LAND USE/LAND COVER CHANGE DETECTION: A CASE STUDYOF BOBI GRAZING RESERVE, MASHEGU LGA, NIGER STATE.

BY

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BEING

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN PARTIAL FULFILLMENT OF THE CONDITIONS FOR THE AWARD OF MASTERS DEGREE OF TECHNOLOGY IN REMOTE SENSING APPLICATION.

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SCHOOL OF SCIENCE AND SCIENCE EDUCATION,
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FEBRUARY, 2002.

CERTIFICATION

This thesis entitled "Land use/Land cover change detection in Bobi grazing reserve" by SAMUEL ATTA OKWOLI, meets the regulations governing the award of the degree of Masters of Technology of the Federal University of Technology, Minna, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To my wife and children

And to all those who have compassionate hearts towards the oppressed in the society.

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ABSTRACT

Bobi Grazing Reserve, Niger State has witnessed changes in its land use pattern since the establishment in 1985 due largely to increase in farming activities, increase in human settlements around the reserve resulting in an increase in human population, increase in animal population because of changes in climate, which has accelerated the spread of desert from the northern part of the country.

Landsat MSS of 1970, Landsat TM of 1987 and SPOT (XS) of 1993 were used as the major sources of data. Topographic map of 1964, livestock census of 1989/1998 and rainfall data of 1991/2000 for Minna synoptic station were used as secondary sources of data.

During ground truthing, GPS coordinates of points of interest were obtained.

The research work was based on computer interpretation of the imageries using ERDAS, ARC/INFO and ARC/VIEW software.

Results from the study has revealed that all other human activities have continued to increase within the reserve thereby reducing drastically, the area earmarked for grazing purposes.

By implication, the conflicts between the pastoralists and farmers are bound to increase.

It was recommended that for accurate and timely information in a cost effective manner in monitoring and planning, higher resolution imageries should be acquired.

IKONOS, in particular, is very suitable for multi temporal study of the area using powerful computers for monitoring the environment.

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CHAPTER ONE

1.0 INTRODUCTION

Grazing reserves established in almost all parts of the Northern part of this country are large parcels of land set aside by various states and local governments in the federation for the sustenance of livestock farming in the country. They are set aside for the grazing of animals and production of small quantities of agricultural crops for the sustenance of the pastoralists and their animals. Because of the vast areas of land involved for this purposes the grazing land (otherwise known as rangeland) supports different vegetation types including shrubs, grasslands, woodlands (Hall, 2001).

The relief of a grazing reserve area may vary by only a few centimeters per kilometer in plain area to hundreds of meters per kilometer in mountainous regions. These physical factors together with their varied position within the land masses create extreme diversity in precipitation and temperature regimes and magnify the complexity of resource use and management. We often judge grazing reserves as abused of over-grazed without considering that conditions change overtime. Climate, which is the synthesis of weather over a long period of time, is a major determining factor of the various changes that take place within a grazing reserve.

At the core of the present day climate problem is the fact that during the past 100 years mankind has been emitting increasing quantities of carbon dioxide, methane and other greenhouse gases, thus strengthening the greenhouse effect. This, along with feedbacks within the climate system, can lead to a global temperature significantly warmer than at present conditions, and consequently to a regionally

very different sort of climate. The increase in the global mean near-surface temperature is largely due to anthropogenic changes in the composition of the atmosphere (Climate of the 21st century, 2000).

With growing population pressures, the need for responsible management of our natural resources base is increasingly of concern.

Fortunately, recent developments in environmental information technologies offer a range of exciting new products and procedures to assist this management process.

Remote sensing applications provide accurate and timely information about the plants and environment associated with all rangelands (grazing reserves), about the animals that use these lands, and about the impact, which the animals and man have on the vegetation and soil resources.

1.1 PROBLEM STATEMENT

Going by the frequent conflict between the pastoralists and the farmers in various parts of the country, the Federal Government through the National Livestock Projects Division (A World Bank sponsored project) under the Federal Department of Livestock and Pest Control Services in the Federal Ministry of Agriculture and Rural Development in 1985, began to assist various state governments in the establishment of grazing reserves and providing all necessary inputs to them after gazetting by the various state governments. This was with the intent of settling the pastoralists within the reserves.

It is in the light of the above context that the Bobi grazing reserve was established formally within Niger State. Before this time, it was a forest reserve area.

The population of animals within the reserve at its inception as compared to what it is now has changed dramatically and the number of such animals in agriculture is expected to double within the next decade.

The human population within the reserve is also expected to increase drastically with the increase in livestock population. This is especially so because the future changes in climate will probably accelerate the spread of desert because they will include no increases or even a decrease in precipitation as the temperature increases in many arid zones.

Within the past few years of the establishment of this reserve notable activities have taken place resulting in some form of changes whether positive or negative, which have not helped in the relationship between the pastoralists and the arable farmers. Of concern to the pastoralists are where he could get fodders for the animals, good drinking water and area that are ridden of harmful pests e.t.c.

In the light of the foregoing, the following issues that needed investigation\study within the last 20 years, are considered:

a) **To what extent has the vegetation been changed within this period?**
b) **What is the average animal population within the reserve now as compared to when it was newly established?**
c) **Has there been an increase in human settlement that has altered the balance of ecosystem since the inception of the reserve?**
d) **Has there been an increase in the farming activities as a result of © above?**
e) **How much of the land is still left for grazing?**

1.2 AIM AND OBJECTIVES

This research is aimed at providing information on the changes in Land cover within Bobi Grazing Reserve in Niger State using LANDSAT and SPOT imageries as a tool for studying and analyzing change detection and therefore fulfilling the following objective:

To assess the changes in terms of environmental (vegetation and hydrology) and human (farming and settlement) within the study area between January 1970 and March 1993.

1.3 JUSTIFICATION

With the intensification of the pressure by man upon his resources and the environment, there is a rapidly growing need for more and better information for multidisciplinary decisions and action programmes. The complexity of man's impact on the environment in relation to land-use planning and management demands more efficient and rapid methods to acquire and analyse resource information (POULTON, 1985). According to HUPFER and LOZAN (2000), the sea level has been rising since the beginning of the Holocene Warm period and coastlines have receded Worldwide. The earth was then only thinly populated. During this time the area of rainfall extended across the Sahara, which is today the largest desert in the world, and the amount of rain was sufficient for the formation of a savannah-type habitat.

The most threatening aspect is the alteration of the atmospheric composition by man without even considering the consequence for the natural environment and human society.

Fortunately, recent advances in science and technology continue to create hope and produce new techniques, which will help to collect up-to-date data for land degradation problems. These include the application of remote sensing in the area of mapping, monitoring and modeling land degradation and hazards. Infact, many dynamic geo-physical processes occurring in very difficult locations are difficult to reach and survey. This restricts the monitoring of changes on the land to conventional means, which may be too difficult and time consuming.

Remote sensing therefore, offers an alternative, often more efficient and cost effective techniques for mapping, assessing land changes on the grazing lands (Holz, 1985).

Although, remote sensing is not a panacea for resource development and management, it can provide the data that are the basic tools for resource inventory, monitoring and management.

It is, therefore hoped that this study will not only help to identify the real hindrances to the developments of the grazing reserve in Bobi, Niger state but will also serve as an indicator to the negative phenomenon observed in other reserves within the country. With these, it is hoped that solutions will be found to the frequent clashes between the pastoralists and the farmers through the assistance of the National Livestock Projects under the Dept. of Livestock and Pest Control Services in the Federal Ministry of Agricultural and Rural Development, Abuja.

1.4 THE STUDY AREA

1.4. 1 Location:

This was formally known as Funa-Funa Grazing Reserve in Niger State under the First Livestock Development Project (FLDP) which was one of the six identified by the World Bank for development.

Now known as Bobi Grazing Reserve, it is located approximately 50km South East of Kontagora and off the newly completed Kaduna-Lagos highway. It is within Mashegu L.G.A. It covers an area of about 31, 398.68 Hectares between latitude 10° $00'$ to 10° $10'$ and longitude 5° $46'$ to 6° $00'$. It is located on sheet 141 of the Nigeria

MAP OF NIGER STATE SHOWING BOBI GRAZING RESERVE



Source: Spectrum Road Map of Nigeria, 9th Edition 1999

Fig 1.1

Scale 1:12,000,000

Map series of 1963 (fig. 1.1 shows the map of study area). The grazing reserve was gazetted in December 1987 by the Niger State Government (i.e. NSLN No.2 Vol. 13 of 11th February 1988, NSNG No.2 of 1987).

The reserve is drained by a network of several rivers and their tributaries including the rivers Beiri, Zambuga, Agogo in the West and Asimdira Ashina, Gaba and Dabangara in the East.

1.4. 2 Climate: Rainfall records of six stations surrounding the reserve show a mean annual rainfall of 1200mm. The rainfall is unimodal commencing about May and increasing in frequency and distribution to a peak in August and finally terminates in October. The North-East trade winds laden with harmattan dust predominate during the dry season which runs from November to April. The South-West wind prevails during the wet season. The mean annual temperature is 27°C.

1.4. 3 Vegetal Cover: According to Keay's 1959 classification, the grazing reserve falls within the Guinea Savannah zone. The vegetation is transitional between the humid forested areas in the South and the continental semi-grassy and grassy plains of the North. The main tree species include Daniella Oliveri, Isoberlinia spp., while the grass cover includes Hyparrhenia and Andropogen spp.

1.4. 4 Geology and Soils: A small area to the north-east of Bobi Grazing Reserve overlays undifferentiated pre-cambrian basement complex while the remainder is based on sedimentary Nupe sandstone.

The soils are fairly consistent throughout the reserve being predominantly ferruginous tropical soils, pockets of lithosol occur, as do small areas limited in depth by iron pans. The ferruginous soils are considered to be very naturally fertile

but have low productivity under the traditional management practices. According to FAO, the soil is of low present productivity, but with adequate soil management, is capable of improvement. The lithosols are shallow, moderately leached with little organic matter and with variable potential.

1.4.5 Land Use Activities:

The grazing reserve with an area of about 31,398.68 hectares is made of the following activities

i. **The area is heavily utilized by transhumance herds which spend some 3 weeks in the grazing reserve on their way north to south and vice-versa, and also by stock belonging to local mixed farmers.**

ii. **Three distinct groups were identified within the grazing reserve. The Fulani pastoralists, the migrant Hausa farmers and other farming groups, which have migrated into the grazing reserve at different times. An interview conducted by the National Livestock Projects Division in 1988 revealed that many of them had settled in the Grazing reserve for the past 20 years while others came and settled for dry season grazing.**

iii. **Vigorous farming goes on in the grazing reserve by both the pastoralists and the arable farmers themselves who also keep some form of quantities of cattle, sheep and goats.**

iv. **The farming entails forest cut and bush burning which further degrades the land.**

1.5 SCOPE AND LIMITATIONS

The study is focused on change detection and analysis of its impact on Bobi Grazing Reserve in Niger State between the period of January 1970 and March 1993.

The research is limited to what is only available within this period in terms of satellite imageries, which are suitable for change detection studies.

The available imageries are those obtained from Landsat and Spot imageries with Ground resolution of 30m and 20m respectively at a scale of 1: 250, 000.

If higher resolution imageries from Landsat, Spot or Ikonos are available, more distinct features depicting small changes could have been noticed. This has, therefore, made the identification of some features difficult with these imageries.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 AERIAL PHOTOGRAPHS

The earliest form of remote sensing techniques used in the inventory, evaluation, and monitoring of range (grazing) ecosystem is the aerial photography Reid et al (1942) clearly demonstrated the efficiency of using aerial photographs for range survey even though they stated then that it was not economically justifiable considering the direct costs and benefits if the photographs were to be used only to map range vegetation.

Henriques (1949), had discussed the advantages of controlled mosaics for range resource mapping in photomosaics as a compilation base.

Poulton and Isley (1970), stated that Federal and State agencies in the early to mid-1960's had grown more interest in developing more efficient ways to inventory and monitoring rangelands, gave some of the initial stimulus to remote sensing in this area. The inventory of a state-owned rangeland in Oregon was an example of ultimate reliance on the interpretation of aerial photography applied to a rangeland environment.

Carneggie (1968), proved that colour infra-red often increases ones ability to discriminate between vegetation and soil surface and geological features that are not always clearly separable on colour photography and rely on black and white. He then summarized the advantages of colour photography for range applications in the greater ease and reliability with which the following information can be

interpreted from the proper scale and season of photography when combined with appropriate field investigations:

a) **Delineating and classifying plant communities and their associated soils**

b) **Determining species composition and foliage density of the dominant shrubs, grasses and herbs,**

c) **Determining an index of plant vigor, surface rockiness and texture, amount of accumulated litter, pressure of surface and sub-surface moisture**

d) **Evaluating forage utilization and**

e) **Locating other features affecting range management including springs, stock watering sites, salt grounds, fences e.t.c.**

Parker (1951), developed a procedure for evaluating range conditions and range trend. Over a period of years, the photographs provide a qualitative, yet permanent visual record of the plant and soil conditions. They also provide valid data on vegetation and soil changes which have occurred during the period of observations.

Adeniyi and Omojolu (1999) demonstrated the use of aerial photographs to generate land use and land cover changes involving such information as the trend, rate, nature, location and magnitude of change in Sokoto-Rima Basin of North Western part of Nigeria.

Bradford (1990's), used the 500 aerial photographs of livestock grazing allotments donated to the Denver Public Library by United States Forest Services to document range condition changes over time.

Ullah (1993) showed how remote sensing in the form of aerial photography served the purpose of identification, delineation and measurement of spatial extent of

wetlands caused by flooding within an area of 100 sq. miles around Enders Lake over a period of several years.

Amuyunzu and Bijl (1998), used black and white aerial photographs of January 1994 in Evaluating and monitoring of wild life habitats located in South Eastern Kenya, a buffer zone between Tsavo East and Tsavo West national parks.

It is therefore, very clear from the above applications that the role of aerial photographs in remote sensing is highly significant particularly with the improvement in sensor design.

The present study will, however, not concern itself with this.

2.2 LANDSAT AND SPOT IMAGERIES

Remote sensing multi-temporal data provides for change detection. According to Tucker et al (1985); Jansen (1994), remotely sensed digital satellite data and spatial analysis techniques provide timely and relatively inexpensive land cover/land use information. Over recent years, computer aided classification of satellite digital data has proved useful for inventorying and monitoring the land cover/land use of large and varied landscapes. Chakanga et al., utilized multi-spectral Landsat TM and SPOT XS data for the production of satellite image maps (SIMS) and digital scene data of Northern and North-Eastern part of Namibia and also of Kunene and Omaheke region all within Namibia. Yasuoka (1993) did a preliminary study to indicate the usefulness of the NOAA-AVHRR LAC data for continental scale vegetation monitoring. It was also shown that the combination of the high spatial resolution data with the frequent AVHRR data would be required for practical monitoring.

Rud and Kahru (1995) conducted a retrospective study of blue-green algae from 1982 to 1993 using NOAA-AVHRR imageries to show inter-annual variations of surface accumulation of algal bloom in the Baltic Sea.

Ellis and Rossetter (1993), carried out a study on land use/land cover change evaluation in Sokoto-Rima Basin of N.W Nigeria using multi-source remote sensing data SPOT (P, XS) and Landsat (MSS), for 1986.

Wadge (1994), observed that the 10m spatial resolution and 3D capacity of SPOT data competes with small-scale aerial photography, which also is valid for monitoring on local/national scales.

Dinku (1990), concluded that rainfall and vegetation information obtained from satellite data, have been found to be a good supplement to the conventional data sources for drought monitoring over Ethiopia. These data are the only source of information over some remote and inaccessible areas.

Prakash (2000) used remote sensing/GIS techniques for geo-environmental studies of Jharia Coalfield, India. He used Landsat TM of 1990 and 1994, IRS LISS-II of 1990 in conjunction with other available maps, to produce change detection studies of the coalmine fires in the last two decades. The comparison of multi-sensor data with different dates, have shown very interesting general trends.

Kufogbe and Amatekpor (1990) used remote sensing for change detection studies for the period 1985-1991 for Landsat TM images in Sakumo Wetland, which is a rapidly developing area between the twin cities of Temsa and Accra.

Adefolalu (1986), documented five major vegetal covers i.e. woodlands, grassland, shrub land, farmland and burial ground using Landsat data in combination with

data obtained through SLAR and ground truthing using the four pixel's quadrant technique to map out the land use (vegetation) situation in West Africa and Nigeria in particular.

From the various examples listed above, it can be concluded that Remote Sensing brings together the tools to better analyze the scope and scale of changes detected in the grazing reserve areas. High-resolution data provide a detailed view of range land (grazing area). Remote sensing devices provide a view of inaccessible areas. Optical sensors are preferred for monitoring because of the distinguishable spectral signature of vegetation.

Radar is more preferable when imaging in humid tropics because of its all weather capability.

The identification of Land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for base-line thematic maps. Identifying the land use from year to year will help develop strategies to balance conservation, conflicting uses and developmental pressures.

Hence, the method that will be adopted in carrying out this research involves the use of materials like topographic maps, satellite imageries of 1970's, 1980's and 1990's, computers (hardware/software) GPS.

The Stages are:

i. creation of training site.

ii. creation of signature file.

iii. data capture

iv. classification routines

v. identification of areas of change

vi. ground truthing

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

Introduction:

Monitoring of changes within the grazing reserves in the country can be done faster using remote sensing as a tool for change detection particularly in this age when various changes are taking place rapidly than we have anticipated. It is in the light of this that instruments that can give us timely/accurate information about our environment are advocated for. In line with the objective of this study, the method which involves the use of Landsat TM and SPOT (XS) at resolutions of 30m and 20m respectively were used to determine the extent of changes that have taken place in terms of vegetation, farming activities and settlements in the study area between 1970 and 1993.

3.1 Materials

The materials/instruments that were used in the course of this study are as follows:

i. Topographic map of Bobi sheet 141 at scale 1: 50,000 dated 1964 showing demarcated area of Bobi Grazing Reserve.

ii. Administrative map of Niger State

iii. Satellite images of the study area representing three decades were used.

- **Landsat MSS dated January 1970 (see Plate 1).**
- **Landsat TM dated March 1987 (see Plate 2).**
- **SPOT (XS) dated June 1993 (see Plate 3).**

iv. Compaq (Prolinea 4/5) desktop personal computer

v. Hewlett Packard Design jet 640C colored printer

vi. Hand held Gemini Global Positioning System (GPS)

- For the purpose of obtaining coordinates directly from the field.

The soft wares used are:

i. 'Earth Resources Data Acquisition System' (ERDAS) Imagine Version 8. 3. 1. This is Remote Sensing Software.

ii. ARC/INFO version 7.1.2 – a remote sensing editing software (GIS Software)

iii. ARC/VIEW version 3.0a (GIS Software)

They all operate on Windows NT environment.

The images were acquired from the Federal Department of Agricultural and Land Resources (FDALR), GIS/Remote Sensing Unit, Kaduna.

The images available had already been processed for restoration and enhancement that are usually done before image classification.

3.2 Training Site

The coordinates of the study area were imported to clip out the scene of the study area from the satellite scene.

ERDAS imagine software version 8:3:1 were used to import the imageries from CD and display on the screen (ERDAS is a remote sensing software that enables the imageries to be moved around on the computer).

3.3 Data Capture

Data capture refers to the digitization process through which analogue map data is transferred into digital format for storage and analysis in the computer.

The mouse of the computer was used to digitize the imageries on the screen with the aid of ERDAS tools, thus enabling the delineation of land use and features into

polygon and hence the interpretation. All the layers of information interpreted and digitized in ERDAS were edited "cleaned" and "built" as line and polygon coverages in Arc/Info. The digitized boundary which, was saved as a shape file (native file of Arcview) was converted to Arc coverage, edited, "cleaned" and "built" as line and polygon.

Geographical coordinates of points obtained from the field were down loaded from the GPS and this provided a layer of information. The geographical coordinates were projected to UTM using the ARC command "project" in Arc/Info.

Separate digitization was carried out in Arcview on the demarcated boundary of the grazing reserve obtained from the 1: 50,000 scale topographic map to produce a boundary layer.

3.4 Signature File

After creating training site vector file, the creation of signature file commenced. Signature file have statistical information about the reflectance values over different bands for these sites.

To create signature file, ARC /INFO was used. As the ARC/INFO was running, it would ask for the name of the vector file and the name of each of the landcover/landuse class to which identities were assigned.

3.5 Classification Routines

Visual and computer classification were made use of and in the process, pattern of extremely small units encountered, were generalized and predominant category within each parcel labeled.

The mapping unit was based on what could be satisfactorily interpreted and delineated on the Landsat TM, Landsat MSS and SPOT (XS) images.

In the course of visual interpretation one encountered features that were difficult to interpret, and provision was made for field visits to accurately assess those features and also to be familiarized with natural and man- made features of the area.

3.6 Identification of Areas of Change

The already interpreted and classified image was scanned into the computer and then geo- referenced.

Supervised classification technique was used on the satellite image to cross- check the accuracy of the interpretation and classification. Using the 'INITIAL' and 'POLYRAS' module in ERDAS, vector images created were converted to raster images. The pixel values within each landuse class automatically took an identifier number.

The 'OVERLAY' module was used to superimpose the 1993 data on the 1987 data and 1987 data on the 1970 data by using the 'RATIO (FIRST IMAGE/SECOND IMAGE) routine. This resulted into other images (the composite Landuse change maps) to depict areas of change and areas of no change between 1987/1993 and between 1970/1987 respectively.

3.7 Ground Truthing

This is also known as field verification, which was conducted to acquaint me with the study area and also to obtain the GPS coordinates of some of the points that were not too clear during the process of visual interpretation/classification. Points

for which GPS coordinates were obtained are along motorable roads that are not visible on the imageries, positions of settlements and the only modern nomadic school within the reserve.

Oral interviews were carried out with some of the pastoralists and settlers within and around the grazing reserve area.

3.8 STATISTICAL ANALYSIS

This was achieved by querying the polygon coverages for areal statistics in Arcview thus obtaining values for areas of the various land use types for three decades in the grazing area. The differences in these values revealed the changes in the land uses over the decades.

The values were converted to percentages of the total area of the reserve and presented as bar charts.

CHAPTER FOUR

4.0 ANALYSIS AND DISCUSSION OF RESULT

This chapter gives an analysis of the imageries used in assessing the extent of various land uses over the three decades i.e. 1970, 1987, and 1993.

Various land use categories were identified and mapped; their area coverages were similarly taken in hectares.

4.1 Land use in Bobi Grazing Reserve and Environs

The following land use categories were identified and mapped out.

a) Cultivated area

b) Grazing area

c) Dams

d) Settlements

e) Major road

f) Minor road

g) Streams/rivers

Table 4.1 Land use/Land cover of Bobi Grazing Reserve in 1970

S/N	Land use/Land cover	Area of coverage in Hectares	Percentage
1	Cultivated area	2,480. 56	7. 8
2	Grazing area	28,916. 070	92. 1
3	Settlements	2. 046	0. 1
4	Dams	0	0
	TOTAL	31,398.676	100.0

Source: Data obtained from the Change Analysis of Bobi Grazing Reserve using Land sat MSS dated January 1970.

From the Table 4.1, it can be observed that the grazing area covers 28,916. 70Ha (i.e. 92. 1%) of the total land surface area which is 31,398. 68Ha and is uniformly distributed over the entire study area (see fig. 4.1).

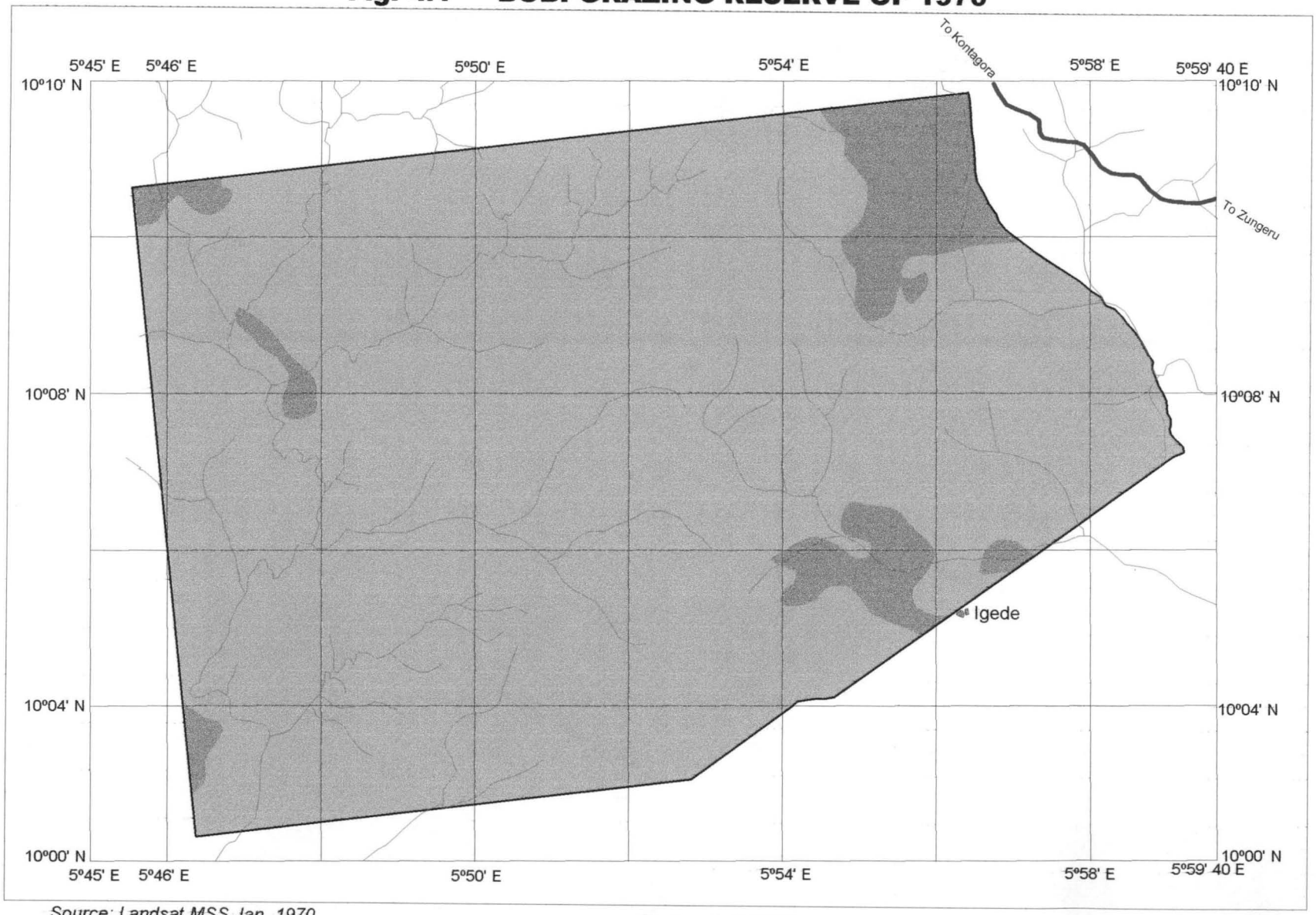
Cultivated area covers 2,480. 56Ha (i.e. 7. 9%) of the total area is next to grazing area and found mostly close to settlement areas around the boundary of the reserve.

Settlements, which were very scanty, occupy only 0.1% of the total area of the reserve (i.e. 2.046Ha).

It can be observed that in 1970, there were no dams and hence zero area coverage and zero percentage.

The percentage land use of 1970 can be observed in fig. 4.2.

Fig. 4.1 BOBI GRAZING RESERVE OF 1970



Source: Landsat MSS Jan. 1970

Scale:- 1:150000

Kilometers

3 0 3 6 Kilometers

Fig. 4.2 BOBI GRAZING RESERVE: PERCENTAGE LANDUSE OF 1970

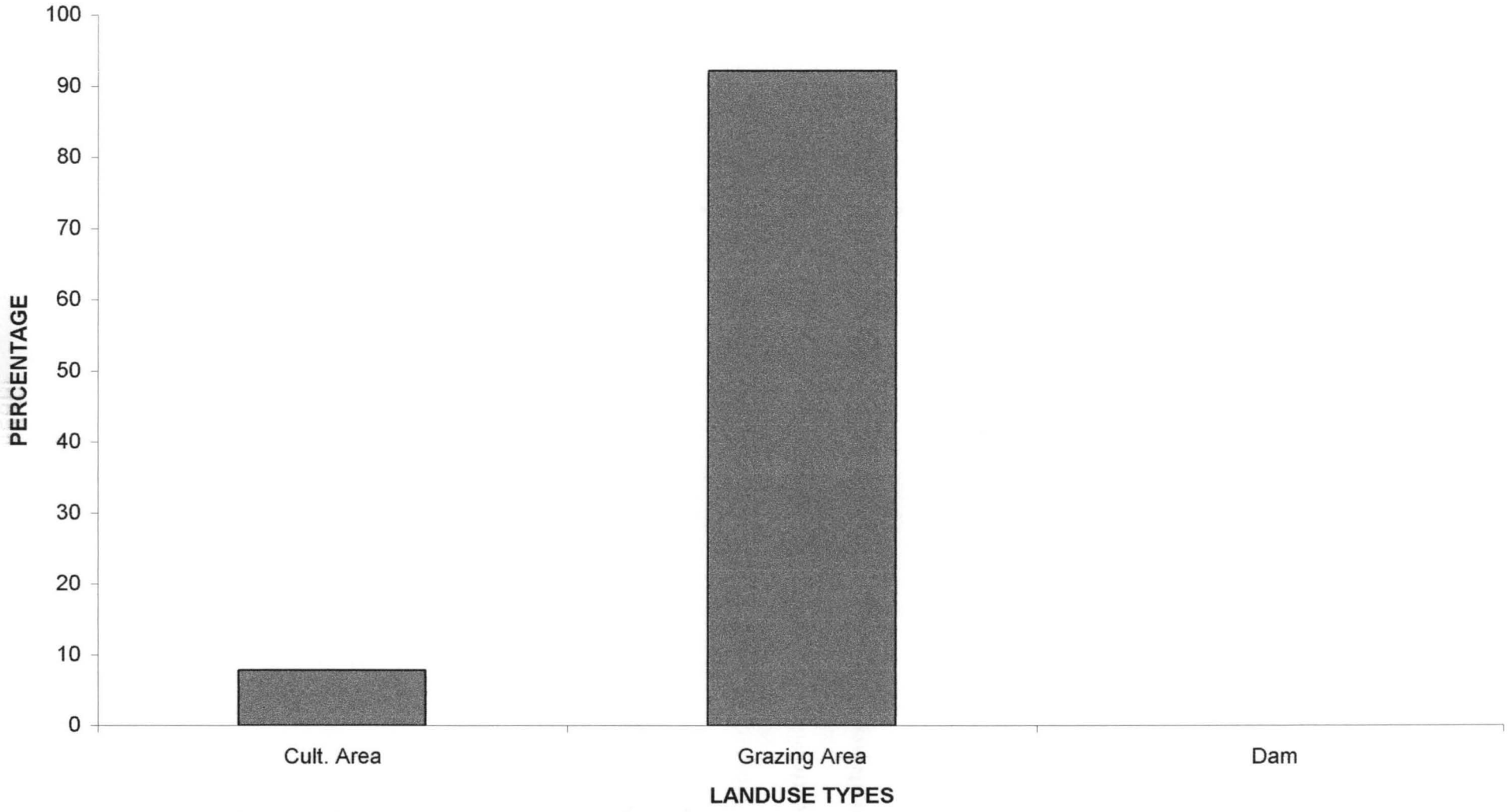


Table 4.2 Land use/Land cover of Bobi Grazing Reserve in 1987

S/N	Land use/Land cover	Area of coverage (Ha)	Percentage coverage
1	Cultivated area	3,285. 68	10. 5
2	Grazing area	28,083. 645	89. 4
3	Settlements	29. 360	0. 1
4	Dams	0	0
	TOTAL	31,398.685	100.0

Source: Data obtained from the Change Analysis of Bobi Grazing Reserve, using Landsat TM dated March 1987

As shown in Table 4.2 in 1987, grazing area covers 89.4% (i.e.28, 083. 645Ha) of the total area.

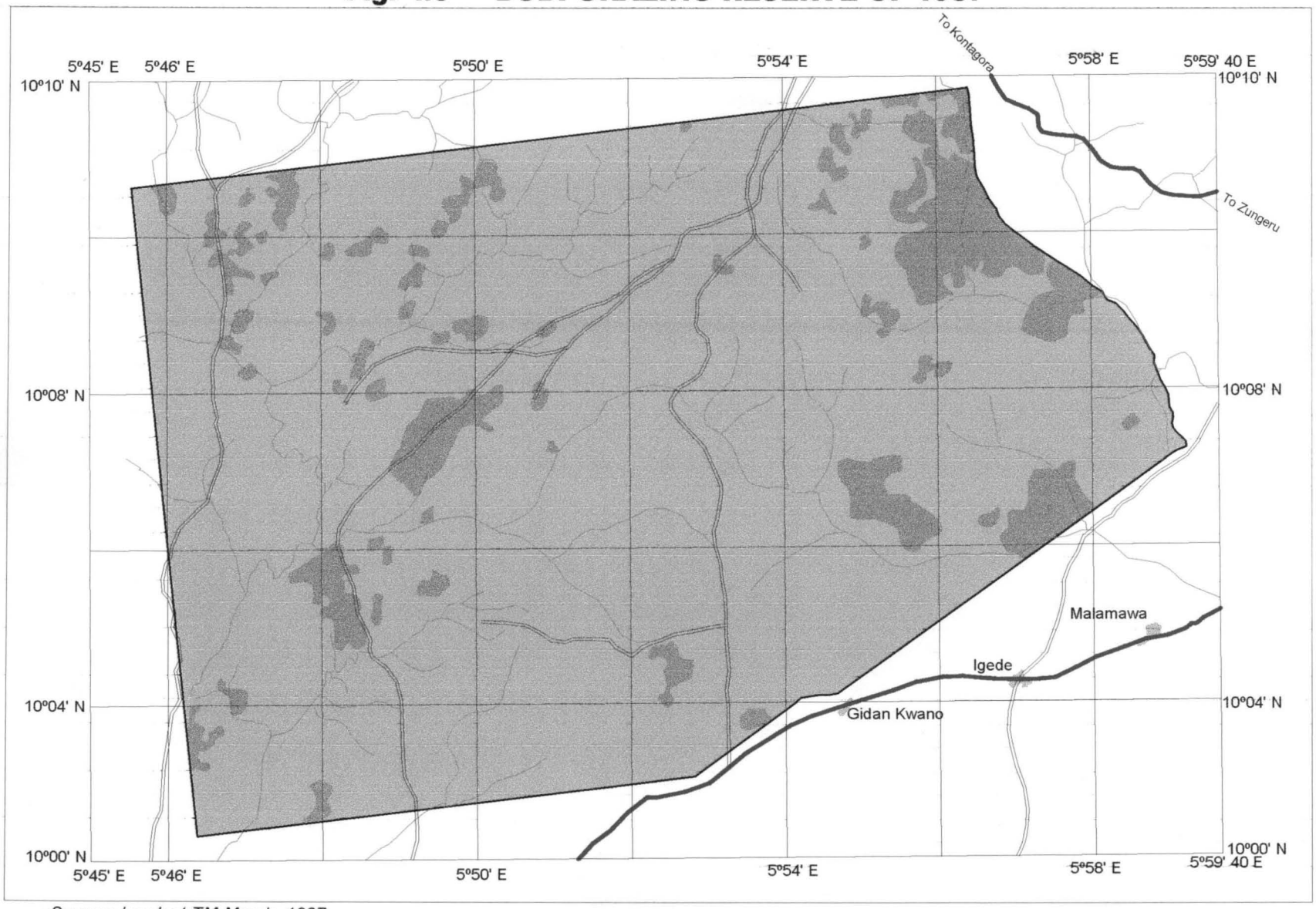
Cultivated area covers 10. 4% (i.e.3, 285. 68Ha) of the total area and can be seen scattered within the whole reserve (see fig. 4.3).

Settlements covered an area of 0.1% (i.e. 29.360Ha) of the total land area.

It can also be observed that dams occupy zero percentage (i.e. zero Hectare) of the total land area.

The bar chart showing percentage land use/land cover for 1987 is shown in fig. 4.4.

Fig. 4.3 BOBI GRAZING RESERVE OF 1987



Source: Landsat TM March. 1987

Scale:- 1:150000

Kilometers 3 0 3 6 Kilometers

LEGEND

- Boundary
- Major Road
- Minor Road
- Stream
- Settlement
- Cultivated A
- Grazing Are

Fig. 4.4 BOBI GRAZING RESERVE: PERCENTAGE LANDUSE OF 1987

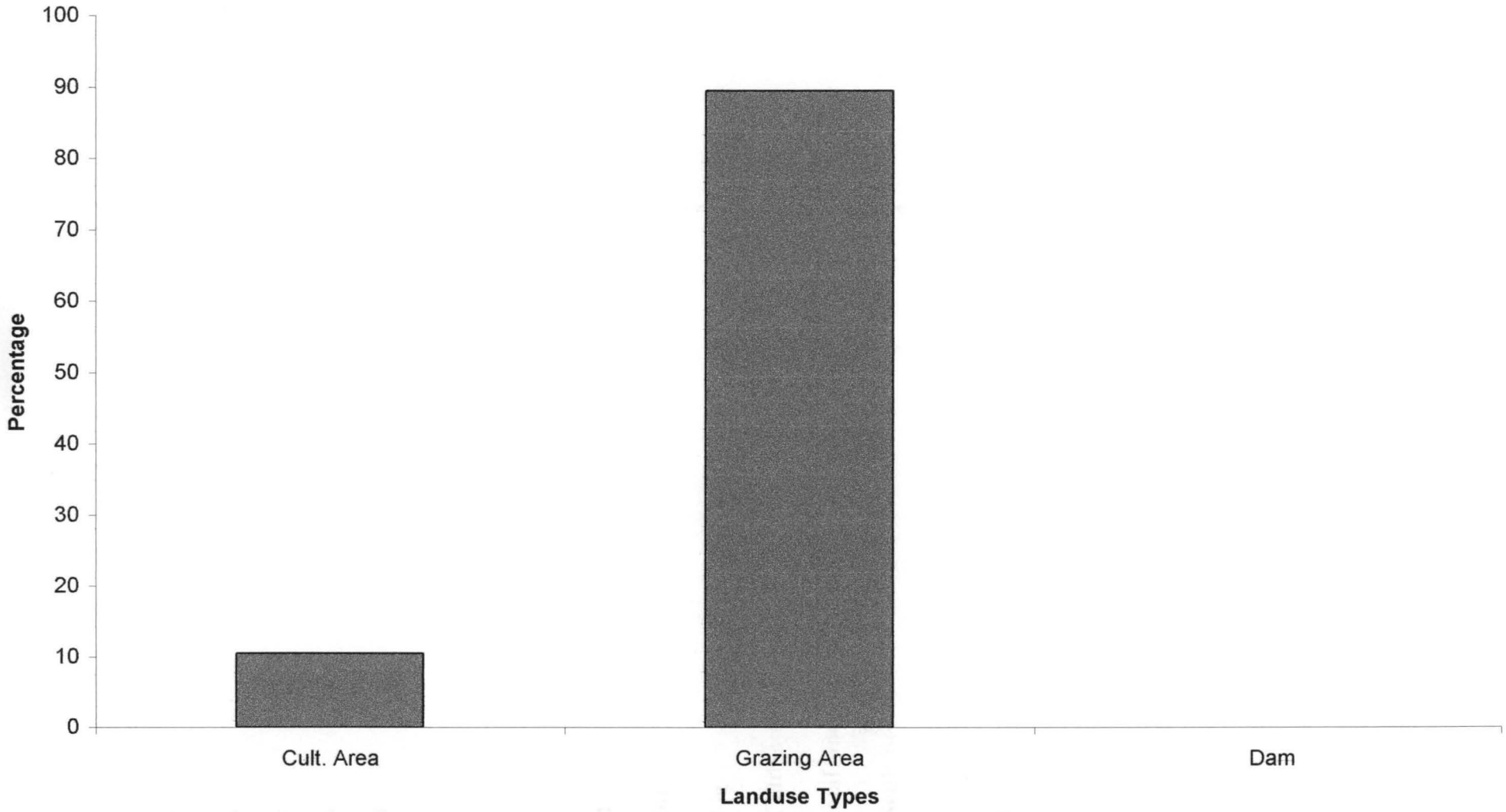


Table 4.3 Land use/Land cover situation in 1993

S/N	Land use/Land cover	Area of coverage (Ha)	Percentage coverage
1	Cultivated area	12,470. 353	39. 7
2	Grazing area	18,862. 68	60. 1
3	Settlements	37. 008	0. 1
4	Dams	28. 635	0. 1
	TOTAL	31,398.686	100.0

Source: Data obtained from the Change Analysis of Bobi Grazing Reserve, using SPOT (XS) dated June 1993.

Table 4.3 shows that in 1993 grazing area covers 60.1% (i.e.18, 862. 68Ha) of the total land area of the reserve concentrating mainly in the central area.

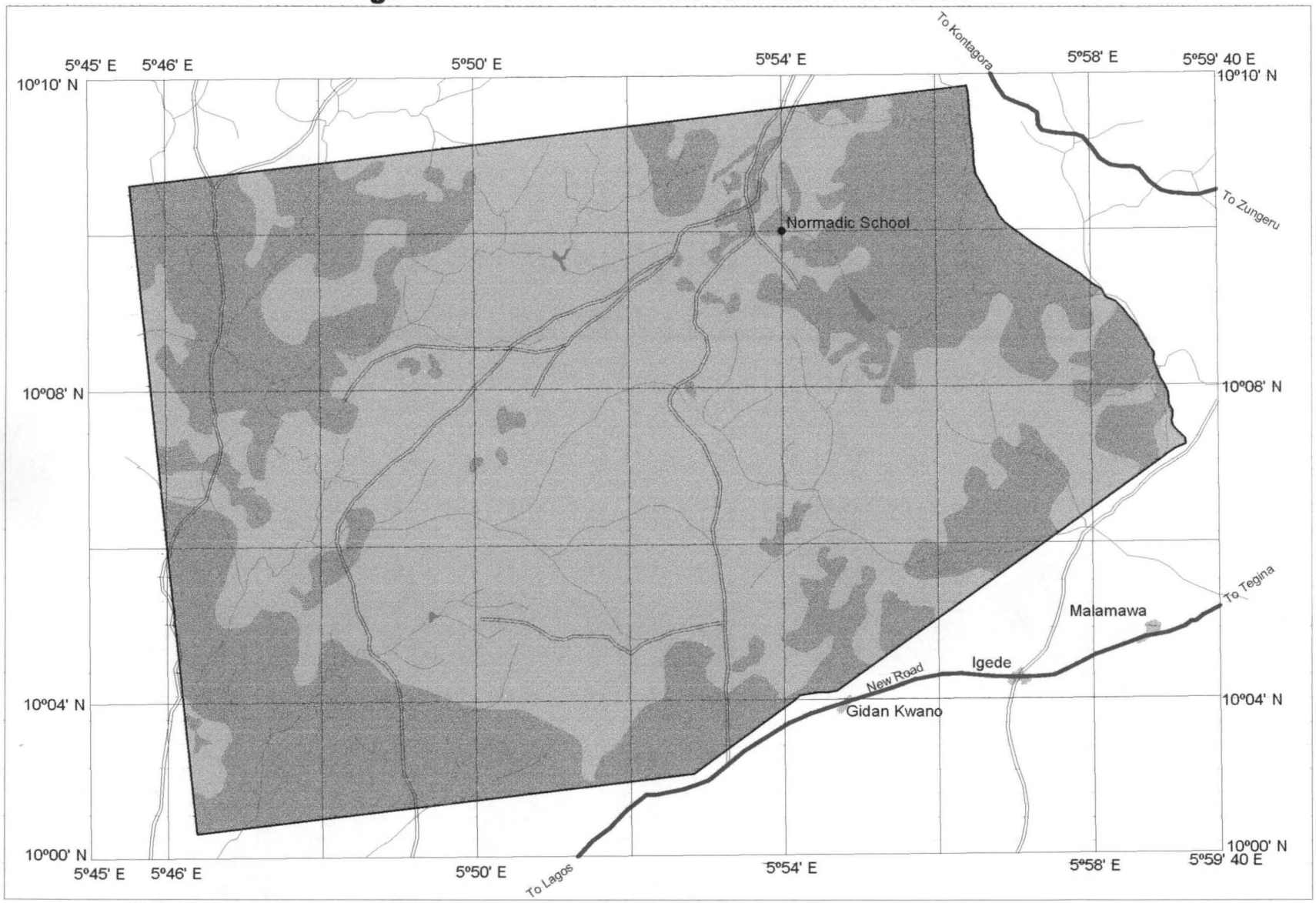
Fig. 4.5 shows the land use map of 1993.

Cultivated area comes next covering an area of 39.7% (i.e.12, 470. 353Ha) of the total land area.

Settlements cover an area of 0.12% (i.e. 37.008Ha) of the total land area. Dams occupy an area of 0.1% (i.e. 28. 635Ha) scattered within the entire reserve.

Fig. 4.6 shows the bar chart for the percentage Land use/Land cover of Bobi Grazing Reserve in 1993.

Fig. 4.5 BOBI GRAZING RESERVE OF 1993



Source: SPOT XS June 1993

Scale:- 1:150000

Kilometers 3 0 3 6 Kilometers

Fig. 4.6 BOBI GRAZING RESERVE: PERCENTAGE LANDUSE 1993

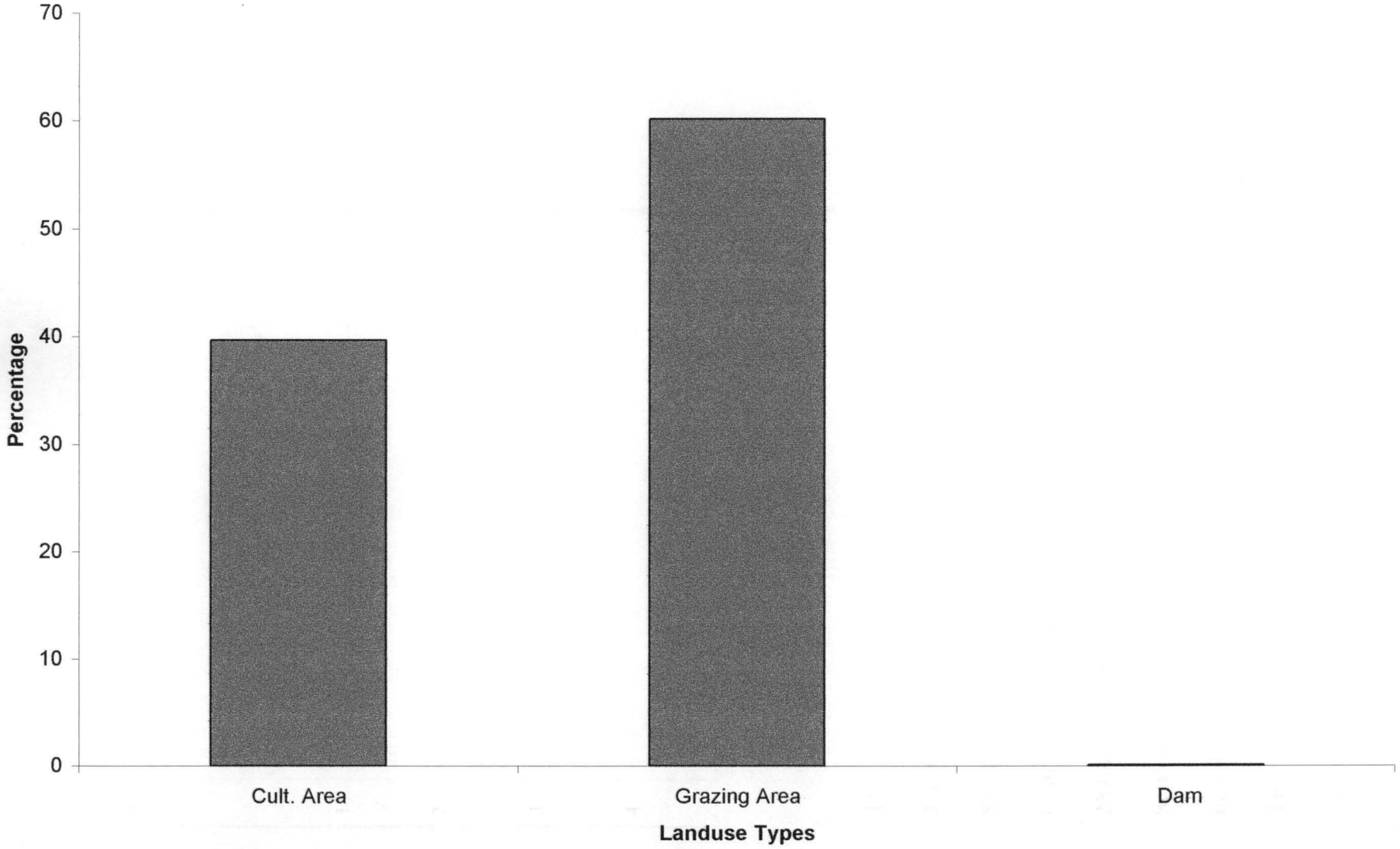


Table 4.4 Land use change between 1970 and 1987

S/N	L/USE,L/COVER CHANGE	AREA COVERAGE (HA) 1987	AREA COVERAGE (HA) 1970	PERCENTAGE COVERAGE 1987	PERCENTAGE COVERAGE 1970	PERCENTAGE CHANGE	CHANGE IN HA	DEC/INC CHANGE
1	Cultivated area	3,285. 68	2,480. 56	10. 5	7. 9	+32.58	805. 12	Positive change
2	Grazing area	28,083.645	28,916.07	89. 4	92. 1	-2. 88	832. 4	Negative change
3	Settlements	29. 36	2. 05	0. 09	0. 07	+1332. 20	27. 3	Positive change
4	Dams	0	0	0	0	0	0	0
		31,398. 68	31,398.68	100%	100%		1,664. 8	

Source: Data obtained from the change analysis of Bobi Grazing Reserve, using Landsat MSS and Landsat TM dated January 1970 and march 1987 respectively.

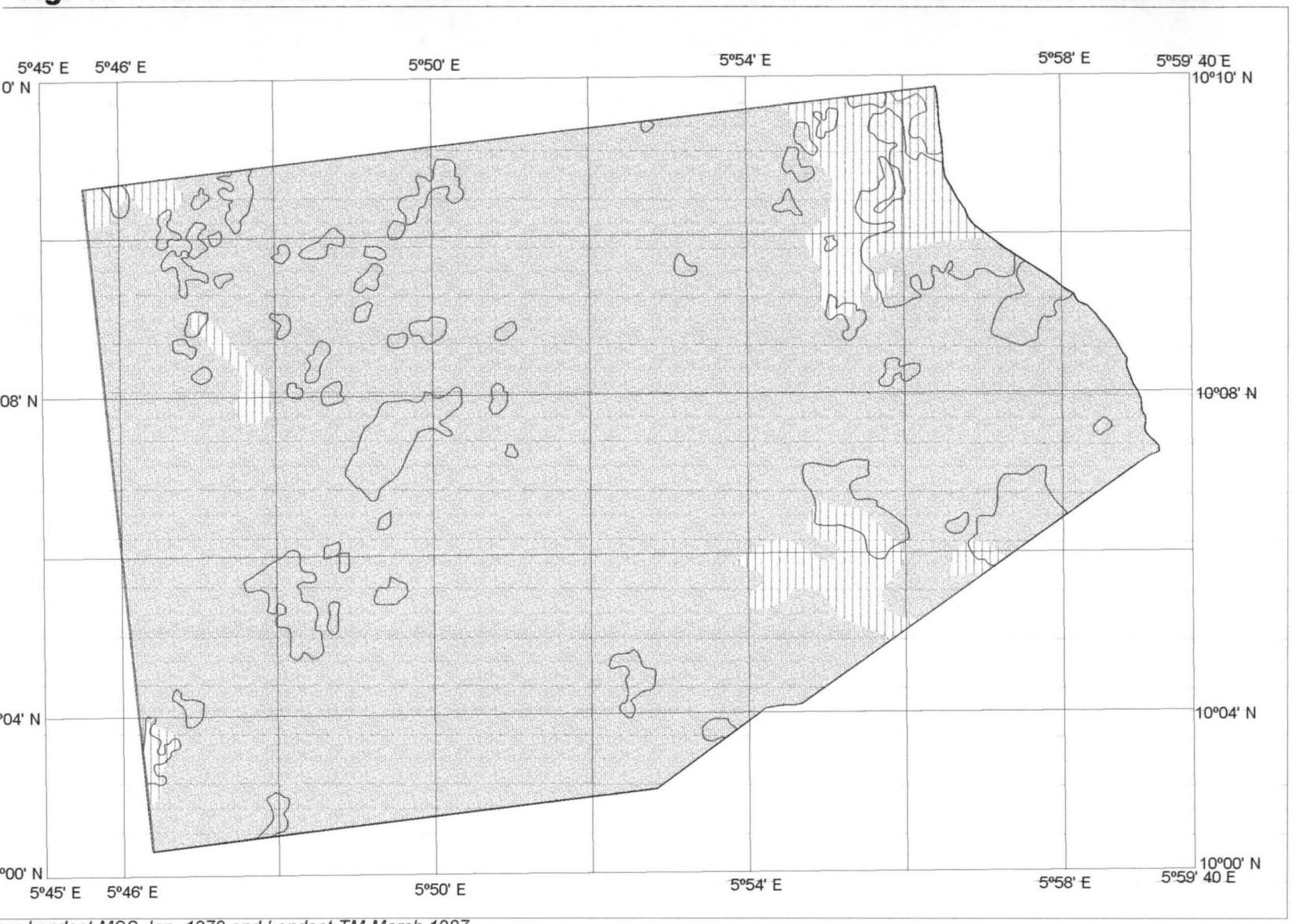
The cultivated area is the most highly affected. The area covered increased from 2,471.02Ha in 1970 to 3,276.13Ha in 1987 showing that farming has increased by 805.11Ha or 32.58%. See fig. 4.7.

Grazing area on the other hand had decreased from 28,916.07Ha in 1970 to 28,083.65Ha in 1987, indicating a decrease of 832.4Ha or 2. 88%.

Settlements increased from 2.05Ha in 1970 to 29.36Ha in 1987 indicating an increment of 27.3Ha or 1332.20%.

There was no evidence of dams in 1970 and 1980. Fig. 4.8 shows the bar chart of percentage Land use changes between 1970 and 1987.

Fig. 4.7 BOBI GRAZING RESERVE: LANDUSE CHANGES BETWEEN 1970 AND 1987



ce: Landsat MSS Jan. 1970 and Landsat TM March 1987

LEGEND

- Cultivated Area of 1993
- Grazing Area of 1993
- Cultivated Area of 1987
- Grazing Area of 1987

Scale:- 1:150000

Kilometers 3 0 3 6 Kilometers

Fig. 4.8 BOBI GRAZING RESERVE: PERCENTAGE LANDUSE CHANGES BETWEEN 1970 and 1987

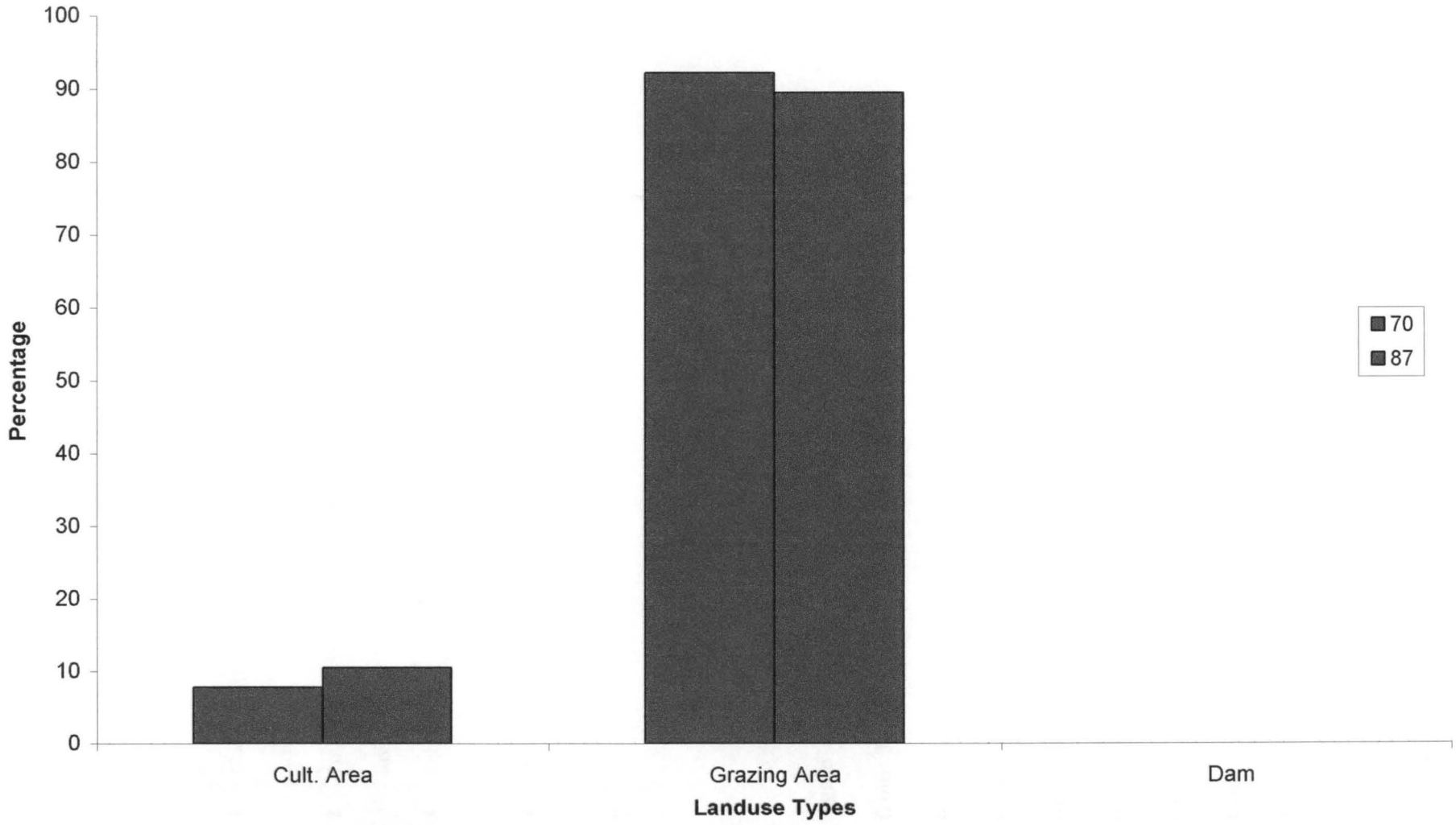


Table 4.5 Land use change between 1987 and 1993

S/N	L/USE,L/COVER CHANGE	AREA COVERAGE(HA) 1993	AREA COVERAGE(HA) 1987	PERCENTAGE COVERAGE 1993	PERCENTAGE COVERAGE 1987	CHANGE IN HA	PERCENTAGE CHANGE	DEC/INC CHANGE
1	Cultivated area	12,470. 353	3,285. 68	39. 7	10.5	9,184. 67	+279. 54	Positive change
2	Grazing area	18,862. 68	28,083. 65	60. 1	89.4	9,220.97	-32. 83	Negative change
3	Settlements	37. 008	29. 36	0. 12	0.1	7. 65	+26. 05	Positive change
4	Dams	28. 635	0	0. 1	0	28. 64		Positive change
		31,398. 68	31,398. 69	100%	100%	18,441.93		

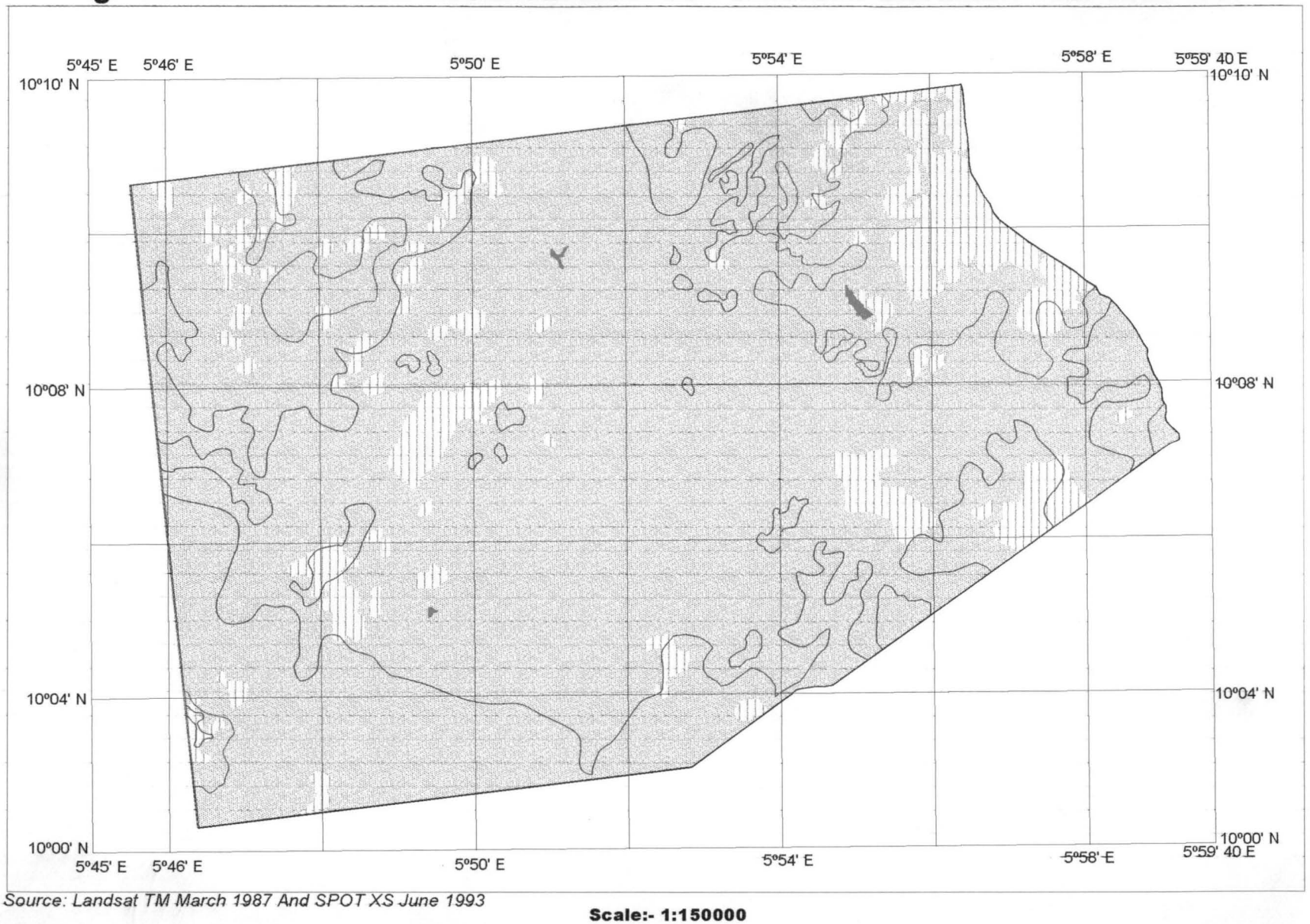
Source: Data obtained from the change analysis of Bobi Grazing Reserve, using Landsat TM and SPOT (XS) dated March 1987 and June 1993 respectively.

Again the cultivated area is the most highly affected. The area covered increased from 3,285.68Ha in 1987 to 12,470.353Ha in 1993 showing that farming has increased by 9184.67 or 279.54%. See fig. 4.9.

Grazing area had continued to decrease. Again it had decreased from 28,083.65Ha in 1987 to 18,862.68Ha in 1993, which is 9220.97Ha or 32.83%. Settlements also increased marginally from 29.36Ha in 1987 to 37.008Ha in 1993 or 26.05% positive change.

From 1987 to 1993 dams were built in various locations indicating a positive change. The percentage of land use changes between 1987 and 1993 can be observed in fig. 4.10.

Fig. 4.9 BOBI GRAZING RESERVE: LANDUSE CHANGES BETWEEN 1987 AND 1993



Source: Landsat TM March 1987 And SPOT XS June 1993

Scale:- 1:150000

Kilometers 3 0 3 6 Kilometers

Fig.4.10 BOBI GRAZING RESERVE: PERCENTAGE LANDUSE CHANGES BETWEEN 1987 AND 1993

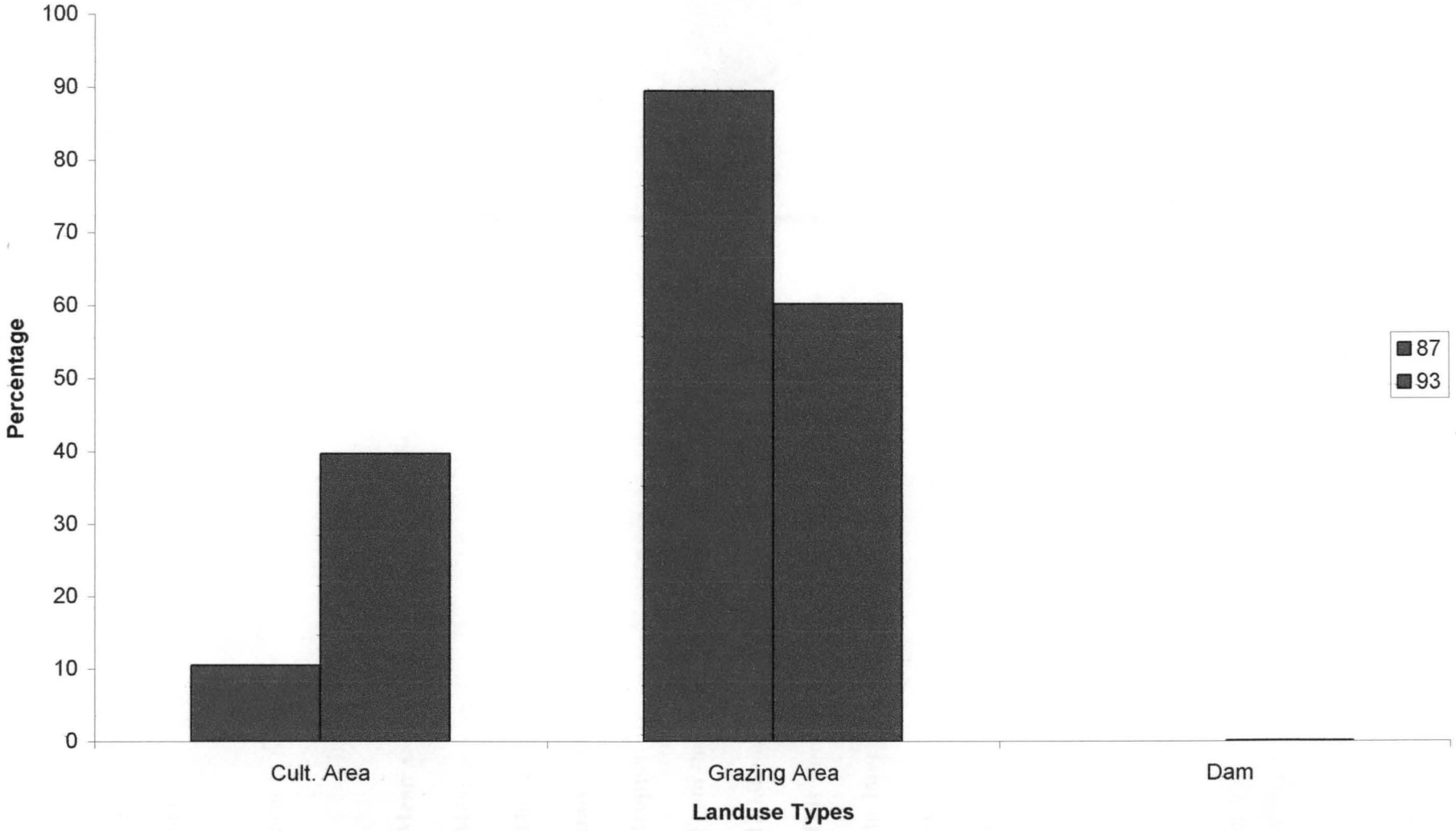


Table 4. 6 Rainfall Data for Minna Synoptic Station (1991, 2000)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1991	0	0	0	114.5	336.0	180.1	192.9	268.5	190.8	33.9	0	0
2000	0.3	0	0	3.6	135.9	161.0	208.8	308.5	153.4	0	0	0

Source: Nigeria Meteorological Dept., Kaduna.

Mean annual for year 1991= 109. 72cm

Mean annual for year 2000= 106. 16cm

The temperature analysis from the rainfall data available for Minna synoptic station covering the area of study shows that the mean annual rainfall of 1991 dropped from 109.72cm to 106.16cm in the year 2000.

From the report of National Livestock Project in 1985, the mean annual rainfall was 120.0cm.

This shows that the early years of the grazing reserve witnessed more rainfall than the later years.

The decline in rainfall will affect the reserve in terms of vegetation growth and water supply.

Table 4. 7 Cattle, Goats and Sheep numbers in Mariga Local Govt. Area (1989).

	CATTLE	SHEEP	GOAT
Number	154, 519	152, 746	304, 041
No./Sq.km	9.4	9.3	18.4

Source: Report of livestock and Land use in Niger and Anambra States by RIM Limited, UK.

Mashegu Local Government Area is part of the old Mariga Local Govt. Area in which Bobi grazing reserve is situated. The area of the reserve is 31,398.68Ha = 313.9868sq.km.

Going by the number of cattle, sheep and goat per square kilometer from the table, the following total numbers of livestock in the reserve are obtained.

i) Cattle = 2,952.

ii) Sheep = 2,920.

iii) Goats = 5, 778

Total = 11,650

As at 1989, an estimate number of the above livestock population was 11,650.

In 1998, a regular user survey carried out by National Livestock Projects, Kaduna in the reserve during dry season shows that there were 142 families with an average family size of 9 while average herd size documented for each family is cattle 94, sheep 16 and goat 18. For the 142 families, we have the following numbers:

i) Cattle = 13,348

ii) Sheep = 2,272

iii) Goats = 2,556

Total = 18,176 as at 1998

It can be observed that the numbers of animals within the grazing reserve increased significantly which has negative impact on the land use/land cover.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The research work is concerned with identification of various Land use/Land cover changes that have taken place at Bobi Grazing Reserve and its environs using Remote Sensing technique and to establish its relationship with the pastoral farmers and to determine the efficacy of Landsat and Spot imagery at the resolution of 30m and 20m respectively in assessing land degradation and to make suggestions on the future planning of the reserve.

The reserve in the 70's formed part of the forest reserve in the then North Western State of Nigeria until in the mid-80's when the reserve was earmarked solely for grazing.

As a result of the type of imageries used due to their resolutions, it was not possible to capture the animals (i.e. cattle, sheep and goats) with the satellites. Other methods of getting livestock population were undertaken.

At the early 70's when it was a forest reserve, it was obvious that any form of human settlements within the reserve was totally prohibited.

Field investigation showed that grazing was scanty in the early 70's because of the few animal populations

The vegetation was more vigorous due to less impact by humans and the mean annual rainfall then was higher.

From the analysis of land use and land cover situation between 1970 to 1983 and 1983 to 1993, the area understudy had shown a significant increase in cultivated area due to increased interest in the reserve as a result of provision of social

amenities like access roads within the reserve, dams and schools. Settlements around the reserve had increased significantly resulting in land degradation within the reserve as these had led to deforestation and witnessed a lot of conflicts between the arable farmers and the pastoralists. The grazing area had decreased greatly while the population of the animals had continued to rise thereby exerting pressure on the available facilities. Even with the construction of dams towards the 90's, the water situation had continued to decline as a result of desert encroachment caused largely by human activities.

5.2 CONCLUSION

From the above summary, the following conclusions can be made.

a) **It was found that the use of Landsat (TM) and Spot (XS) imageries at the resolutions of 30m and 20m respectively were not efficient in assessing Land use and Land cover changes in Bobi Grazing reserve.**

b) **From the satellite imageries of Bobi grazing reserve, it was not possible to make head count of each grazing animals due to their resolutions and the number of each animal varies with seasons.**

c) **Thatched houses were difficult to interpret in the imageries.**

d) **Minimizing negative human activities helps to reduce conflicts with the pastoralists.**

e) **Reliable temperature and rainfall data covering the area for the duration was not possible to come by, I had to make do with whatever was available to meet up with time.**

f) **Accurate livestock census for the period of study was a problem. The only available data covered only one decade.**

5.3 RECOMMENDATIONS

It is very important to have timely and accurate information for the purpose of monitoring Land use/Land cover changes for effective planning and development thereby minimizing the conflicts between the pastoralists and the farmers.

Remote Sensing is the modern technology available that can provide such data in a cost effective manner.

The imageries used for this research were the only available and affordable ones within the time framework for this study.

The resolutions of 30m and 20m for Landsat (TM) and Spot (XS) respectively are too poor for this kind of work.

Higher resolutions that will provide repetitive coverage for change detection are recommended for further research. For higher accuracy work that can be depended upon for proper planning it is recommended that higher resolution imageries from IKONOS, SPOT PANCHROMATIC and LANDSAT 7 be acquired and made use of. These have resolutions of 1m, 10m and 15m respectively.

Images should also be acquired during drying season particularly between November and March.

It is recommended that NDVI (i.e. Normalised Difference Vegetation Index) be run in area where degradation seems not to be shown on the imageries to determine the extent of depletion of the forest areas.

I recommend the acquisition of remote sensing data particularly for IKONOS so as to make multi-temporal study of the area-using computer that is very fast and reliable as a means of monitoring the environment generally.

It is also recommended that similar research work be conducted in the other grazing reserves within the country for comparative analysis, which will lead to better management and less conflicts with improvement in protein production and enhancement of economic status of livestock farmers.

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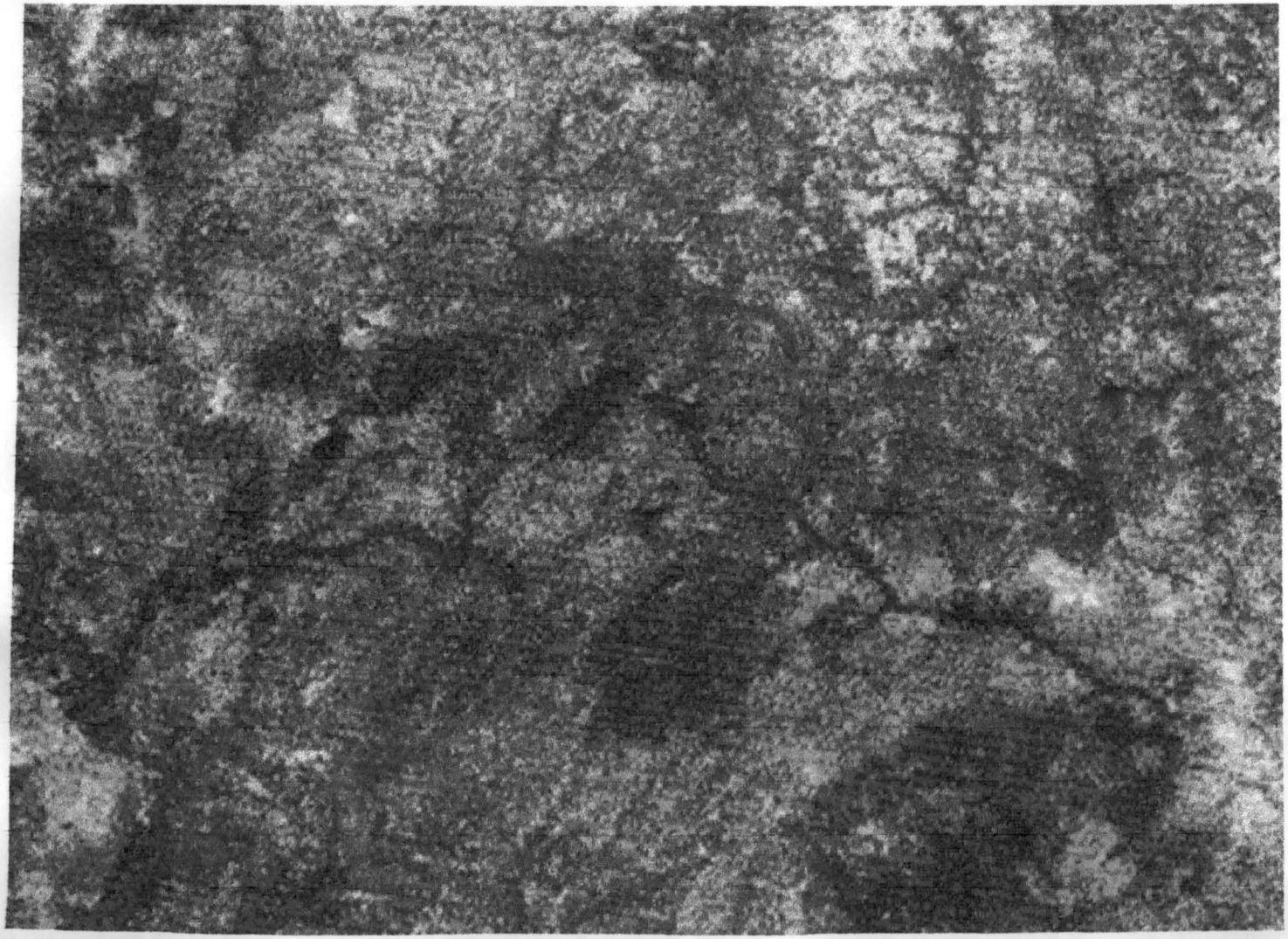
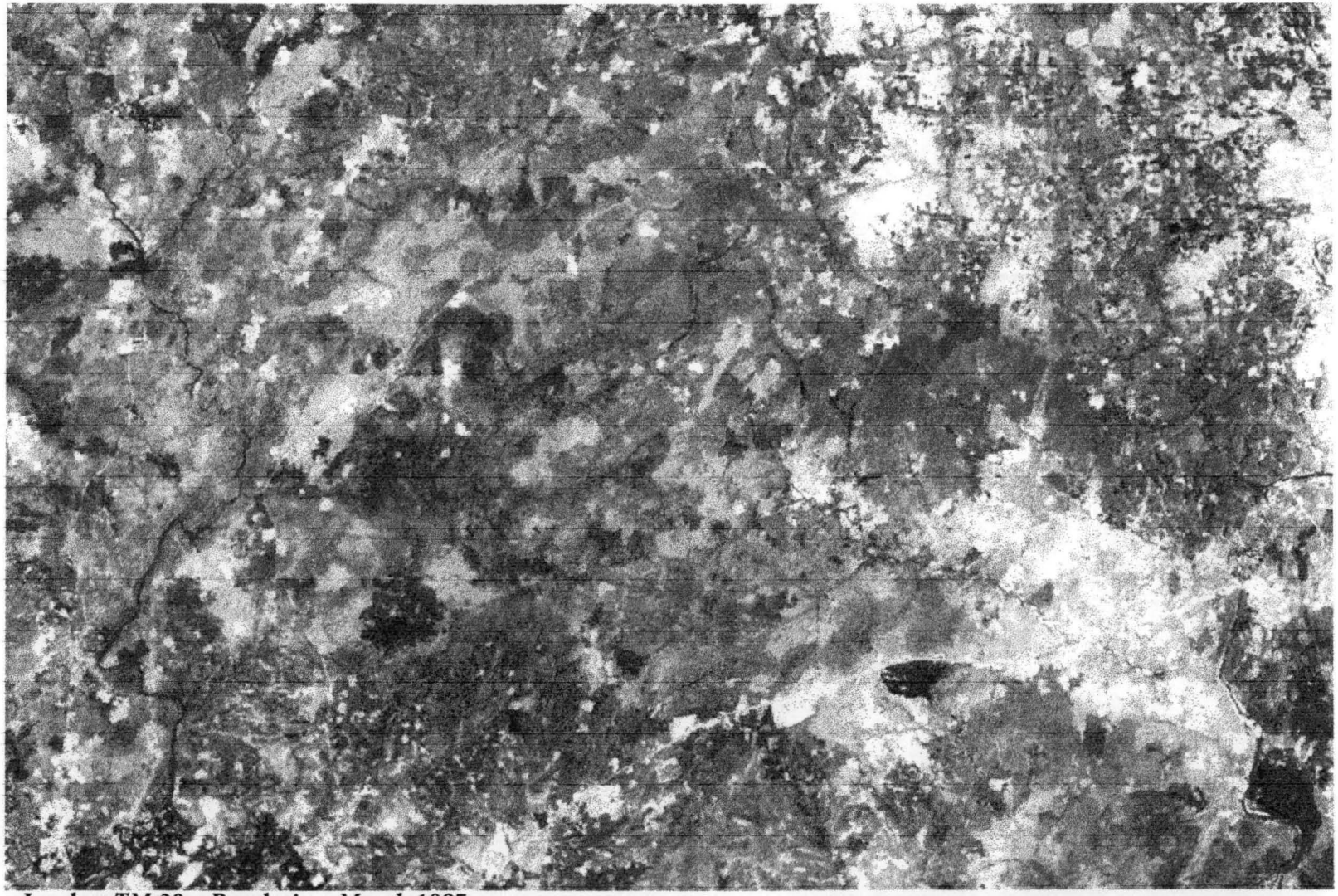
APPENDIX 1: BOBI GRAZING RESERVE- LANDSAT SATELLITE IMAGERY OF 1970



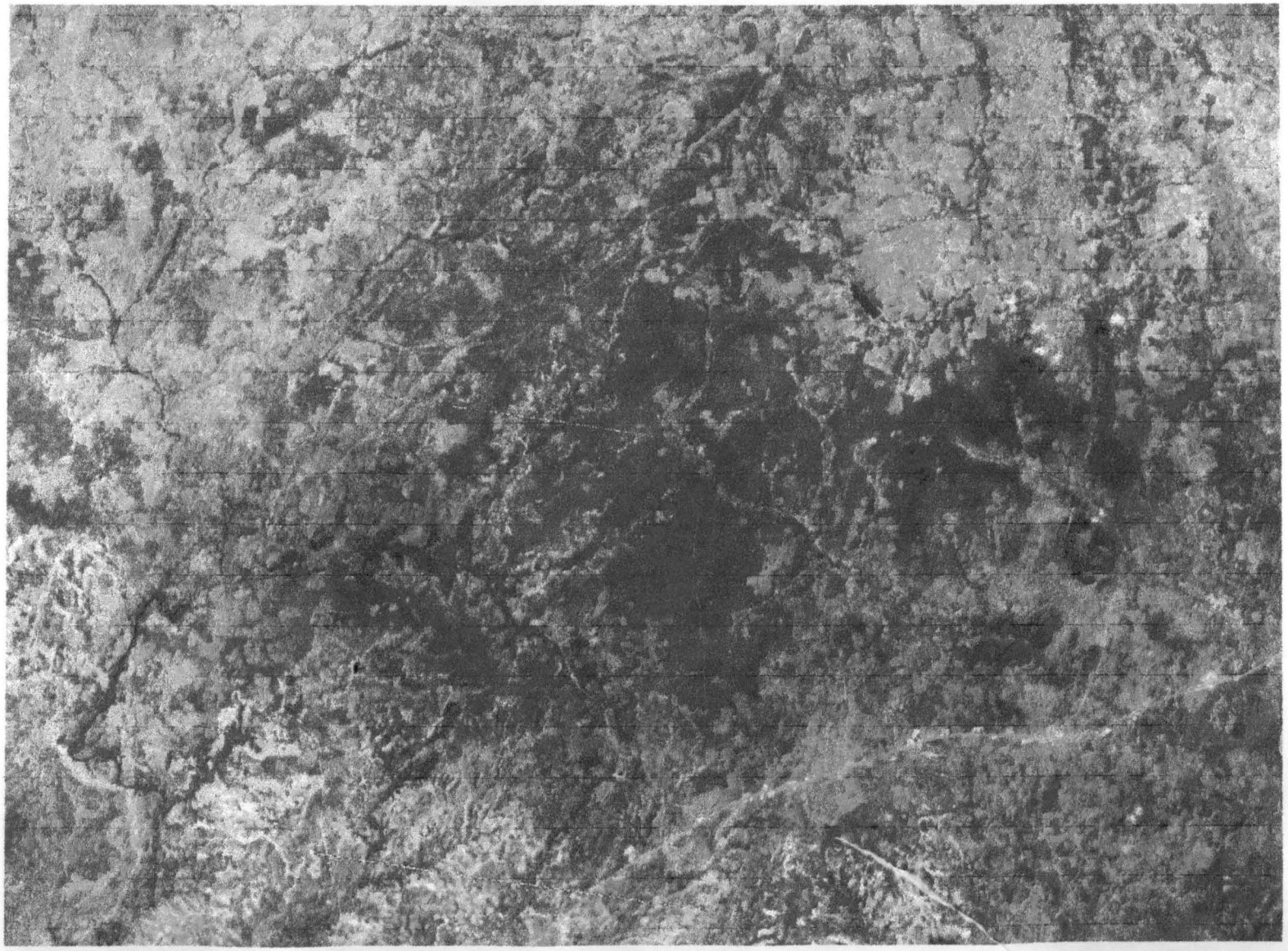
Landsat MSS 50m Resolution, Jan. 1970 (Resampled)

APPENDIX 2: BOBI GRAZING RESERVE- LANDSAT SATELLITE IMAGERY OF 1987



Landsat TM 30m Resolution, March 1987

APPENDIX 3: BOBI GRAZING RESERVE- SPOT SATELLITE IMAGERY OF 1993



SPOT XS 20m Resolution, June 1993