 and 1981-85 (Alebaid, 2003). According to Sudan metrological station, (SMS, 2004) the shifting position of the mean annul rainfall during 1970-2004 and the changes during of the wet season in Khartoum, and El-Dueim the two nearest meteorological stations to the study area (Dueim and Khartoum) registered the annual rainfall in mm, (Table 3.1) over the same period are presented in Figure (3.3). It elaborated a direct relationship existing

between average annual rainfalls, average rain fed area and its production. When the annual rainfall was less than 400 mm, the season of the rainfed agriculture is not successful and affects farmers income. In addition, the fluctuations of rainfall and destruction of vegetation cover, however, expose the area to sand encroach

3.4 Soil and Topography

The soil of the study area is composed of dark cracking clay (Vertisols), which is often referred to as black cotton soil. The effect of sand deposition led to adverse changes in the physical properties of the cracking clays, reflected in the permeability, water holding capacity and bulk density (Fadul, 2002).

The chemical properties are generally known to have low values of organic carbon, nitrogen and available phosphorus. However, the sand-encroached sites have even lower values of organic carbon, nitrogen and available phosphorus, which further degraded the fertility of the Vertisols (Fadul, 2002).

3.5 Land use

Land use is the term used to describe human uses of the land, or immediate actions modifying or converting land cover. And the concept of land utilization includes the kind of crop, the succession of the crop in the rotation and the farming system.

The crop rotation in the study area of the Gezira scheme is made up of five course rotations (Cotton-Wheat-Groundnut/Vegetables-sorghum-Fallow). But now in Abu Guta Block groundnut and vegetables are taken out of the rotation due to the reduced water supply below their demand.

3.6 Sand encroachment in the study area

The study prepared by Alebaid (2003) in the study area used remote sensing and the Geographical Information Systems (GIS) to assess and monitor sand encroachment as desertification indicator in this semi-arid environment. This study used the remote sensing and GIS interpretation and compiled by three satellite images of different periods 1972, 1986 and 1996, which revealed that the area was invaded by sand. The area north of latitude 14º- 30° was almost totally covered by sand. Accordingly, cultivation in parts of the Gezira scheme had been abandoned due to the buried channels and the destroyed gravity irrigation system.

3.6.1 The source of sand encroachment in the area

(Fadul, 2002) by Satellite images and field observation revealed the presence of the dominant sites however, the reactivated Gozes of Kordofan as the primary source and the desertified White Nile terraces as secondary source. The medium of transport is the south westerly winds through a corridor crossing the White Nile.

3.6.2 Sand dune formation in the area

Dunes are formed by accumulation of transported sand, mainly by wind. Alebaid (2003) recognized four types of sand dunes in north-western part of the Gezira Scheme:

1. Mobile sand dunes: they are accumulated on depressions and swales in the alluvial plains, their heights are between 7-15 meters and their longitudinal formation reveals the intensity and direction of the wind. The top soil is generally characterized by sand with low water holding capacity and is non-calcareous.

2. Partially fixed dunes: These units are characterizes by yellow to brown colors with surface vegetation cover and moisture contents in the sub soil. They are nearly the same as the mobile dunes except for the fine roots on the top and sub surface soil.

3. Hummocks and thin sands sheets: these are accumulated sands on the alluvial plain and alluvial deposits of the White Nile and the boundaries of clay plain of the Gezira Scheme, they cover the surface soil to about 10-40 centimeters.

4. Alluvial plain with thin sand sheets: they correspond to the erosion forms and appear as bare soil or gravel covered. They show a severe state of desertification with characteristics of brown to dark brown colors and well drain soil. This soil is rained cultivated and is exposed to wind actions most of the year.

3.6.3 The impact of sand encroachment on the area

Some canals of Begiega Block are filled with wind blown sand, and the fields around this canal have irregular topography due to sand encroachment. The buried canals and the irregular topography have aggravated the problem of gravity irrigation and made it difficult to satisfy the crop water requirements, in addition to this, some villages were affected by sand encouragement to different rates.

3.7 Shelterbelts establishment

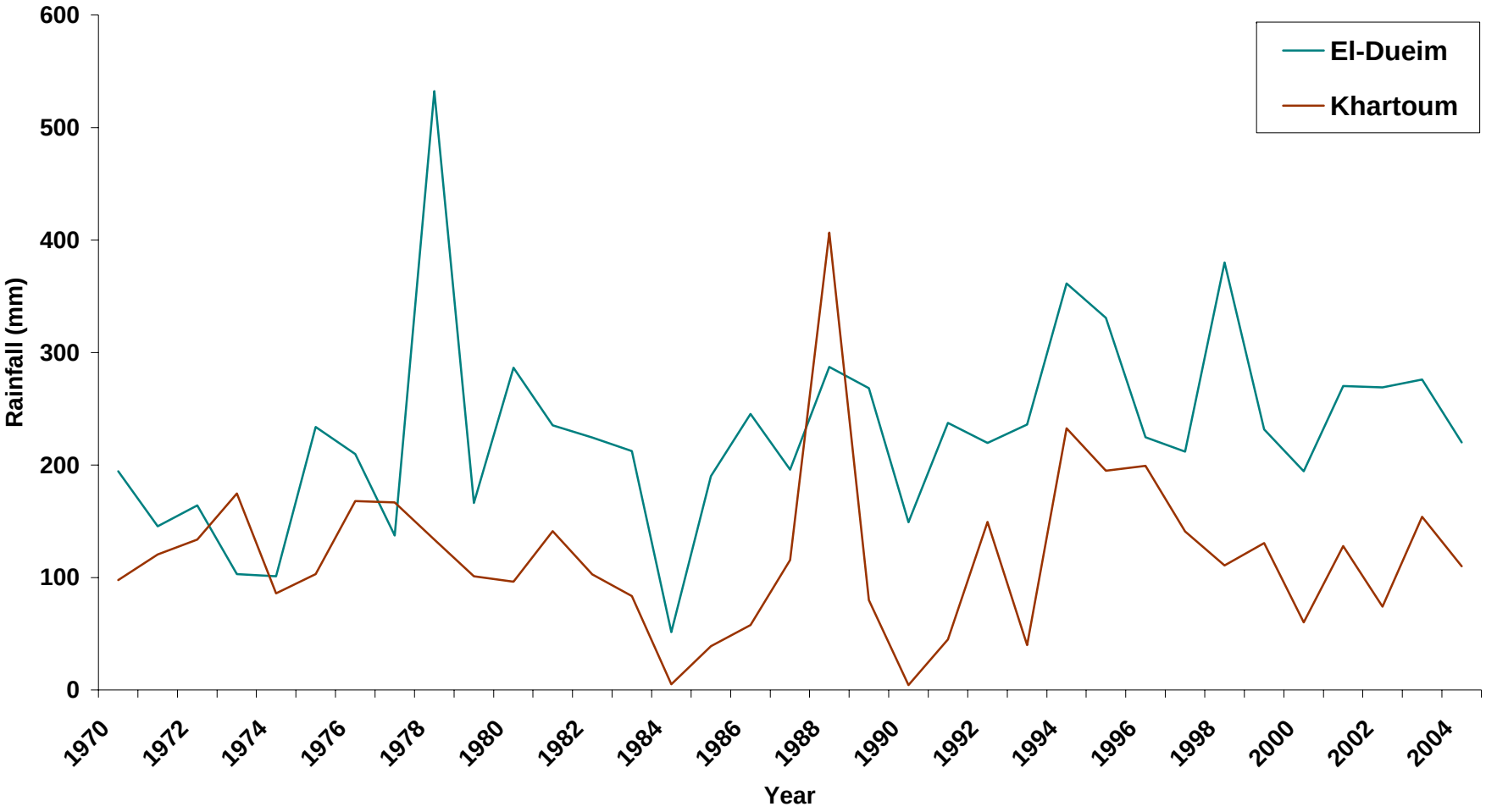
The most important tree belts are El-Tahameid and El-Sihaimab belts (irrigated Eucalyptus shelterbelts). The establishment of these shelterbelts led to the protection of some channels and rehabilitated some irrigated areas from sand encroachment (UNEP and LAS, 1995).

Table (3.1) Annual rainfall in mm in Khartoum and Elduim metrological station (1970 -2004):

Years	Khartoum	Elduim	Years	Khartoum	Elduim
1970	97.6	194.5	1988	406.5	287.2
1971	120.5	145.5	1989	79.8	268.2
1972	133.6	164	1990	4.4	149.2
1973	174.7	103.1	1991	44.9	237.4
1974	86	101.1	1992	149.3	219.5
1975	103	233.8	1993	39.8	235.9
1976	168	209.7	1994	232.6	361.3
1977	166.7	137.2	1995	195	330.7
1978	133.6	532.1	1996	199.3	224.6
1979	101	166.3	1997	141	211.9
1980	96.3	286.3	1998	110.7	379.9
1981	141.1	235.3	1999	130.6	231.5
1982	102.7	224.4	2000	60	194.5
1983	83.4	212.3	2001	127.8	270.2.
1984	5	51.5	2002	74	269
1985	38.8	190	2003	154	276
1986	57.7	245.3	2004	110	220
1987	115.6	195.9			
Total	**1925.3**	**3628.3**	**Total**	**2259.7**	**4096.8**

Source: Sudan meteorological station, (2005).

Fig. (3.3) Annual rainfall in Khartoum and El-Dueim metrological station (1970-2004).



3.8 Questionnaire

The questionnaire was the main method used in this study to collect the primary data (Appendix1). The questionnaire was designed in Arabic to make sure that respondents understand and fill the questionnaire accordingly.

In most cases, the farmers were contacted in the field or through the village's leaders to gain their confidence and cooperation. The interviews were done by the researcher covering 6 villages (Sihaimab) (Artimili) (Qurada) (El-Teilaih) (El-Suail) (Eid-Kair Allah), located not far from El-Sihaimab shelterbelts in Abu Guta and Begeiga blocks. 80 tenancies were selected randomly, 40 of whom were chosen from the rehabilitated fields and the other 40 tenancies were chosen from areas affected by desertification.

3.9 Official records and reports

Some secondary data were obtained from Abu Guta administrative unit including records, documents and reports for crop yield, cultivated land and others. These data were closely examined to help in assessing the effect of desertification in the study area.

3.10 Statistical Analysis

The descriptive statistics was used to analyze the data obtained in the study area. This process was accomplished by critically examining the data through the use of statistical package for social science, (SPSS) version number 11.0. Construction of simple tables and cross-tabulation, allows for capturing the answers to many of the questions being asked in the survey. Descriptive statistics included frequency, percentage, average calculation and use of tables and figure.

CHAPTER FOUR
RESULTS AND DISCUSSION

4. Introduction

Descriptive statistical method was applied to data concerning socio-economic characteristics for tenancies in areas previously affected by desertification then rehabilitated and tenancies in areas affected by sand encroachment and not rehabilitated. Respondent's perspectives about the different aspects are given and discussed in this chapter.

4.1 Results of socio-economic characteristics

The personal characteristics analysis aim was to compare socio-economic status between tenancies in rehabilitated areas and tenancies in area that were not rehabilitated, (with respect to relevance to level of agricultural productivity) as they live in the same geographical area. The characteristics used were:

(a) Age and education level (b) Marital status (c) Off-farm activities, off-farm income and family annual income (d) Drinking water sources (e) House types (f) Crop sharing system and reasons of crop sharing.

4.1.1 Age and education level

Age and education level my have an influence over the life style and status enjoyed by individuals in the society. Age distribution with education level of rehabilitated and non rehabilitated tenancies respondents are shown in Tables (4.1) and (4.2).

The results revealed that about 71% of rehabilitated and 60% of non rehabilitated tenancies fell within age groups of 50 and over 60 years.

For both groups it may be remarked that they both have the majority of their composition falling in age group above 50 and over 60 years old. This may reflect social stability among the two groups alike. The majority of individuals within the two groups were illiterate or had elementary level of education associated with age ranging between 50-60 and over 60 years old. This might be due to low appreciation of the concept of formal education by the society in the area in the past. This illiteracy and low level of education are expected to have a direct and indirect effect on the performance of the agricultural adoption of innovations and agronomical packages. Pudasaini (1983) stated that education contributes positively to agricultural production. Rahamtalla (1982) also mentioned that literacy affected the performance of cultural practices in the field and educated farmers were more willing to adopt new innovations, which are thought to be risky by less educated farmers.

Tenancies age is supposed to affect productivity in one way or others. Ali (1990) argued that advancing age seems to be accompanied with a reduction of physical effort. But on the other hand advancing age may add to the experience and skills of tenancies.

Table 4.1 Distribution of rehabilitated tenancies respondents by age-range and education level**:**

Educational level	Age range (years)					
	20-30	30-40	40-50	50-60	> 60	Total %
Illiteracy	0	0	0	20	30	50
Khalwa	2	1	4	9	7	23
Primary	7	5	3	5	0	20
Secondary	0	2	2	0	0	4
University	3	0	0	0	0	3
Total %	12	8	9	34	37	100

Source: field survey, 2004.

Table 4.2 Distribution of non rehabilitated tenancies respondents according to age range and education level:

Educational level	Age range (years)					Total %
	20-30	30-40	40-50	50-60	> 60	
Illiteracy	0	0	11	23	28	62
Khalwa	5	5	5	2	7	24
Primary	5	4	2	0	0	11
Secondary	3	0	0	0	0	3
University	0	0	0	0	0	0
Total %	13	9	18	25	35	100

Source: field survey, 2004.

4.1.2 Marital status distribution

Table (4.3) revealed that about 89% of the rehabilitated tenancies respondents were married and about 3% were divorced, while about 5% were widowed and about 3% were single. In the same table about 83% of non rehabilitated tenancies were married, while about 5% were divorced and about 7% were widowed and about 5%were single.

Comparing the marital status of the two groups of respondents (89%) of rehabilitated and non rehabilitated tenancies (83%) were married. These high percentages may be attributed to the simplicity of married life, which reflected social stability in the area.

Table 4.3 Distribution of marital status of rehabilitated and not rehabilitated tenancies respondents:

Martial status	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Married	36	89	33	83
Divorced	1	3	2	5
Widowed	2	5	3	7
Single	1	3	2	5
Total	40	100	40	100

Source: field survey, 2004.

4.1.3 Off farm activities

Agriculture is the main occupation that shaped the main career of the communities in the study area.

Table (4.4) shows that the majority of the rehabilitated tenancies (about 73%) were occupied in agriculture, while the others (about 27%) had other occupations in addition to agriculture. The situation is quite opposite in the case of the non rehabilitated tenancies. Only 22% of the total respondents were mainly occupied in agriculture, while the rest (about 78%) had other additional occupations. Such alternative employment may reflect the effect of available agriculture resources for the two groups of tenancies.

From Table (4.5) few of the rehabilitated tenancies had off farm income in addition to agriculture. Among those, about 46% were working in trade, followed by 39% in free business and about 15% as government employees.

On the other hand, almost more than 75% of the non rehabilitated tenancies had other sources of income apart from agriculture. Most of these groups (about 65%) work as laborers, while 19% work in free business.

It is obvious that more than half of the non rehabilitated tenancies worked as laborers since they had low level of income from agriculture.

Table 4.4 Distribution of rehabilitated and non rehabilitated tenancies with respect to agricultural occupation:

Occupation	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Non- agricultural occupation	29	73	9	22
Agricultural occupation	11	27	31	78
Total	40	100	40	100

Source: field survey, 2004.

Table 4.5 Description of rehabilitated and non rehabilitated tenancies according to off farm activities:

Other sources of income	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Trader	6	46	2	6
Free business	5	39	6	19
Governmental employees	2	15	3	10
Laborers	0	0	20	65
Total	13	100	31	100

Source: field survey, 2004.

4.1.4 Sources of drinking water for the two groups

Accessibility to safe drinking water is important against infection with water borne diseases like diarrhea, dysentery and other diseases. Unprotected sources are more likely to carry these diseases affecting human health.

Table (4.6) shows that more than half of rehabilitated and non rehabilitated tenancies families which settled in the same village rely on less safe drinking water sources (sub canals). About 25% of all respondents and their families, can be said to have safe drinking water from protected wells, while few of them (less than22%) get drinking water from different protected and unprotected sources (canals/ wells, canals and open wells).

A large numbers of tenancies and their families who settled in the same village, had no access to protected wells because some villages were located far away from protected water sources or protected water sources were not enough to meet the require. However, most of tenancies were found to be exposed to water borne diseases, which may have a negative effect on manpower productivity. WHO (1997) stated that water associated diseases are debilitating and seriously reducing the productivity of labor.

Table 4.6 Drinking water sources for rehabilitated and non rehabilitated tenancies respondents:

Drinking water Source	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Canals	21	53	25	63
Wells	10	25	8	20
Canal /wells	5	12	4	10
Canal /open well (idd)	4	10	3	7
Total	40	100	40	100

Source: field survey, 2004.

4.1.5 Comparative description of house types

In the study area the two groups had almost the same type of house construction. These houses made of mud were owned by more than 80% of each of the two groups (table 4.7).

Vulnerable groups were exposed to sand encroachment. Thus most of tenancies built their houses from mud for easy rebuilding in other places in the same village when covered by sand.

It was observed that some villages were surrounded by natural forests which contributed to stopping or reducing the affect of sand.

Table 4.7 Comparative description of respondents according to house types:

House type	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Wood/mud	1	3	3	7
Mud	32	80	32	84
Mud/blocks	4	10	3	7
Wood/blocks	3	7	2	2
Total	40	100	40	100

Source: field survey, 2004.

4.1.6 Tenancies and sharing system

Some tenancies share cultivated areas with workers however, the owners were bear the costs of all agricultural operations and workers in all farming operations and agreed to divide the revenue equally after deducting costs.

Table (4.8) gives the percentage of crop and no crop shares. Few of the two groups share crops with laborers, while the majority of rehabilitated

tenancies (about 88%) and non rehabilitated tenancies (about 75%) did not share crops with others.

Of those who share crops (Table 4.9), the rehabilitated respondents indicated that they can not afford to perform the hard work needed by farming (about 60%) or had other occupations (40%). Most of the 80% of the rehabilitated respondents indicated that agriculture in fact was not rewarding and thus they share with others. Some tenancies migrated out side the area for different reasons and share they farms.

Table 4.8 Rehabilitated and non rehabilitated tenancies dealing with sharing system:

Sharing system	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Crop share	5	12	10	25
No crop share	35	88	30	75
Total	40	100	40	100

Source: field survey, 2004.

Table 4.9 Rehabilitated tenancies and non rehabilitated tenancies respondents according to reasons for crop sharing system:

Reason of Sharing	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Incapability of tenant to perform field hard work	3	60	0	0
Agriculture not rewarding	0	0	8	80
Migration	0	0	2	20
Other occupations	2	40	0	0
Total	5	100	10	100

Source: field survey, 2004.

4.1.7 Families annual income

Tenancies and their families annual income are calculated by adding the revenue from three main crops of: wheat, cotton and sorghum, plus the income from other agricultural products such as fodders, livestock and of farm business income.

Table (4.10) shows that about 17% of the rehabilitated families earned an annual income ranging from SD200 thousands and SD300 thousands, while about 48% earned between SD300 thousands and SD 400 thousands and about 22% ranging between SD400 thousands and SD500 thousands and about 13% over SD500 thousands.

The annual income of about 17% of the non rehabilitated families ranged between SD50 thousands and SD200 thousands, while about 80% had income ranging between SD100 thousands and SD200 thousands, and about 7% had income ranging between SD200 thousands and SD300 thousands.

This high annual income of the rehabilitated tenancies and their families reflected the stability in farm production and other occupations, whereas the non rehabilitated tenancies had low level of annual income as they had been affected by sand encroachment on their farms.

Table 4.10 Distribution of rehabilitated and non rehabilitated tenancies according to their total annual income:

Annual range of families income (SD)	Rehabilitated respondents		Non rehabilitated respondents	
	Frequency	Percent	Frequency	Percent
50000-100000	0	0	7	17
100000-200000	0	0	25	63
200000-300000	7	17	3	7
300000-400000	19	48	2	5
400000-500000	9	22	2	5
>500000	5	13	1	3
Total	40	100	40	100

Source: field survey, 2004.

4.2 Crop performance

4.2.1Crop production

Tables (4.11) and table (4.12) give average area and average crop yields for the seasons 2002/03 and 2003/04 for the two groups of respondents. Tenancies that did not produce any thing or had a reduction in their cropped area were found only in fields affected by desertification. Canals were filled with sand and did not receive water. Although non rehabilitated tenancies had one option that was to grow sorghum only, it required less irrigation provided that it was grown in rainy seasons to benefit from the rain.

4.2.2 Crop yields

On average the yield obtained by the rehabilitated tenant for season 2002/03 was found to be about 5.7 sack/feddan for sorghum and about 4.8 sacks/feddan for wheat. Cotton gave yield of 5.2 kantars/feddan. The non rehabilitated tenant obtained about 1.7 sacks/feddan for sorghum.

During 2003/04 season the average yields obtained by the rehabilitated tenant were found to be about 5.2 sacks/feddan for sorghum and about 3.8 sacks/feddan for wheat. While for cotton the average yield was 6.1 kantars/feddan. Comparing this result with the results of the non rehabilitated tenants it has been found that the latter produced about 1.9 sacks/feddan for sorghum.

Sorghum is the only option for non rehabilitated tenancies and was sown in the rainy season. Some times tenancies break the main canals and dig sub canals covered by sand for irrigation of sorghum to secure their food.

From this result it can be concluded that areas cultivated with crops in rehabilitated tenants were greater compared to areas in non rehabilitated tenants through out the two seasons. Accordingly this reduction in the cropped area and productivity were the cause low income of tenancies that non rehabilitated.

Productivity in non rehabilitated farms and crop areas were directly affected by desertification and may be used as an indication of the degree of desertification in the area.

4.2.3 Gross revenue from crops

In this part the average gross revenue per tenant was calculated by multiplying the average area by the average yield per feddan by the average price of sack as follows:

Average gross revenue: average area*average yield*average price = SD/tenant.

From Tables (4.11) and (4.12) it was found that the average gross revenue for rehabilitated tenants was about SD70.292 for sorghum, about SD85.854 for wheat and SD173.292 for cotton for the season 2002/03 compared to SD13.391 for sorghum for non rehabilitated tenants. Similarly, the revenue for the season 2003/04 for rehabilitated tenants was about SD71.970 for sorghum, about SD52.893 for wheat and was about SD205.266 for cotton, and the average gross revenue of non rehabilitated tenants was about SD17.774 for sorghum.

From this result it may be concluded that rehabilitation tenancies obtained higher gross revenue, and gained more from cotton production followed by wheat and then sorghum. They may sell most of their wheat production. Some of them preserve sorghum for home consumption and some of them may sell their sorghum. As for the non rehabilitated tenancies, it was found that most of them sell their sorghum and some of them preserve sorghum for home consumption. It was realized that the average gross revenue of the rehabilitated tenancies from crops was equal to SD329.438/tenant compared to 13.391/tenant for non rehabilitated. This is because rehabilitated tenancies have three crops grown while the non rehabilitated tenancies were affected by sand and have one crop grown in rainy season.

Table 4.11 Average crop area, yield and prices of crops for rehabilitated and non rehabilitated tenancies respondents in season 2002/2003:

Groups	Average total area/fed			Sorghum			Wheat			Cotton	
	Sorghum	Wheat	Cotton	Yield (Sacks/feddan)	Price (SD/sack)	Gross revenue (SD)	Yield (Sacks/feddan)	Price (SD/sack)	Gross revenue (SD)	Yield (kontars/feddan)	Gross revenue (SD)
Rehabilitated tenants	2.6	2.9	2.8	5.7	4,743	70,292	4.8	6,167	85,854	5.2	173,292
Non rehabilitated tenants	1.9	-	-	1.7	4,146	13,391	-	-	-	-	-

Source: Field survey and Gezira scheme, official records of Abu Guta Block, 2004.

- : Not grown

Table 4.12 Average crop area, yield and prices of crops for rehabilitated and non rehabilitated tenancies respondents in season 2003/2004

Groups	Average total Area (fed)			Sorghum			Wheat			Cotton	
	Sorghum	Wheat	Cotton	Yield (Sacks/feddan)	Price (SD/sack)	Gross revenue (SD)	Yield (Sacks/feddan)	Price (SD/sack)	Gross revenue (SD)	Yield (kontar/feddan)	Gross revenue (SD)
Rehabilitated tenants	2.8	2.5	2.4	5.2	4,943	71,970	3.8	5,567	52,893	6.1	205,266
Non rehabilitated tenants	2.1	0	0	1.9	4,446	17,774	-	-	-	-	-

Source: Field survey and Gezira scheme, official records of Abu Guta Block, 2004.

- : Not grown

4.3 Comparison between rehabilitated tenants and other tenants not affected in Abu Guta block

This part gives the effect of the rehabilitation process on recovering the status of previously sand creeping affected areas. It compares the rehabilitated and other non affected tenants in the block of Abu Guta (study area), for the season of 2002/03 and 2003/04 using the official records for cotton.

4.3.1 Cotton area and productivity

From Table (4.13) average rehabilitated tenants areas were found to be less than those of non affected tenants for the season of 2002/03. The average area per rehabilitated tenants was about 2.6 feddans, compared to about 2.8 feddan for non rehabilitated areas.

For the season 2003/04, the average area per rehabilitated tenants was about 2.4 feddan, compared to about 2.7 feddan for non affected tenants.

The difference in the total areas for crop grown may be related to the Geziera Scheme administration system on crop rotation basis and the areas wounded for establishing the shelterbelt.

Regarding yield, it was found that the average yield for rehabilitated tenants was less than the yield obtained by tenants in non affected areas. The yield for cotton for example was 5.2 kontar/feddan for rehabilitated tenants compared to the yield obtained by tenants in non affected areas (5.9 kontar/feddan). This yield confirmed by calculating the average yield for the season 2003/04 and found that the average yield for rehabilitated tenants was 6.1 kontar/feddan, however it was less than the average yield obtained by tenants in non affected areas (6.7kontar/feddan). This may be attributed to the quality of the soil being affected by sand after rehabilitation. Fadul, (2002) reported that the

invasion of sand has affected the morphological, physical and chemical properties of the soil. The blown sand also had its prints by burying canals system and on topography of the field. The morphological characteristics of the Gezira Vertisols changed, especially in color, structure, and the cracking pattern reflected in block density, water holding capacity and permeability of the soil. In addition, sand accumulation with low values of organic carbon, nitrogen and available phosphorous are expected to reduce the fertility of the soil.

4.3.2 Gross revenue of cotton

Gross revenue of cotton was used to determine and calculate the different between average gross revenue of cotton for rehabilitated tenants compared to those tenants not affected by sand encroachment in the same block of Abu Guta.

The average gross revenue for rehabilitated tenants was about SD173, 292 and about SD205, 266 for the season 2002/03 and 2003/04 respectively .On the other hand the average gross revenue for not affected tenants was about SD191, 166 and about SD242, 359 for the season 2002/03 and 2003/04 respectively. Cotton obtained the highest gross revenue in cultivated area because the Scheme Administration compels the farmers to use inputs in form of seeds, chemicals (fertilizers and pesticides), do land preparation and carry out irrigation, then markets cotton through the national cotton company, however resulting in high income for farmers. Moreover other crops maybe subjected to lack of supervision and different market price fluctuation.

From what been mentioned above, the average area and average yield of rehabilitated tenants were not different from those of non affected tenants. The revenue indicated a small variation since the rehabilitation

process was successful in bridging the gap between the two classes of tenants.

Table 4.13 Cotton average area, yield, and revenue for rehabilitated tenants compared to non affected tenants in Abu Guta block (2002/03) (2003/04):

Groups	Average area of cotton (fed)		Average cotton yield (kontars/fed)		Average cotton revenue (SD/tenant)	
	Season 2002/03	Season 2003/04	Season 2002/03	Season 2003/04	Season 2002/03	Season 2003/04
Rehabilitated tenants	2.6	2.4	5.2	6.1	173,292	205,266
Non affected tenants	2.8	2.7	5.9	6.7	191,166	242,359

Source: Gezira scheme, official records of Abu Guta Block, 2004.

4.4 Tenancies livestock

The principal livestock species in the area are cattle, sheep, goats, donkeys and chicken. Sometimes tenancies may sell some of their livestock products or the animals themselves in case of high production or an urgent need for money. Most of them are sold at Abu Guta market. The tenancies in the area feed their animals from crop residues after harvest, and on natural pasture grasses around villages. Few tenancies feed their animals from local market. No cross breeding and/or poultry production were practiced in the study area.

4.4.1 Tenants livestock problems

It is necessary to address the problems related to livestock in the study area because animals provide an important source for income. Producers stated various constraints next to progress of livestock production in the study area.

For both groups, it may be remarked that the majority of respondents suffered from lack of access to fodder and to pasture and few of them have their animals suffer from animal diseases (Table 4.14).

This scarcity of fodder may be referred to the Gezira scheme administration for their uninterested in inclusion of forage production in the rotation. Yet the scarcity of pasture may be associated with range land deterioration, annul rainfall fluctuations and over stocking of animals.

In addition, the market prices of agro-industrial by-products such as cotton seed cake, groundnut cake and molasses have risen so much as to put them out of the reach of purchasing power of the farmers.

Table 4.14 Problems of tenancies respondents livestock:

Constrains	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	percent
Lack of fodder	6	15	2	13
Lack of pasture	7	17	3	18
Diseases	3	8	2	13
Lack of fodder and pasture	22	55	8	50
Lack of water	2	5	1	6
Total	40	100	16	100

Source: field survey, 2004.

4.4.2 Livestock population and animal production in the area

Table (4.15) shows that the average number of cows was about 5 cows, about 6 goats and of sheep was about 4 sheep for rehabilitated tenancies families. Milk production of cows was about 3.8 bound/cow/day and that of goats was about 1.8 bound/goat/day. The average milk production of sheep was about 0.9 bound/sheep/day. On the other hand the average number of cows was about 2 cows and the number of goats about 3, but the average number of sheep was about 1for non rehabilitated tenancies families. It was found that the average production of cows and goats was about 3.4 bound/cow/day and about 1.4 bound/goat/day respectively, and the average milk production of sheep was about 0.7 bound/sheep/day.

It may be concluded that rehabilitated tenancies owned more animals than the non rehabilitated tenancies. This was reflected that non rehabilitated tenancies had lower level income.

For the two groups the average milk production was low because most of animals compete for limited feed in the same pasture. This situation is likely to have contributed to marketed reduction in milk output.

4.4.3 Livestock prices

Table (4.15) shows that for rehabilitated tenancies the price of cows in the study area was about SD66, 875 and that of goats was about SD5,782 while that for sheep was about SD17236. For non rehabilitated tenancies the price of a cow was about SD56, 457 and that of a goat was about SD5, 324 and for sheep was about SD16, 523.

The variability among those prices for the two groups resulted from ability of rehabilitated tenancies to keep their animals and sell them

when market prices where high. On the other hand the non rehabilitated tenancies are compelled to sell their animals to satisfy urgent consumption needs to compensate for their low income from other sources.

Table 4.15 Distribution the average number, production and average price of livestock tenancies respondents:

Groups	Cows			Goats			Sheep			Market milk Price (SD/bound)
	average number	average milk production (bound/day)	average price (SD/cow)	average number	average milk production (bound/day)	average price (SD/goat)	average number	average milk production (bound/day)	average price (SD/sheep)	
Rehabilitated tenancies	5	3.8	66,875	6	1.8	5,782	4	0.9	17,236	35
Non rehabilitated tenancies	2	3.4	56,457	3	1.4	5,324	1	0.7	16,523	35

Source: field survey, 2004.

4.5 Environmental degradation

Environmental degradation is an important factor that may affect the community in the area through trees over cutting and vegetation overgrazing leading to desertification contributing to negative socio-economic welfare.

4.5.1 Trees cutting

When asked about reasons for not cutting trees, the majority of the rehabilitated (about 70%) and non rehabilitated respondents (about 60%) mentioned that their awareness was the main reason for not cutting the trees.

On the other hand, about 30% of rehabilitated and 40% of non rehabilitated respondents mentioned that the law enforcement was the main reason for not cutting the trees (Table 4.16).

This result indicated that most of the people in the area had a good appreciation for the environment. Control efforts to sustain surrounding environment was also appreciated. It seems that past experience played a key role in improving the behavior of the people in the study area about environment conservation.

Table 4.16 Reasons of not cutting trees by tenancies and their families:

Reasons of not cutting trees	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Awareness	28	70	24	60
Law force	12	30	16	40
Total	40	100	40	100

Source: field survey, 2004.

4.5.2 Type of fuel use

In general, the main energy source for the two groups was obtained from crop residues. It appears from Table (4.17) that about 50% of rehabilitated and about 59% of non rehabilitated tenancies obtained their energy from cotton stalks and dung. About 15% of rehabilitated and 17% of non rehabilitated tenancies used dung and branches for fuel. An alternative source of energy such as gas (about 23%) was used by rehabilitated tenancies and their families, against about 8% only of the non rehabilitated tenancies and their families.

This result reflected the importance of agriculture. Reliance on crop residues reduces the pressure on the limited natural vegetation. But the use of cotton stalks not allowable by Gezira Scheme authorities since they can be a source for distribution of black arm disease on cotton.

The increased rate of alternative energy used such as gas helped to conserve the environment in the study area.

Table 4.17 Distribution of respondents by type of fuel use:

Type of fuel	Rehabilitated tenancies		None rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Cotton stalk	2	5	3	8
Dung/ straw	3	8	4	10
Dung/ branches	6	15	7	17
Cotton stalk/ dung	20	50	23	58
Gas	9	23	3	8
Total	40	100	40	100

Source: field survey, 2004.

4.6 Desertification effect

The problems of desertification and its consequences on land and human life is the common feature in the area. The following tables indicate to some extent the expected effect of desertification on irrigation, villages in the study area and on migration of tenancies.

4.6.1 Desertification effect on irrigation

Most of tenancies in the study area have suffered from the shortage of irrigation which has a critical impact on crop yields.

In general, about 80% of the rehabilitated tenancies and all of non rehabilitated tenancies had irrigation problems (Table 4.18).

This resulted in some tenancies being unable to grow all crops in the rotation and unable to obtain high crop yield per feddan.

Table 4.18 Irrigation problems of rehabilitated and non rehabilitated tenancies:

Irrigation problems	Rehabilitated Tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Yes	32	80	40	100
No	8	20	0	0
Total	40	100	40	100

Source: field survey, 2004.

Irrigation problems varied among rehabilitated tenancies. About 28% of rehabilitated tenancies mentioned that their irrigation problems were caused by weeds and mud covering canals. About 37% mentioned irregular irrigation water was the main problem, but about 28% mentioned that the water shortage towards

the end of the season was the main problem. About 7% mentioned that the problem was lack of irrigation water during the season (Table 4.19).

These results indicated that the problems were relevant to Gezira Scheme Administration. However, the administration explained that the inadequate water supply during and towards the end of the season was found on the borders of the scheme, where the canals carrying capacity of water was always too low.

There was no relevance to sand creeping in this area since, the shelterbelts protected those fields from sands. UNEP and LAS (1995) stated that the establishment of El-Sehaimab shelterbelts in the study area had positive effect on protecting some irrigated fields and some canals from moving sand.

Overall, non rehabilitated tenancies indicated that their main problem was due to sand covering main and sub canals. These results point out that there were different problems of irrigation experienced between rehabilitated and non rehabilitated tenancies. The non rehabilitated tenancies irrigation problems stemmed mainly from sand creeping and the desertification process experienced in the study area. Gezira Scheme Administration refers this problem to shortage of finance to maintain canals.

Table 4.19 Irrigation problems according to point of view of rehabilitated tenancies respondents:

Irrigation problems	Frequency	Percent
Weeds and canals covered by mud	9	28
Irregular supply of irrigation water	12	37
Shortage of water at the end of the season	9	28
Inadequate water supply during season	2	7
Total	32	100

Source: field survey, 2004

4.6.2 Desertification effect in villages

Wind is considered as an important source of erosion in the study area as it carries the sand particles over long distances.

Table (4.20) shows the effect of sand creep on villages in the area. For the two groups who lived in the same villages, about 85% of rehabilitated and 73% of non rehabilitated respondents were affected by desertification in their villages.

The houses of the two groups of tenancies were distributed randomly in the same village. Most villagers in the area suffered from sand creeping. However, some of them were protected from wind by natural forests around their.

Table 4.20 Tenancies affected by desertification on villages:

Effected of desertification	Rehabilitated tenancies		None rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Affected	34	85	29	73
Not affected	6	15	11	27
Total	40	100	40	100

Source: field survey, 2004.

4.7 Solution suggested by villagers

Respondents have pointed out their concern about desertification problem. The degree of severity of the problem varied from one site to another in the same village. Table (4.21) depicts that villagers have their own proposal to approximate the rate of desertification in villages. They agree that the rate of sand creeping varied in the same villages (rare 35%, moderate 27%, and high 38% according to the villagers answers). This variation occurred because some houses

were found in locations susceptible to sand encroachment, while others were protected from sand by natural forests or found in the center of the village.

They suggested solutions to combat desertification in their villages. About 67% suggested that establishment of community forests around village, while 9% suggested the movement of the village into the scheme and about 24% did not have any solutions. These suggestions were proposed by villagers in a way that considers the ability of affected peoples to have more active participation.

The rural people gave their suggestions based on observations and experiences of combating desertification. The different suggestions given may be explained by the large size of villages and the rate of sand creep in diverse areas. The study suggested the grouping of small villages in safe areas in or out side the scheme. For large villages, the study suggested the establishment of community forest around those villages as an appropriate solution.

Table 4.21 Solution for combating desertification in villages according to villagers suggestions:

Suggested solutions	Rate of sand creeping			Total
	Rare	Moderate	High	
Establishment of community forest and forests around village	23%	15%	29%	67%
Transfer the village into the scheme	-	3%	6%	9%
No solution	12%	9%	3%	24%
Total	35%	27%	38%	100%

Source: field survey, 2004.

- : No response

4.8 Suggested solution for combating desertification in the crop field according to affected tenancies

The Gezira scheme protected some fields from sand encroachment by planting trees as shelterbelts and rehabilitated canals covered by sand. However, this effort was limited in scale and did not cover other fields and canals.

All of the non rehabilitated tenancies were suffering from sand creep in their fields. Accordingly they suggested the following solution for combating sand creeping. The majority of the respondents (91%) believe that rehabilitation of canals and establishment of shelterbelts around them and around fields would stop the sand creep. Few (6%) suggested the establishment of natural forests and community forests, about 3% did not suggest any solution (Table 4.22).

The general agreement was that the establishment of shelterbelts as the most viable solution in non rehabilitated fields reflects the impact of the shelterbelts on rehabilitated fields. In view of that it is a suitable solution to protect and guard against encroachment of sand over rehabilitated canals and sub canals.

Table 4.22 Solutions for combating desertification in desertified fields according to tenancies suggestions**:**

Suggested solutions	Frequency	Percent
Establishment of natural forests and community forests	2	6
Establishment of shelterbelt and rehabilitated canals	29	91
No solution	1	3
Total	32	100

Source: field survey, 2004

4.9 Desertification effect on migrants

The reasons for migration are often complex, but the relationship between certain environmental conditions and population movements can be identified. Items presented below give the number of migrants, their type of jobs before migration and the reasons for migration.

4.9.1 Number of migrants

Tenancies and their families moved to other areas for different reasons and in different numbers.

Table (4.23) shows that less than 39% of rehabilitated tenancies and their families migrated and more than half had not migrated. On the other hand, the majority (about 73%) of non rehabilitated tenancies and their families had migrated while few of them did not.

The high rate of migration of people from non rehabilitated crop fields may reflect instability in their income.

Table 4.23 Comparison between rehabilitated and non rehabilitated tenancies and their families according to migration:

Migration	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Migrated	15	39	29	73
Did not migrate	26	61	11	27
Total	40	100	40	100

Source: field survey, 2004

4.9.2 Type of migration

Table (4.24) showed that about 34% of rehabilitated tenancies and their families migrated out of the country, while half migrated to towns and fewer migrated to other villages.

It was also shown that migrants occupation before migration varied from about 25% on farm, about 6% as pastorals, about 5% employers, about 12% in trade, about 18% in free business, and about 21% as laborers.

From the above mentioned, migration of rehabilitated tenancies and their families is a natural migration, similar to migration all over the country. It indicated the instability in their income, and that they had migrated to increase their income and improve their quality of life, as will be seen in part 4.9.3.

Table 4.24 Rehabilitated tenancies respondents according to type of job and type of migration:

Type of jobs before migrate	Type of migration			Total (%)
	Out of Country (%)	To towns (%)	To other Villages (%)	
Farmers	6	19	0	25%
Pastorals	4	2	0	6%
Employers	5	13	0	18%
Traders	4	8	0	12 %
Free business	9	3	6	18%
Laborers	6	6	9	21%
Total	34	51	15	100%

Source: field survey, 2004

Table (4.25) shows that more than about 78% of non rehabilitated respondents and their families migrated to towns, while few of them migrated to other villages and out of country.

It also shows that jobs before migration varied among tenancies about 58% farmers, to pastorals about 4%, governmental jobs about 6%, traders about 3%, free business about 8%, and labors about 21%.

This indicated that more than half of tenancies and their families had migrated to town in search for other sources of income as seen in part 4.9.3.

Table 4.25 Non rehabilitated tenancies respondents according to type of jobs and type of migration:

Type of jobs before migrate	Type of migration			Total (%)
	Out of country (%)	To Towns (%)	To other villages (%)	
Farmers	-	51	7	58
Pastorals	4	-	-	4
Governmental jobs	2	4	-	6
Commerce	3	-	-	3
Free business	-	8	-	8
Labors	3	15	3	21
Total	12	78	10	100

Source: field survey, 2004.

- : Nil

4.9.3 Reasons for migration

About 20% of the rehabilitated tenancies and their families indicated that they migrated because of the decrease in agricultural benefit compared to about 62% of non rehabilitated respondents. About 67% of rehabilitated respondents indicated that they migrated to increase their income compared to about 24% of non rehabilitated respondents. Only few of the two groups migrated for other different reasons (Table 4.26).

Rehabilitated tenancies and their families had migrated out of the country to improve their income and quality of life.

However, most of non rehabilitated respondents migrated because of the decline in agricultural income, which reflected their non-viability of agricultural activity has actually had been affected by desertification as the main reason for migration.

Table 4.26 Distribution of rehabilitated and non rehabilitated tenancies and their families according to reasons of migration:

Reason of migration	Rehabilitated tenancies		Non rehabilitated tenancies	
	Frequency	Percent	Frequency	Percent
Decline of agric benefits	3	20	18	62
To increase the income	7	47	7	24
Others	5	33	4	14
Total	15	100	29	100

Source: field survey, 2004.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

In this study an attempt was made to investigate the socio- economic status of Gezira Scheme tenancies in areas previously affected by desertification then rehabilitated compared to other tenancies who were not rehabilitated, with respect to level of agriculture productivity as they live in the same geographical area.

The first chapter of this study began by introducing desertification, as universal phenomena, in Africa, in Sudan and in Gezira Scheme. It also explains the statement of the problem and finally states the socio-economic aspects and the objectives of the study.

Chapter two reviewed the relevant literature related to desertification and the direct or indirect effects on socio-economic status of people, desertification and it is definitions and their development through time, then the wide spread causes of desertification (Over grazing, deforestation, over cultivation, wind erosion), and elaborated on the importance and impact on production with figure showed a hypothesis of causes and mechanism of desertification.

This chapter also focused on the effect of desertification in Sudan, on land and on agricultural production, on food and food security, on poverty, on migration, the effect of people on desertification and vice versa.

The end of this chapter elaborated on relevant techniques to reduce and control desertification like soil conservation and water harvesting techniques, and suggested strategies to reduce or to prevent the hazards of desertification in Sudan. It also attempted to investigate practices of desertification control in

Sudan like establishment of forests, use of energy, shelterbelts establishment, and regeneration of vegetation and introduction of agroforestry.

The third chapter highlighted the Gezira scheme and Abu Guta and Begiga Blocks in the Northern-west boundaries of the Scheme, describing vegetation cover, climate, soil, topography, land use after being exposed to sand encroachment. Then the aspects of sand encroachment in the study area, it is source and sand dune formation and the type of this dune. Also the impacts of this sand on the area and the most important tree belts that protected some canals and rehabilitation of some fields from sand encroachment.

This chapter also described the methods used in data collection and data analysis. The questionnaire was the main method used in this study to collect the primary data from 80 tenancies that represented the total population in the study area. Secondary data were obtained from Abu Guta administrative unit including records, documents and reports for crop yield and cultivated land. The descriptive statistics was used to analyze the data obtained in the study area including frequency, percentages, average and use of tables and figures.

Chapter four aimed at investigating and comparing the socio-economic status of the rehabilitated and non rehabilitated tenancies. The statistical analysis of the socio-economic characteristics revealed that tenancies respondents were more or less homogenous as they lived in the same geographical area. The majority of the two groups were illiterate or had elementary level of education associated with age ranging between 50-60 and over 60 years old. High percentages marital status of the two groups of respondents may be attributed to the simplicity of married life, which reflected a social stability in the area. Few of the rehabilitated tenancies had farm income in addition to agricultural income. On the other hand, most of the non rehabilitated tenancies had other sources of income particularly as laborers since they had low level of income from

agriculture. Large numbers of tenancies and their families, who settled in the same village, had no access to protected wells. Most of tenancies were found to be exposed to water borne diseases, which may have a negative effect on manpower productivity. Most of them built their houses from mud which in easy to rebuild in other places in the same village or to carry to other safe areas when affected by sand. It was observed that some villages were surrounded by natural forests which contributed to stopping or reducing the effect of sand.

Some tenancies in the area shared field operations with laborers. Few of the two groups shared crops with laborers for different reasons. The investigation of the annual income of the two groups found that the high annual income of the rehabilitated tenancies and their families reflected the stability of farm production and other occupations, whereas the non rehabilitated tenancies had low level of annual income as they had been affected by sand encroachment on their farms.

A general comparison was made of the economic crop performance for the rehabilitated and non rehabilitated tenants in seasons 2002/03 and 2003/04. The comparison items used were: crop production, crop yields and gross revenue for crops. Tenancies that did not produce any thing or had reduction in their cropped area were found only in fields affected by desertification and they had only one option to grow sorghum. The productivity of the crops under study for rehabilitated tenants that greater compared to that of non rehabilitated tenants throughout the two seasons. Productivity in non rehabilitated farms was directly affected by desertification. Gross revenue analysis for crops showed that the rehabilitated tenancies respondents had obtained more income from cotton production followed by wheat and then sorghum than non rehabilitated tenancies.

Another comparison were made between rehabilitated tenants and other tenants not affected by desertification inside Abu Guta block for the season 2002/03 and 2003/04 using the official records for cotton. The average area,

average yield and average revenue of rehabilitated tenants were not far below of those of non affected tenants for the two seasons. The revenue indicated a small variation since the rehabilitation process was successful in bridging the gap between the two classes of tenants.

The principal livestock species in the area are cattle, sheep, goats, donkeys and chicken. For both groups, it may be remarked that the majority of respondents suffered from lack of access to fodder and to pasture and few of them suffered from animal diseases. In spite of these problems the rehabilitated tenancies owned more varied animals than the non rehabilitated tenancies. This reflected that non rehabilitated tenancies had low level income. For the two groups the average milk production was low because most of the animals compete for limited feed in the same pasture. This situation is likely to have contributed to marked reduction in milk. The variability among prices for the two groups resulted from ability of rehabilitated tenancies to keep their animals and sell them when market prices were high. On the other hand the non rehabilitated tenancies were compelled to sell their animals to satisfy urgent consumption needs to compensate for their low income from other sources.

As for environmental degradation, more than 90% of both groups were found to conserve the environment and were not cutting trees. This reflected their awareness and control by forest laws enforced in the area. It seemed that past experience played a key role in improving the behavior of the people in the study area about environment conservation. In general, the main energy source for the two groups was obtained from crop residues and the increased rate of alternative energy used such as gas which continuously helped to conserve the environment in the study area.

Most of the tenancies in the study area suffered from the shortage of irrigation which has a critical impact on the tenancies yield. However, irrigation

problems varied among rehabilitated tenants and non rehabilitated tenants. Non rehabilitated tenancies indicated that their main problem was due to sand covering main canals and sub canals.

Villagers in the area suffered from sand creeping. But some of them were protected from wind by forests near their households. For the solution of this problem the rural people gave their suggestions based on observations and experiences on combating desertification. The different suggestions given may be explained by the large size of villages and the rate of sand creep in diverse areas. The general agreement was on the fact that the establishment of shelterbelts was the most viable solution for the non-rehabilitated fields.

Finally, this chapter investigated desertification effect on migration and it was shows that tenancies and their families moved to other areas for different reasons and in different numbers. More than half of rehabilitated tenancies and their families had not migrated. On the other hand, the majority of non rehabilitated tenancies and their families had migrated. Migration of rehabilitated tenancies and their families was natural, similar to migration all over the country. However, more than half of non rehabilitated tenancies and their families had migrated to towns in search for other sources of income. Most of the non rehabilitated respondents migrated because of decline in agricultural income, as a result of non-viability of agricultural activity which was affected by desertification.

5.2 Conclusions

The socio-economic analysis of rehabilitated tenancies respondents and the non rehabilitated tenancies respondents revealed that they were more or less homogenous. Most of them were sharing the same social characteristics. Economically, the high annual income of rehabilitated tenancies reflected the

stability of cultivated areas farm production, and the total average gross revenue. These results reflected the efforts for establishment of shelterbelts, which led to protection of some canals and restored some irrigated areas from sand encroachment. For non rehabilitated tenancies, productivity was directly affected by desertification. Most of them work as laborers since they had low level of income from agriculture.

Indication of environmental degradation showed that most of the people in the area had a good appreciation for the environment. Moreover, the increased rate of alternative energy used such as gas helped to conserve the environment in the study area. The houses of the two groups of tenants were distributed randomly in the same village. Most villagers in the area suffered from sand creeping, others were protected from wind by forests.

Most of non rehabilitated respondents migrated because of the decline in agricultural income, which reflected non-viability of agricultural activity which had been affected by desertification.

5.3 Recommendations

Experience has shown that there is no single solution for desertification, furthermore all available methods should be used. For this to overcome its environmental and socio-economic impact the following recommendations are given:

1. Establishment of the community forests for environmental protection in general and erosion control in particular.
2. Protection of already existing vegetation and rehabilitation of degraded vegetation.
3. There should be appropriate laws, legislation and a unified policy for the management and protection of the environment.

4. Irrigation authorities must put more efforts to overcome water problems, so that all tenants out of production may be able to grow cash crops to raise their income.
5. More efficient alternative source of energy such as biogas and gas should be developed and disseminated in order to save trees from cutting and reduce the use of cotton stalks which is not allowed by the Gezira scheme administration the possibility of carrying diseases from season to season.
6. Digging wells for healthy water to avoid human diseases, while lead to increase productivity.
7. Establishment of nurseries to produce seedlings.
8. Small villages must be combined to form large villages in safe areas that are not exposed to sand creeping so that authorities can easily provide services.
9. Protection of present shelterbelts so as to protect the scheme from sand encroachment and must be established urgently in areas not protected from sand.
10. Attention should be given to livestock as the most important source of income, focusing on a number of aspects of improvement livestock production and control of diseases and improvement processing of animal products.
11. Improvement the education and health services for the areas under study.
12. Use of various conservation techniques like mulching and water harvesting technique to improve soil structure and water availability in away to increase productivity.

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APPENDICES

Appendix (1)

بسم الله الرحمن الرحيم

معهد دراسات التصحر واستزراع الصحراء

استبيان عن الاثار الاجتماعية والاقتصادية لاعادة التاهيل بالمناطق الزراعية المتصحرة شمال غرب مشروع الجزيرة

(أ) **المعلومات الشخصية:**

1/ الاسم..... 2/ التفتيش.....

3/ النوع: ذكر ( ) أنثى ( )

4/ العمر: ( )

5/ الحالة الاجتماعية: متزوج ( ) مطلق ( ) أرمل ( ) عازب ( )

6/ المستوى التعليمي: أمي( ) خلوة ( ) ابتدائي ( ) متوسط ( )
ثانوي ( ) جامعي ( )

7/ مصدر الدخل: تجارى ( ) رعوي ( ) زراعي ( ) أعمال حرة ( )
وظيفة ( )

8/ هل تمارس أي نشاط آخر مع الزراعة؟ نعم ( ) لا ( )
في حالة الإجابة بنعم. حدد نوع النشاط:

.....

9/ عدد أفراد الأسرة ( )

10/ الدخل السنوي بالتقريب ( )

11/ نوع السكن: طين ( ) طين/ قش ( ) طين/ طوب ( ) قش/طوب ( )
قش ( )

12/ عدد أفراد الأسرة المنتجون: ( )

13/ من أين تتحصل على مياه الشرب؟ بئر عادية ( ) حفير ( ) بئر ارتوازية ( )
عد( ) ترعة ( ) أخرى حدد ( )

(ب) القطاع الزراعى:

14/ ما هي المساحة الكلية المزروعة داخل المشروع؟ ( )

15/ هل تواجه مشاكل في الري؟ نعم ( ) لا ( )

في حالة الإجابة بنعم . ما هي هذه المشاكل؟

.....

16/ هل تعمل بنظام الشراكة في الحيازة المملوكة؟ نعم ( ) لا ( )

في حاله الإجابة بنعم:لماذا؟

.....

17/ شكل الشراكة:.....

18/ نوع المحاصيل المزروعة للموسم **2003/2002** والإنتاجية وأماكن البيع والأسعار:

اسم المحصول	فول سوداني	ذرة	قمح	قطن	موالح	أخرى (حدد)
الإنتاجية						
مكان البيع						
الأسعار						

19/ نوع المحاصيل المزروعة للموسم **2004/2003** والإنتاجية وأماكن البيع والأسعار:

اسم المحصول	فول سوداني	ذرة	قمح	قطن	موالح	أخرى (حدد)
الإنتاجية						
مكان البيع						
الأسعار						

(ج) الثروة الحيوانية:

النوع	هجين	بلدي	العدد	إنتاجية اللبن والبيض	مكان الرعي	مكان البيع	الأسعار
أبقار							
ماعز							
ضان							
دواجن							
البان							
أخرى							

(د) القطاع الغابي:

20/ هل تقوم بقطع الأشجار؟ نعم ( ) لا ( )

في حلة الإجابة بنعم يكون ذلك ل:.....

.....

في حالة الإجابة بلا يكون ذلك ل:

قوة القانون ( ) معرفتي بأهمية الأشجار في مكافحة التصحر ( )

21/ ما هو نوع الوقود المستخدم؟

روث ( ) قصب ( ) سيقان أشجار ( ) سيقان قطن ( )

أخرى حدد:.....

22/ هل هناك عمالة موسمية من خارج المشروع؟

نعم ( ) لا ( )

في حالة الإجابة بنعم أين تسكن هذه العمالة أثناء فترة إقامتها؟

.....

وعددها.....

(ه) الهجرة:

23/ هل هناك هجرة لاحد أفراد الأسرة من القرية؟

نعم ( ) لا ( )

24/ نوع الهجرة:

خارجية ( ) داخلية ( ) للمدن ( ) لقرى أخرى داخل المشروع ( )

25/ إذا وجدت هجرة. ما هي المهنة الرئيسية للفرد أو الأفراد الذين هاجروا؟

مزارعين ( ) رعاة ( ) موظفين ( ) تجار ( ) أعمال حرة ( ) عمال ( )

26/ في رأيك ما هي أسباب الهجرة؟.....

.....

.....

27/ هل تتأثر بزحف الرمال داخل القرية؟ نعم ( ) لا ( )

مستوى اثر الزحف: ضعيف ( ) متوسط ( ) عالي ( )

28/ ما هي الحلول المناسب لهذه المشكلة في رأيك؟

1. تحويل القرية إلى داخل المشروع. **( )**

2. استزراع الغابات الشعبية والغابات حول القرى. **( )**

3. لا اعرف حلا؟ **( )**

29/ هل تتاثر بزحف الرمال في الحقل؟ نعم **( )** لا **( )**

في حالة الإجابة بنعم. ما هي الحلول المناسب لهذه المشكلة في رأيك؟

1. استزراع الغابات الشعبية وزيادة مساحة الغابات. **( )**

2.زراعة ألاحزمة الشجرية ونظافة قنوات الري. **( )**

3. لا اعرف حل؟ **( )**