DEPARTMENT OF EARTH SCIENCES
ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

GIS IN PROJECT IMPACT ASSESSMENT

Southern Tsetse Eradication Project
Humbo Woreda (SNNPR)

BY

DEREJE GETAHUN

JULY 2005
ADDIS ABABA

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ABSTRACT

The objective of this study is to further expand the use of Remote Sensing and GIS techniques in the country, especially in the area of project planning, monitoring, evaluation and impact assessment in the agriculture sector. Impact assessment of the Southern Tsetse Eradication Project (STEP) was carried out using Remote Sensing and GIS techniques, by taking Humbo Woreda (SNNPR) as a case study.

Landsat ETM^+ image of the area was used and agricultural sample survey was conducted in 11 peasant associations in the study area. Pertinent questions categorized into household characteristics, agricultural data, tsetse fly and trypanosomiasis condition as well as environmental related issues regarding pre and post project periods were included in a structured questionnaire. Statistical comparison of with and without project situation of various parameters was made. These include size of cultivated land, amount of crop production, method of cultivation, number of livestock, oxen out put, situation of tsetse infestation and trypanosomiasis prevalence and environmental situations in the area, etc. Survey data was manipulated and spatially presented by creating a spatial database in GIS software and using spatial facilities such as grid interpolation, proximity analysis, density calculation, map query, grid analysis and layout facilities.

The project had no socio-economic baseline data thus, farmers' recall method was applied as alternative source of information. In addition to this, due to the absence of recent satellite image, it was not possible to compliment the agriculture sample survey with remote sensing data. As a result it was not possible to assess the land use/ cover and environmental change analysis at the desired level.

Assessment based on the available information, showed that the so far undertaken tsetse control intervention by STEP has enabled to significantly reduce the tsetse and trypanosomiasis problem in the area. As a result, livestock health condition has improved while, livestock body and growth condition have not shown similar improvement mainly due to feed and water scarcity. There has been a clear shift from hand cultivation to the use of oxen power while average cultivated size and production of major cereals that normally require oxen power for their cultivation has increased. The impact is more visible in kola areas, probably due to the fact that these areas had been highly affected by the problem and where most impact is expected as a result of the control intervention.

The application of advanced survey and monitoring tools, including remote sensing and GIS, has in general, allowed appropriate situation analysis. Finally, it was recommended that any project need to undertake baseline as well as regular monitoring surveys enabling data collection for future project impact assessments and the use of recent satellite image for detailed land use/ cover change analysis.

Key words: STEP, Impact Assessment, Remote Sensing and GIS, Tsetse fly, Trypanosomiasis, Apparent Fly

CHAPTER 1 - INTRODUCTION

1.1 Background

Ethiopia with a total land area of about 1.15million km^2 and a population of over 70 million is one of the least developed among the developing countries with an annul per capita income of less than US$100 (MOARD, 2005). Agriculture is the mainstay of Ethiopian economy. It accounts for about half of the Gross Domestic Product, 90% of exports and 85 percent of employment. The majority of its economically active population is engaged in subsistence farming adopting low input and low output rain-fed mixed farming with traditional technologies (MEDaC, 1999).

The highlands, constituting 36.3% of the total land area of the country support about 88% of the human population and 70% of the livestock population, while the lowlands account for the balance (MEDaC, 1999). The highlands of the country are over-populated, suffering from over-cultivation and overgrazing. This has resulted in alarming environmental degradation, which in turn has led to low agricultural productivity and food insecurity. (AGRISTUDIO S.R.L, 2004).

Drought and famine are recurrent features of rural life in Ethiopia. Some of the recent incidences with severe impacts include those in: 1957-58; 1964-66; 1973-75; 1987-88 (Degefu, 1988; Hutchison, 1991) and in 2003-04. As many parts of the country are now regarded as incapable of sustaining the current human population, it has been the policy of successive governments to promote the relocation of people from more densely settled drought prone regions to less densely populated regions with greater agricultural potential. Most of the latter areas are lowlands in west and southwest of the country and are tsetse infested (MOARD, 2005). A land suitability study carried out in areas of low population density in southwestern, southern and western Ethiopia revealed that the tsetse-infested lowlands in the western part of the country have great potential for agricultural expansion (AACM, 1987).

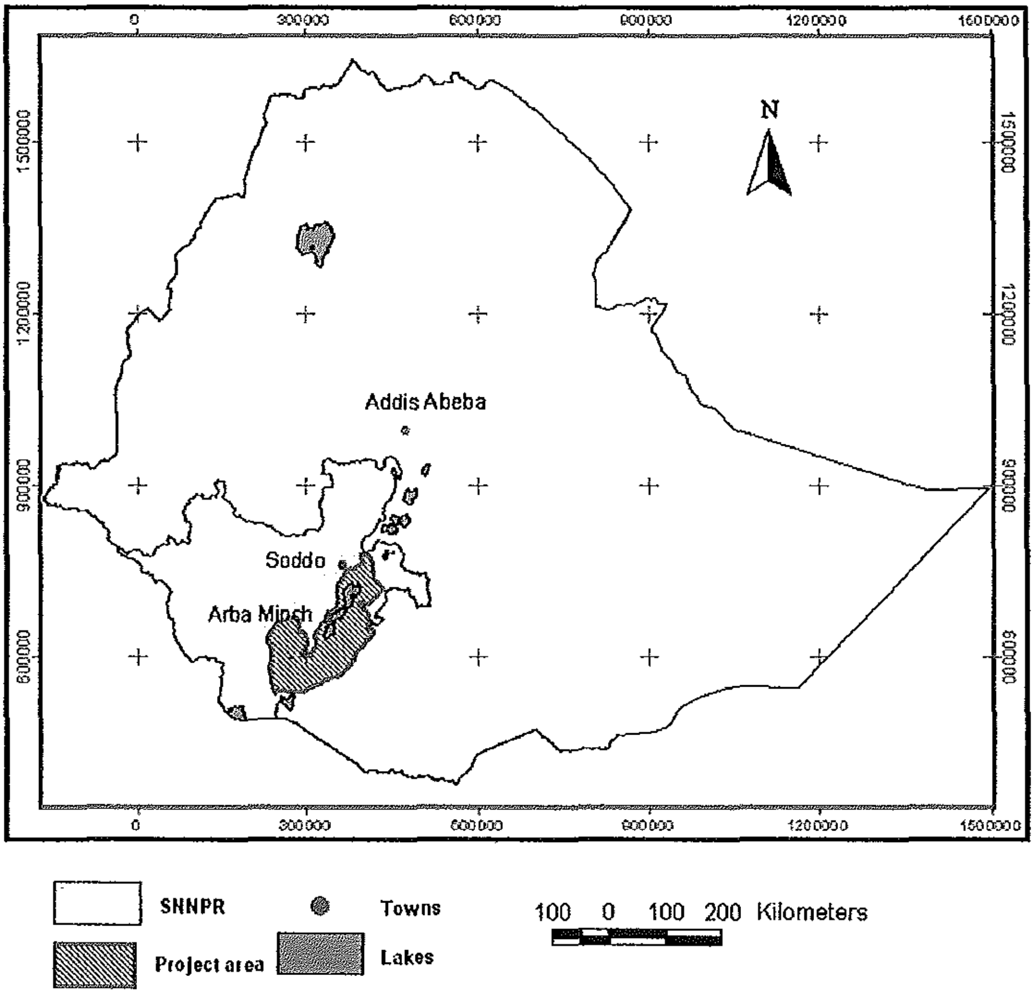
1.2 Southern Tsetse Eradication Project (STEP)

The Southern Tsetse Eradication Project, an International Atomic Energy Agency (IAEA) - Ethiopian Government joint project that has been implemented by the Ethiopian Science and Technology Commission in collaboration with the South Nations and Nationalities Regional State is one of the projects engaged in tsetse and trypanosomiasis control/ eradication in the country. It aims to use the Sterile Insect Technique (SIT) as an area–wide integrated component to eradicate tsetse flies from an area of 25,000 Km2 in the Southern Rift Valley of Ethiopia. The project area is located between $4^0$45' and $7^0$15'N Latitude and $36^0$40' and $38^0$20' E Longitudes in the Southern Rift Valley of Ethiopia (ESTC, 2004) (Figure 1). This site was selected because it is surrounded by high escarpments and sufficiently dry zone that appear to contain and isolate a population of tsetse flies of *G.pallidipes* species, apparently the only species of tsetse in the area (GFDRE, 1997). Furthermore, tsetse infestation is high and local population pressure is putting a severe strain on available fly-free highlands.

SIT is one of the latest methods of tsetse/trypanosomiasis control/eradication. It involves the continuous release of sterile insects among the indigenous insect population at rates sufficient to result in a reduction in biotic potential of the target population. The mating of released sterile insects with indigenous fertile insects causes infertility in the remnant population. The insects for release are propagated at large scale rearing facilities.

Implementation of STEP commenced in 1997/98 with entomological and parasitological baseline studies at first, followed by environmental study of the area was carried out later on. The socio-economic survey of the whole project area, long overdue is currently underway. Tsetse and trypanosomiasis control and monitoring have been going on since 2000/ 2001 in an initial area of 5100km^2 (Block 1) using traps, insecticide impregnated targets, pour-on insecticide applications and the use of trypanocidal drugs (ESTC, 2004).

Figure 1: Southern Tsetse Eradication Project Area



The recently carried out Mid-term Review of the project has reported that though formal quantitative impact assessment has not been carried out due to the absence of socio-economic baseline data, some qualitative impacts of the project such as improvement in the body condition of cattle, increase in milk and meat production, improvement in work performance and decrease in frequency of treatment of animals with trypanocidal drugs are already observable. On the other hand, it was reported that significant land use change has already occurred in the areas where suppression has been taking place. For example, along the roadsides from Humbo to Merab-Abaya, there are new settlements and clearing of bushes and trees for new cropland taking place. Likewise, in the Deme Valley and Eastern part of Lake Abaya in Gelana Woreda there are newly selected resettlement sites in the framework of the food security program of the Federal Government (ESTC, 2004).

In relation to this, the envisaged study is considered important and timely to substantiate the reported changes as well as assess the impacts of the control activity.

1.3 Objective of the study

In Ethiopia, regular agricultural extension and field service programs have been going on since late 1960s. A number of developmental and service projects financed by various multilateral and bilateral creditors, donors and countries as well as by the Ethiopian government it self were implemented. However, after such a long time of intervention and huge expenditure, the agriculture sector of the country in general is still subsistence type, employing backward technology and its performance during the last decades was dismal. According to MOFED (2002), the average annual growth of agricultural value added during the periods 1980/81 to1991/92 and 1992/93 to 2001/02 was –0.43% and 0.2% respectively as opposed to the average annual population growth of 2.89% in 2001/02. Lack of appropriate sectoral policies and strategies, improper project design, poor coordination of effort, lack of continuity and the general problems of insufficient trained manpower and weak implementation capacity are known to be some of the major causes. In addition to these, project monitoring and evaluation in the country is in generally weak while project impact assessment almost non-existent.

In this regard, the general objective of this study is to further expand the use of remote sensing and GIS techniques in the country, especially in the area of project planning, monitoring, evaluation and impact assessment in the agriculture sector. Hence, this research work aims to apply Remote Sensing and GIS techniques for project impact assessment taking the Southern Tsetse Eradication Project (STEP) in Humbo Woreda (SNNPR) as a case study.

Impact of the tsetse control intervention by STEP on crop and livestock production in the area would be evaluated. As the project is a 10 years project and currently, it is in its initial stage of tsetse suppression, this impact assessment is not final one, rather it is meant for assessment of impact so far accrued as the result of the tsetse control activity in the area.

1.4 Research questions

The research work will try to investigate and give answers for the following key questions pertaining to the objective:

- o Is there any change in the fly density in the area?
- o Is there any change in the prevalence of trypanosomiasis in the area?
- o Is there any change in the number of livestock and specifically oxen number?
- o Is there any change in oxen holding and method of cultivation in the area?
- o Is there any change in oxen output in the area?
- o Is there any change in the size of cultivated land in the area?
- o Is there any correlation between oxen holding and size of cultivated land?
- o Is there any change in crop production?
- o Did the project make any impact on the agriculture in the area?
- o Is there any significant change in land use/ land cover of the area?

1.5 Materials and methods

Main sources of data for the study are satellite imageries, agricultural sample survey and secondary data. The spatial database was created using Microsoft Access 2003, Microsoft Excel, CartaLinx, ENVI 3.5, ARCGIS 8.2 and ArcView GIS 3.2 softwares.

1.5.1 Satellite image processing

Landsat 7 Enhanced Thematic Mapper (ETM^+) image (14, February 2001 covering the study area has been used for study especially for land use/ cover mapping and the preliminary change analysis. Appropriate image preprocessing and processing stages of geometric rectification and image enhancement that are discussed in Lillesand, T.M. et al,(2000) and described below have been applied on the image prior to interpretation.

Rectification: Raw digital images usually contain geometric distortions so significant that they can not be used directly as a map base without subsequent processing (Lillesand, T.M. et al, 2000). The images were rectified to Universal Transverse Mercator (UTM) projection with a pixel resolution of 15 meters using first-degree polynomial with bilinear interpolation method. Initially band 8 of the Landsat ETM^+ image was georeferenced with ENVI 3.5 Software using as a base the 1:50,00 scale topographic map of the area that was produced by the Ethiopian Mapping Agency in 1979 and then the other bands were georeferenced using the georeferenced band 8 image as a abase map. In the rectification procedure, well distributed ground control points 24 in number that occur in the image were analyzed against their counterparts on the base map. The root mean square was less than 0.5.

Radiometric Correction: Scattered path radiance which normally causes greater scattering effects on shorter wavelengths, introduces haze and reduce image contrast. To reduce its impact, dark subtraction was done as haze compensation procedure.

Enhancement: Image enhancement procedures are applied to image data in order to more effectively display or record data for subsequent visual interpretation. They normally involve techniques for increasing the visual distinctions between features in a scene. Both images were resized to the dimension of the study area and were linearly stretched.

Image processing: Different image processing methods such as true and various false color composites, band ratios, Principal Component Analysis (PCA) and Normalized Difference Vegetation Index (NDVI) were tried to come up with best images that are convenient for land use/ land cover classification and change analysis.

Image classification: Broad classification of different types of land use/ cover types of the area for the for year 2001 was done by visual interpretation/ classification of the image basically using discernible texture and patterns of the different classes on the image and relevant ground information gathered through extensive field visit of the area. In both cases, the boundaries of the different classes were screen digitized using the facilities in ArcView GIS 3.2 software.

Digital Elevation Model: The elevation contour of the study area at 20 meters interval has been screen digitized from the scanned 1:50,000 scale topographic map of the area with facility in ARCGIS 8.2 software and Digital Elevation Model (DEM) of the area was generated for display purpose.

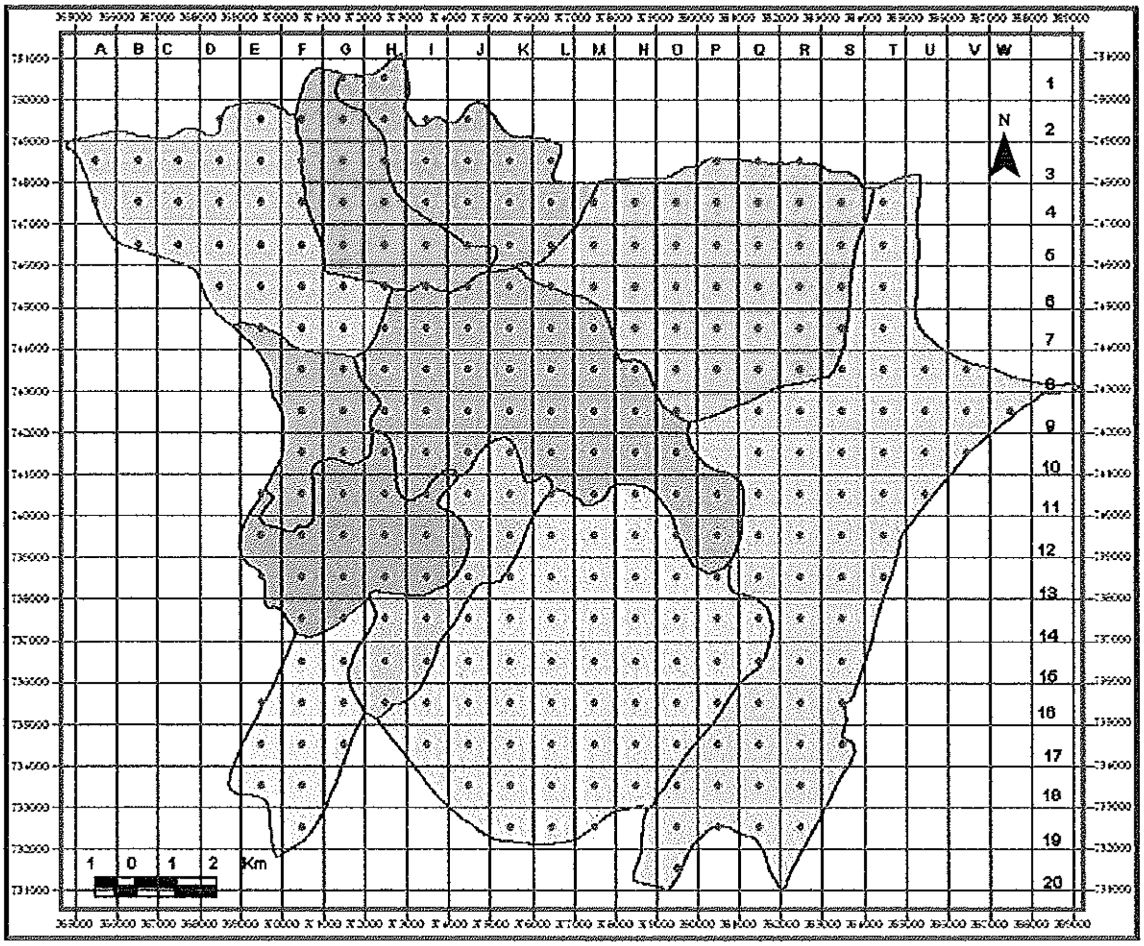
1.5.2 Agricultural Sample Survey

Survey method

An agricultural sample survey was conducted in the 11 peasant associations found in the study area using a structured questionnaire that has been developed for this purpose (Annex 1). The questionnaire has 4 major parts: household characteristics, agricultural data, tsetse fly and trypanosomiasis as well as environmental related questions, regarding the before and after project situations. For easy and accurate data collection purpose the questionnaire was fully translated into Amharic language. One day training was conducted to familiarize enumerators with the questionnaire and train them with GPS operation, while close field supervision and guidance in the survey process was done to collect, as much as possible, accurate data.

Stratified systematic sampling technique in which the study area was divided into equal grids of 1km by 1km and one observation is placed in each cell was employed to maintain the spatial distribution of the samples over the study area (Campbell J.B., 1996). A 1:50 000 scale map of Humbo Woreda with peasant associations boundaries, which was prepared by the Cartographic Section of the Central Statistics Authority (CSA), in October 1997.E.C. for population census purpose, was rectified against 1:50,000 topographic map of the area by taking 6 ground control points and table digitized using CARTALINX software to prepare the enumeration grid maps. The data was collected from a total of 273 grids. (Fig 2) For this purpose each of the enumerators were provided with map of their respective enumeration area, list and identification numbers of enumeration grids, UTM central point locations of grids and a pocket calculator. Besides they were given Garmin 12 Geographical Positioning System (GPS) equipment to locate themselves in each grid and georeference the observation points (household). In fully habited areas, the data was collected as much as possible from a household that is found at or closer to the center of the grid while, in sparsely habited areas or non-settlement areas, where there are no houses at the center of the grid, data was collected simply from households available in the grid for the sake of representation of the grid. As the study is also interested in change in the settlement situation, information was also collected from areas without settlement.

Figure 2: Enumeration grids of the study area



Analysis of survey data

Relational database comprising more than 40 main and associated lookup tables has been created in Microsoft Access 2003 software and the collected data was entered in the database after proper cleaning and consistency check. Statistical comparison of with and without project situation of various parameters was made. These include size of cultivated land, amount of crop production, method of cultivation, number of livestock, oxen out put, situation of tsetse infestation and trypanosomiasis prevalence and environmental situations in the area, etc... The comparison was done by making use of the lucid query and statistical facilities of Microsoft Access 2003, Microsoft Excel 2003 and SPSS software. The observations and changes in the above parameters were spatially manipulated by creating a spatial database in Arcview 3.2 software and using spatial analyst facilities such as grid interpolation, proximity analysis, density calculation, map query. The output is presented using Arcview 3.2 layout facilities.

1.6 Limitations of the study

- The STEP had undertaken Entomological and Parasitological baseline survey at the commencement of the project i.e. during 1998/ 99 and the complementary socio-economic baseline data was not done at the time. However, the project has undertaken a socio-economic survey very recently, during 2003/04, and data input and analysis is currently underway. As a result, it was not possible to get concrete and documented socio-economic and agricultural data for the area for the pre-project period.

- The fact that the current study, is basically relying on farmers' recall for its analysis i.e., based on the responses of farmers given to the questions posed in the questionnaire for the indicated period and that no physical measurement and sampling was taken regarding size of cultivated land as well as crop and livestock production, might reduce to some extent the accuracy of data.

- Despite the cooperation of the Ethiopian Science and Technology Commission and the willingness and generosity of the International Atomic Energy Agency to procure and avail recent satellite image of the study area, due to the encountered delay in the procurement process, it was not possible to acquire the item in time for the intended land use/ cover change analysis. Hence it was not possible to compliment the agriculture sample survey with supporting information from remote sensing data.

Despite these limitations, this study is a useful addition to application of GIS techniques in project assessment in general and specifically for STEP impact assessment.

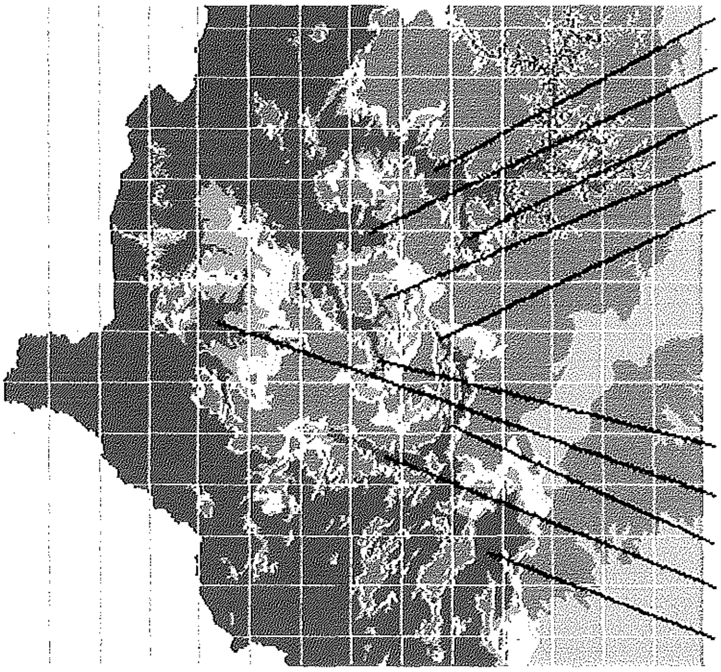
CHAPTER 2 - LITERATURE REVIEW

2.1 Tsetse and trypanosomiasis problem in Ethiopia

Five species of tsetse namely Glossina longipennis, G. morsitans submorsitans, G. pallidipes, G. fuscipes fuscipes and G. tachinoides, are found in Ethiopia and they are confined to southern and southwestern low lands of the country (Langridge, 1976). (Figure 3).Tsetse-transmitted trypanosomiasis is one of the most significant and economically important animal diseases in the fertile lowlands of Ethiopia. Estimates showed that a total of about 10 million cattle are under threat by tsetse and trypanosomiasis and the livelihood of some 5 million people is directly or indirectly negatively affected by tsetse fly and trypanosomiasis (GFDRE, 1997). Unlike many other African countries, human sleeping sickness in Ethiopia is rare and confined to date to a very limited locality in the southwest, particularly in Gambella region and its vicinity. Different authors, Baker et al., 1970; Mc Connel et al., 1970; and Hutchinson, 1971 have documented that an outbreak of sleeping sickness had occurred in the Gambella region of southwestern Ethiopia in the late sixties and early seventies and that it has subsided and few new cases have been reported. According to Langridge, 1976, earlier outbreaks of sleeping sickness are suspected amongst the Mursi people in the lower Omo.

Various authors estimated differently the potential area of tsetse infestation in the country. A total area of 66,000 km^2, based on a 1,500m breeding limit (Ford et al., 1976); 97,855km^2 based on 1,600m breeding limit (Langridge, 1976); and between 135,000 – 220,000km2 based on maximum dispersals up to 1,700m and 2,000m. (Slingenbergh, 1992a&b) are some to mention. The great majority of the livestock live in the highlands or semi-arid eastern lowlands. Tsetse infests much of the land below 1600-1700m (fig. 3) in west and southwestern Ethiopia amounting to some 10% of the country (David et al., 2001) About six million of the 44 million cattle that are exposed to cattle trypanosomiasis in Africa are found in these areas (Slingenbergh, 1992).

Figure 3: Tsetse infested areas of Ethiopia



Source: Derived from Erkelens *et al.* (2000)

In addition to preventing livestock farming in these areas, trypanosomiasis is a direct problem in the uplands where an increasing number of livestock are being forced into contact with tsetse flies. With the gradual saturation of the non-infested highlands, pressures on the tsetse-infested resources have increased steadily, as has the intensity of contact between the fly and animals. While livestock is pushed into contact with the tsetse, distribution of the fly itself is also dynamic, and farming areas at higher altitudes are being progressively invaded by tsetse flies (Slingenbergh, J. 1992b)

The direct impacts of trypanosomiasis incidence include morbidity, mortality, lower work efficiency and huge costs of treatment of diseased animals. The indirect impacts of it include changes in human settlement, crop production and land use that occur due to the reduced output of existing animals (Swallow, 1997). The impacts of tsetse/ trypanosomiasis control therefore must be assessed in terms of decreases in livestock mortality and morbidity; increases in farmers' abilities to hold livestock of different breeds; increases in the use of animal draft power where appropriate; and effects on crop productivity of expansion and intensification of cultivation (Steven et al.,1999). In addition to this, control of tsetse and trypanosomiasis, has also other indirect benefits of better nutrient cycling of waste crop residues, better soil fertility through an increased supply of manure and increased capability to transportation of heavy materials and hence link with the market (DFID, 2001).

2.2 Tsetse and trypanosomiasis control impact

2.2.1 livestock health and productivity

Trypanosomiasis makes infected animals anaemic and the effectiveness of their immune system reduced. It severely affects the productivity of cattle and if untreated is often fatal. The disease affects productivity by reducing production in terms of milk yield, live weight gain and work output. It also affects fertility, causes abortions and stillbirths and delay sexual maturity (Budd L., 1999).

In Ethiopia, in tsetse-infested areas, trypanosomiasis is one of the most significant and costly diseases causing livestock death and production losses. It is the livestock disease most feared by the local animal rearing communities. In the Southern Rift Valley of Ethiopia, for example tsetse-borne trypanosomiasis has been the major reason that the 25000 km2 of agriculturally suitable land remains under utilized. It was reported that in STEP area, in the early 90s about 50% of all cattle mortalities were attributable to tsetse-borne trypanosomiasis and up to 90 % of veterinary drug expenditure of the area was on trypanocidal drugs (GFDRE, 1997).

The DFID funded study on economic analysis of DFID-funded tsetse and trypanosomiasis research programme has used in its analysis a conservative estimate of a 20 percent loss of cattle productivity in terms of meat and milk production to determine the probable forgone benefit at African level. Accordingly, the cattle herd in tsetse-infested areas of Africa are overall producing 20 % less milk and meat compared with herds in tsetse/ trypanosomiasis free areas and the potential herd size in these areas is only half the size it could be if the disease were not present (Budd L., 1999).

FAO as cited by Slingenbergh, J. (1992b), revealed that dramatic change on the farming and other land-use systems has taken place in Chelo area in Didessa river system in western Ethiopia following the invasion of the area by G. morsitans submorsitans during the 1970s. The detailed assessment of the effect of tsetse advances on livestock and crop production in the area showed that by 1986 the farmers had lost 80 percent of their livestock and 60 percent of the cattle were positive for trypanosomiasis. The disease had affected each and every household. Equines appeared most susceptible and had died first, followed by cattle. Small ruminants were also disposed of as farmers tried to replace their draught oxen by selling whatever stock remained. The average cereal production per household, which was 1.6 ha with the use of 2.2 oxen before the fly invasion declined to 0.7 ha per family, using 0.8 oxen. Moreover, the shift in the crop mix from high-value teff to maize had taken place with production of the latter often based on hand cultivation and increased reliance of households on the homestead garden for food supplies.

Assessment of the result of a 3 years pilot tsetse control programme, sponsored by a British NGO, Farm Africa in Konso area of southern Ethiopia has also documented the impact that trypanosomiasis had on livestock development. (Table2.1).The assessment refers only to a transition period of a year i.e. from mid 1994 to November 1995 and showed that significant improvements in livestock mortality and output were achieved with such short period of time.

Table 2.1: Comparison of before and with project livestock situation, Konso Tsetse Control Programme

PARAMETER	BEFORE PROJECT	WITH PROJECT	CHANGE IN %
Cattle mortality due to trypanosomiasis	16%	4.82%	30.1
Calf mortality	58%	0%	100
Abortion	20%	0%	100
Area ploughed per day by a team of oxen	2.86 pe-ota	4.99 pe-ota*	74
Work days per oxen per week	2.3	6.8	195
Value per ox	367	800	118
Milk yield per day	606ml	1180ml	94.7

* Land area measurement

Source: Extracted/ modified from Gemechu G. et al. (1997).

Similar project impact assessment made by ILRI scientists in Ghibe Valley of Ethiopia showed that significant improvement in animal health and condition has been achieved following a 6 year tsetse control activity (Steven et al., 1999). (Table 2.2).

Table 2.2: Impacts of Tsetse/ Trypanosomiasis Control in Ghibe Valley

Parameter	Change/ Improvement
Reduction in Apparent fly density	95 %
Reduction in Trypanosomiasis prevalence in cattle	Over 61 %
Reduction in treatment frequency (cattle)	50 %
Increase in calf growth	20 %
Reduction in calf mortality and abortion	57 %
Increase in cow body weight	4 %
Increase in adult male body weight	8 %
Increase in number of animals	1200 %

Source: Extracted from Steven et al. (Steven et al., 1999).

2.2.2 Draught power and crop production

In Ethiopia, draught power has been widely used for many generations, up to 98 % of primary cultivation being carried out by oxen power (Morton and Sutton 1999). Several studies showed that farming families using draught animals were able to cultivate more land, diversify their crops and feed more people other than themselves when compared to families depending only on hand tools for land cultivation (Budd L., 1999; Morton and Sutton, 1999). According to Temesgen (1994), there is positive association between number of oxen and size of cultivated land in the highlands of Ethiopia and shortages of oxen result in delayed seedbed preparation and planting while its adequacy enables farmers to grow a more profitable mixture of crops. A study in the highlands of Ethiopia showed that farmers with more oxen allotted more land to the production of cereals which have a high market value but requiring more cultivation and timely seed bed preparation while in contrast the proportion of land allotted to pulses that need relatively little cultivation are high among farmers with shortage of oxen power (Getachew 1993).

A comparison of average livestock holding in tsetse control and no tsetse control areas in Ghibe valley of Ethiopia clearly shows the impact of the problem, as the average adult livestock holding in these areas was about 3.72 and 5.53 respectively (Swallow B., 1997). Thus the opportunity to use draught animals alone has great potential to move families from a subsistence existence into the cash economy and thereby creates wealth, which will enable them to benefit from a better standard of living (Budd L., 1999). Thus as trypanosomiasis is denying draught power input for crop production, it is an important constraint to the mixed crop-livestock production system in the country especially in those areas infested with tsetse fly and where animals are in closer contact with the fly.

Table 2.3: Effects of oxen ownership on area and cropping pattern at Debre Zeit

Oxen holding	Crop area/ farm (ha)	Area to cereals (%)	Area to pulses (%)
None	1.2	54	46
One	1.9	44	56
Two	2.7	67	33
Three or more	3.6	92	8

Source: Getachew ., 1993

2.2.3 Environment

Control of tsetse and trypanosomiasis could increase the opportunities and income of the poorest of the poor, thus allowing them to be less reliant on marginal lands and better able to adopt new agricultural technology and resource use practices that will help conserve the natural resource base. As better resource management and use will feedback positively on longer-term human welfare, unsustainable use of natural resources such as overgrazing, uncontrolled hunting, soil erosion and cropping on marginal land, alternatively may decrease human welfare when livestock and crop production begin to decline, ecosystem structure shifts to a less productive state, and options for future use are further limited (Steven et al, 1999)

Tsetse removal could have agro-ecological implications. According to Reid et al, 2000, it is feared that the control of tsetse/ trypanosomiasis will release a pent-up demand for land in Africa's tsetse free areas and cause large-scale agricultural conversion as people and livestock flood into areas as they become free of the fly. Demands on natural resources often deplete those resources, and, especially when not managed well, disturb the local ecosystems, causing general land degradation (MOFED, 2002).

The valley floor of the Southern Rift Valley supports only low cattle densities in most area with higher densities only found along the west side of Lake Abaya. In contrast, the adjacent highland areas have very high cattle and human populations, It is expected that the removal of tsetse from the valley floor will quickly lead to a shift of population from the highland areas in to the valley as has been observed in other areas. Though this could improve the situation in the highlands by reducing pressure there, there will be a risk of over utilization of the valley floor leading to degradation. (ESTS, 1999-2000)

Few studies of environmental change and trypanosomiasis control have been undertaken in Ethiopia. Accounts on changes in land use and land cover changes in Southwestern part of Ethiopia in Angar Valley by David Bourn (2001) and the other study by the International Livestock Research Institute (Reid et al., 2000) in the Ghibe valley, covering the periods from 1957 to 2000 and from1957 to 1993 respectively are some (Bourn et al., 2001).

According to the International Livestock Research Institute (ILRI) study on the impact of tsetse control on land use and land cover in the Ghibe valley of Ethiopia, half of the farmers in the Gullele tsetse control area have revealed that the control intervention has attracted migrants to settle in the area, causing further agricultural expansion while three-quarters of the farmers clearly recognized that within three years of tsetse control (1991-1994), land clearing and excessive wood harvesting in the area has resulted in the loss of tree cover (and fuel wood availability). During this time, many also described a near complete loss of large mammal populations, once abundant in the early 1980s. However, half the farmers said that this decline was caused by the military conflict the country had during that period; the other half recognized that expansion of cropland was the cause (Bourn et al., 2001).

2.3 Economic implication of the problem

A recent economic analysis of the tsetse trypanosomiasis research programme of DFID, estimated that Africa is losing annually agricultural production of both livestock and crop worth USD4.5 billion due to tsetse and trypanosomiasis problem (Budd L., 1999). In Ethiopia, similar estimate shows some USD236 million annual losses to the national economy in terms of mortality and morbidity losses in livestock, denied access to land resources for crop and livestock production, and in controlling the disease (FDRE, 1997).

An assessment carried out by ILRI scientists on impact of tsetse and trypanosomiasis control in Ghibe valley showed that major economic benefits have been accrued both to individual farmers and to the region as a whole. The availability of more draft animals in the area has resulted in significant increases in cropped areas, with each additional ox owned translating into between 0.6 and 0.9 hectares more of cultivated land (Swallow, 1997; Swallow et al., 1998). Expenditures on trypanocidal drugs fell by US$39,000 between 1995 and 1997, which more than offset the US$16,000 cost of the pour-on (chemical used for control of tsetse fly). The additional benefits of increased output of meat (40 percent) and milk (30 percent) equaled US$146,000. This implied a benefit/cost ratio of 11.6 over two years and 9.3 projected over 10 years, and increases in annual household income of between 10 and 34 percent (Mulatu et al., 1999).

2.4 Land use/ land cover mapping

Knowledge of land use and land cover is important for many planning and management activities and is considered as essential element for modeling and understanding the earth as a system There is increasing recognition that sensible use of scarce resources requires comprehensive planning as uncoordinated and unplanned actions can lead into inefficient and undesirable environmental, social, and economic conditions. Land use information is an important element in forming policies regarding economic, demographic and environmental issues (Cambell, J.B., 1996).

The term land cover relates to the type of feature present on the surface of the earth while land use refers to the human activity or economic function associated with specific piece of land (Lillesand, T.M. et al, 2000). Land cover describes the organic cover on top of the inorganic base, and includes the inorganic base where there is no land cover. Land cover therefore, ranges from forest to agricultural land to grassland to bare soil. It includes both the natural land cover, and that produced by man. The latter is more restrictively defined as land use (King, B., 1999).

In land use/ cover mapping, it is important to use classification systems that are compatible with others that have been used in the past or are used for neighboring areas so that temporal and spatial comparison is possible (Cambell, J.B., 1996). The

United States Geological Survey (USGS) devised land use and land cover classification system meant for use with remote sensor has a hierarchical structure that lends itself for use with other images of differing scales and resolution and it is the most widely used system (Cambell,J.B., 1996; Lillesand, T.M. et al, 2000).

Remotely sensed imaged lend themselves to accurate land cover and land use mapping in part because land cover information can be interpreted more or less directly from evidence visible of the images. Preparation of a land use/ cover map from remote sensing data is in essence a process of segmenting the image into a mosaic of parcels, with each parcel assigned to a land use class (Cambell,J.B., 1996). Multispectral data are normally used in image classification and the spectral pattern present within the data for each pixel is used as the numerical basis for categorization since different feature types manifest different combinations of DNs based on their inherent spectral reflectance and emittance properties (Lillesand, T.M. et al, 2000).

Individual land cover categories are formed from collections of diverse objects, features, and structures that are often not individually resolved on the image. Therefore, in manual interpretation of image, the interpreter's task is not so much one of identifying separate objects as it is the accurate delineation of regions of relatively uniform composition and appearance (Cambell, J.B., 1996). With manual image interpretation, elements of image interpretation such as shape, size, pattern, tone, texture, shadows, site, association and resolution are used to identify different classes (Olson, 1960).

Land use patterns change over time in response to economic, social, and environmental forces (Cambell, J.B., 1996). Study of such land use changes permits identification of long-term trends in time and space and the formation of policy in anticipation of the problems that accompany changes in land use (Esters & Senger, 1972; Anderson, 1977; Jensen & Toll, 1982).

2.5 Application of Geographic Information Systems (GIS)

GISs are specialized computer- based data systems that can deal with virtually any type of information about features that can be referenced by geographical locations. Digital computers provides the basis for storage, manipulation and display of large amount of both locational and attribute data of these features that have been encoded in digital format (Lillesand, T.M. et al, 2000; Cambell,J.B., 1996).

A commonly accepted definition of Geographic Information system (GIS) is "a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth" (Dueker and Kjerne, 1989).

GISs not only do permit automated mapping or display of the locations of features, but also these systems provide a capability for recording and analyzing descriptive characteristics about the features. For example, a GIS might contain not only a map of the locations of roads but also a database of descriptors about each road. These attributes might include information such as road width, pavement type, speed limit, number of traffic lanes, date of construction, and so on (Lillesand, T.M. et al, 2000)

Much of the power of a GIS comes from the database management system (DBMS) that is designed to store and manipulate these attribute data. Many GISs employ a relational database, consisting of tables or relations and query facilities to interact with the DBMS and search information. One of the most important advantages of a GIS is its ability to spatially interrelate multiple types of information stemming from a range of sources, an exercise commonly referred as overlay analysis. For example information about topography, soils, land cover, geology etc... about a specific area can be analyzed by using georeferenced data from respective source maps that have been geocoded on cell by cell bases to form a series of land data files or layers (Lillesand, T.M. et al, 2000).

Geographic Information System (GIS) can be applied to create, archive and analyze traditional map data on epidemiology of diseases and to combine these with global environmental data derived from sensors on board earth-observing satellites. using a new generation of commercially available digital geographic databases and hand held geographic positioning systems (GPS) precise point location and maps can be created for disease applications (Getachew et al, 2004).

The analysis of data from high spatial resolution satellite sensors has potential in land cover monitoring. The use of Geographic Information System allows further spatial analysis of the data derived from remotely sensed images and analysis of land cover changes on regional sustainable development (Chen Xiuwan, 2002). Remote sensing data within Geographical Information System (GIS) offers an alternative approach to conventional methods of field survey and can provide an effective means for establishing the rate and extent of land use change (Jt Al-Bakri et al, 2001).

In studying the consequences of tsetse control on land use and natural vegetation, remotely sensed data has proved useful in identifying land cover and quantifying change in an area where there is little information from other sources. (Mills, A. and J. Pender, 1996). The first application of using satellite-derived imagery in relation to tsetse was to monitor the changes that had occurred in land use after tsetse control programs in Zimbabwe and linking this into socioeconomic studies. Soon afterwards, the ability to use such data in order to predict the distribution of a range of tsetse was recognized and a series of projects used remotely sensed satellite data linked with ground-based data for verification purposes in order to provide a series of layers. Such data layers, used in combinations could not only predict the distribution of fly species but also predict the consequences of removing the tsetse fly population on cropping, livestock numbers and even the environment in terms of ground cover (DFID, 2002). Similar geographic information system forecast and risk assessment model for tsetse transmitted trypanosomiasis in Ethiopia was developed by integrating crop production system zones, Normalized Difference Vegetation Index (NDVI) and maximum temperature. (Getachew et al, 2004).

The application of advanced survey and monitoring tools, including remote sensing and GIS- based data storage and interpretation, will in general, permit more appropriate situation assessment and facilitate the development of strategies that ensure an environmentally sound and responsible utilization of natural resources(Steven et al, 1999).

CHAPTER 3- GENERAL DESCRIPTION OF THE STUDY AREA

3.1 Location and Agro- ecology

3.1.1 Location

The study area is found in the southern portion of the main rift valley that is bisecting the country running from the Denakil depression (120m below the Red Sea level) in the northeast, to Lake Turkana in the Southwest. It is found in the South Nations Nationalities Peoples Region, in Humbo Woreda of the Wolaita Zone situated at about 400 kms South of Addis Ababa and at about 20 kms from Soddo town (figure 3). The study area covers an area of about 270.41km^2 and it lies between 6^0 36' and 6^0 47'N Latitudes and 37^0 46' and 37^0 59' E Longitudes (364765-389,143 East and 730,996-751,124 North-UTM). Eleven of the 34 peasant associations in Humbo Woreda that are found in the north eastern part and to the north of Lake Abaya are included in the study (table 3.1).

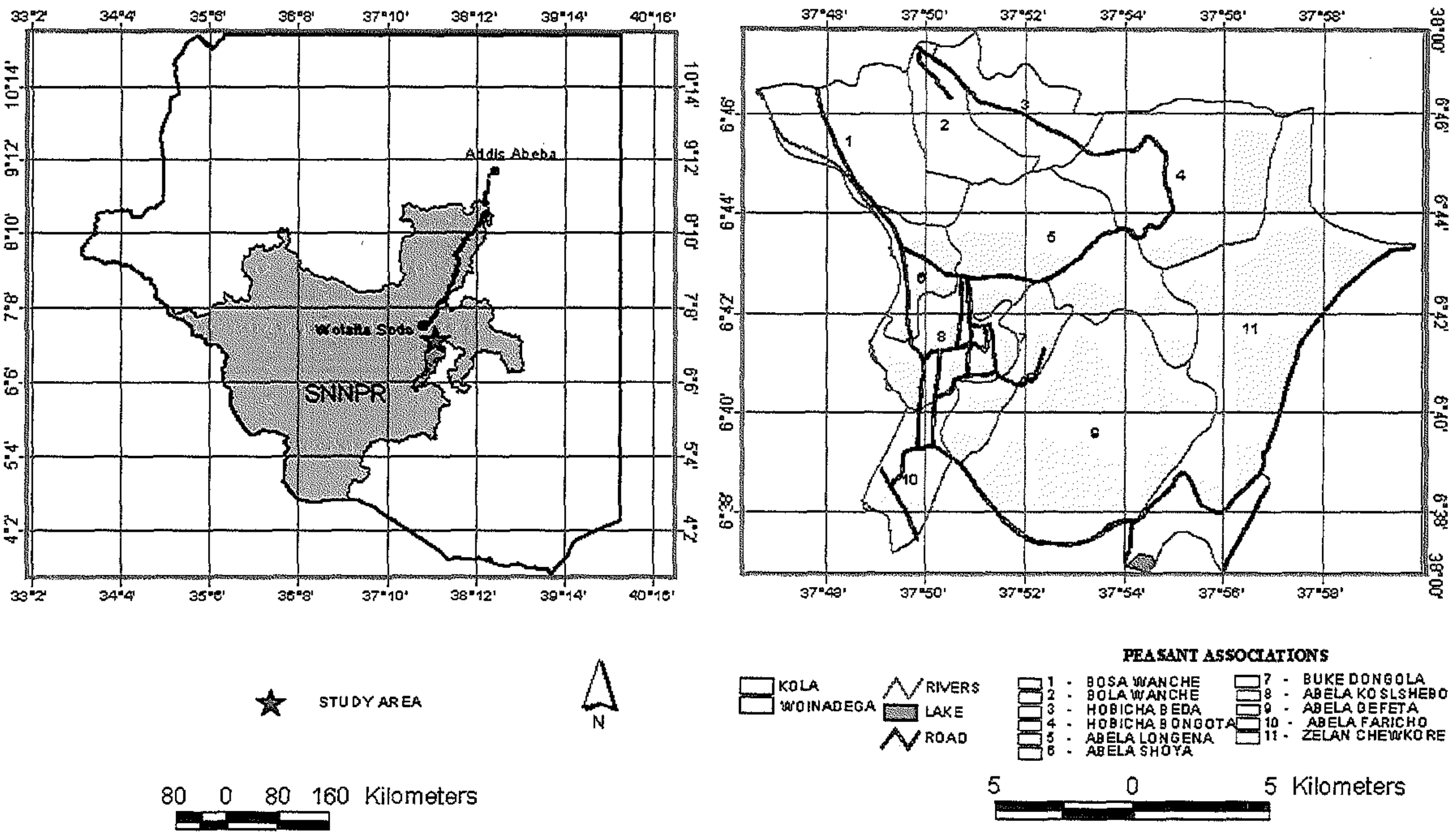
Table 3.1: Peasant Associations Covered by the Study

	PEASANT ASSOCIATION	AREA (HA)	HUMAN POPULATION	CATTLE POPULATION
1	Abela Faricho	1064.919	3,984	1,525
2	Abela Gefeta	4966.759	3,285	1,530
3	Abela Longena	3408.202	6,200	2,039
4	Abela Shoya	812.358	2,320	925
5	Abela kolshebo	1469.455	1350	1052
6	Hobicha Beda	1406.359	8,753	2,950
7	Hobicha Bongota	3474.494	10,045	2,812
8	Bola Wanche	1205.783	2,280	427
9	Bosa Wanche	2450.967	5,798	1,784
10	Zelan Chewkore	13980.842 (5730.84)*	6,157	17,000
11	Buke Dongola	1051.798	3,400	1800
	Total	35291.94	52222	33,844

** Partly covered by the study*

Source: calculated and compiled from Humbo ARDB and STEP records

Figure 4: Humbo study Area with peasant associations



3.1.2 Agro- ecology

Most of the study area is found in the "Hot to Warm Sub-Moist Lakes and Rift Valleys" Agro Ecological Sub-Zone. According to the Ministry of Agriculture, this sub-zone, is identified around Humbo (SNNP) comprising an area of about 308,000 ha and its physiographic unit is described as lakes and rift valleys with an altitude range of 1000-1600m above mean sea level (MOA, September 2000). Altitude in the specific study area ranges between 1180 and 2060 masl.

In this study, for analysis purpose, the traditional agro ecologic classification method commonly employed in Ethiopia was adopted. Accordingly, areas below 1500 masl were categorized as kola (lowland) and above 1500 masl as Woinadega (mid altitude). Kola areas account for about 69.62% of the study area while the woinadega areas for 30.38 percent.

3.1.3 Climate

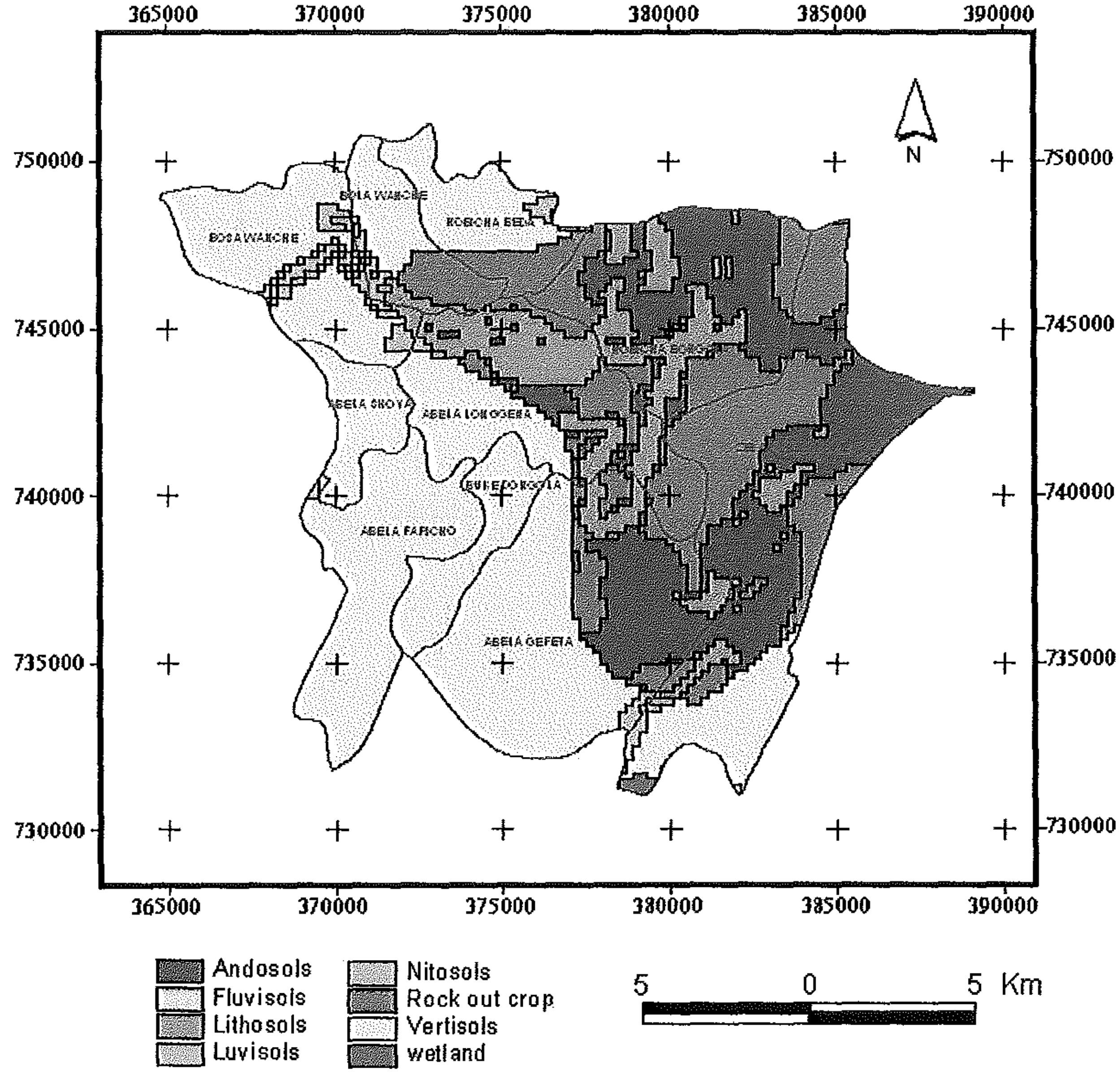
The agro ecologic sub-zone that the study area is found is generally characterized by scanty rainfall ranging from 400-800mm that can not satisfy the potential evapotranspiration demand of 1400-1700mm. This result in a shorter growing period of 61-120 days and as a result the climate is not so favorable for surplus crop production (MOA, 2002). The average annual temperature in the sub-zone ranges from 21 to 27.5^{o}c. According to the local meteorological station in the area, the average annual rainfall in the specific study area is about 854mm while the average annual temperature is 31.59 ^{o}c

3.1.4 Soils

Soil units that dominantly occur in the sub-zone are Orthic Acrisol and Eutric Nitosols. These types of soils, more specifically the Acrisols are less productive soils and better left for plantation. Other soils that exist in this unit are Lithosols), Mollic Andosols, Dystric Nitosols and Eutric Regosols. This sub-zone with its stony, shallow and degraded soils better left for forestry and wild life. In addition the area is not suitable for settlement because of malaria and other diseases (MOA, 2002).

According to Woody Biomass Inventory and Strategic Plan Project of the Ministry of Agriculture and Rural Development, the major soil classes present in the study area include Lithosols, Vertisols and Andisols while there is also rock outcrop and rubble lands (WBISPP, 1997).

Figure 5: soil classes in the study area



<u>Source</u>: Extracted from WBISPP, (1997)

3.1.5 Land use/ land cover

The land use/ cover consists of cultivations, shrub and bush, woodland, wet land and settlements. In the sub-agroeclolgic zone, different tree species are found in the sub agro ecologic zone. Eucalyptus, different types of acacia species, moringa (locally known as shiferaw) and different types bush and scrub vegetations are present in the study area. Annual crops such as maize, sorghum, tuber and cotton are common, while coffee, mango, morinaga (shiferaw), false banana and eucalyptus are the dominant perennials. According to the local people of the area, wildlife such as, lions, different species of bush buck, baboon, porcupine and different snake and pythons, are found especially in thickets. Amessa River crossing Bosa Wanche, Abela Longena, Buke Dongola and Abela Faricho peasant associations, serve as water source for livestock as well as for irrigation by few numbers of households. The wetland in Zelan Chewkore peasant association just at the tip of Lake Abaya serves as a good grazing land especially for the pastoralists in the area and also a source of feed for livestock in neighboring areas.

3.2 Socio-economic characteristics

According to the Central Statistics Authority population and housing census of 1994, the human population of Humbo woreda during 1994 was about 96,642 with 97.1 percent of them leaving in rural areas (CSA, 1996). The estimated human population in the peasant associations included in this study, based on the records of Agriculture and Rural Development Bureau of Humbo woreda is about 52,222, while the livestock (cattle) population according to STEP office is about 32,792 heads (Table 3.2). The dominating farming system in the area is subsistence type mixed crop livestock production system while in the western and southwestern part of the study area, there are semi sedentary pastoralists communities of Sidama ethnic group who are raising relatively large number of cattle. Cattle, sheep, goats and donkeys are livestock raised in the area.

The woreda is one of those drought prone areas in the region with relatively large number of households receiving food aid and safety net assistance. According to the

Agriculture and Rural Development Bureau of the woreda, about 32,000 households are chronically food insecure and receiving food aid for the past five years and about 18,000 households with acute food insecurity, receiving temporary food aid are found. The chronically food insecure households are the very poor ones who could not afford to use agricultural inputs and are normally found in areas where there is shortage of cultivated land, the soil is infertile and agriculture is fully dependent on rain. Effort is being exerted by the regional state and the federal government to resettle these households to other agriculturally potential areas in and outside of the region.

3.3 Tsetse and trypanosomiasis situation

The study area is found in the southern rift valley system, which is one of the tsetse infested areas in the country. As described under 3.1 the altitude as well as the climate and vegetation condition of the area is conducive for tsetse breeding. Other biting flies such as Stomoxys and Tabaniids, which are nuisance to both humans and livestock, are also found in the area (STEP, 2005). Tsetse transmitted animal trypanosomiasis is one of the deadly diseases in the area. The common tsetse fly species found in the area is Glossina pallidipes, while Trypanosoma vivax and T. congolence are the common parasites. The study area is found in the northern part of the 25000 km^2 area of STEP and it is part of the first block (5100 km^2) operation area where tsetse control activity has been going on for the past 3 to 4 years.

3.4 Study population and characteristics

Sample characteristics

Stratified systematic sampling technique in which the study area was divided into equal grids of 1km by 1km and one observation is placed in each cell was employed in the study. Accordingly, a total of 273 observations 64% of which in kola and the balance in woinadega areas were made. Hand held Garmin 12 GPS equipment was used to identify and locate grids and respective sample point at the center of each grid and to geocode the sampled households for due GIS analysis.

Table 3.2: Distribution of samples by Agro-ecology

Peasant Ass.	Kola	Woinadega	Total
A. FARICHO	12	-	12
A. GEFETA	49	-	49
A. KOLSHOBO	13	-	13
A. LONGENA	24	12	36
A. SHOYA	7	1	8
BOLA WANCHE	-	13	13
BOSA WANCHE	-	26	26
BUKE DONGOLA	15	-	15
H. BEDA	-	13	13
H. BONGOTA	2	33	35
Z. CHEWKORE	53	-	53
Total	175	98	273

Population characteristics

Out of the 273 observations 61.5% are in settlement areas while the remaining are in inhabited areas (TABLE 3.3). Analysis in the following sections is therefore, based on the response of the 168 households. General characteristics of the samples are summarized table in 3.3. Pertinent questions that would help to evaluate the impact of the project were posed to the head or decision maker of the household with the help a structured questionnaire prepared for the purpose. The questionnaire is attached in the Annex.

Table 3.3: General characteristics of sample population

PARAMETER	KOLA	WOINADEGA	OVERALL
Total number of sample	175	98	273
In settled areas	93	75	168
In non-settled areas	82	23	105
Migrated households	53	7	60
Female headed HH	7	8	15
Male headed HH	86	67	153
Average family size	7.11	6.71	6.93
Minimum altitude (m)	1131	1500	1131
Maximum altitude (m)	1500	1987	1987
Ave. annual cropland holding (ha)	1.32	0.53	0.97

CHAPTER 4 - RESULTS AND DISCUSSION

Under this chapter, change analysis regarding the different agricultural parameters over the study period (200/01-2004/5) is presented. Thus, data obtained for the period before 5 years and that of the present time are compared for the whole study area as well as at agro-ecologic level. For discussion purpose the term "before" is used to represent the former period.

4.1 Land use/ land cover mapping

Broad classification of different types of land use/ cover types in the area for the year 2001 was done with visual image interpretation. (Fig. 8) Elements of image interpretation i.e., discernible color, texture , size and patterns of the different classes in the image were basically used, while the exercise was benefited from relevant ground information gathered through extensive field visit to the study area. Different color composites, Principal Component Analysis (PCA) and Normalized Difference Vegetation Index (NDVI) were prepared and scrutinized to identify the best image data for use in the classification of the different classes. Accordingly color composite of RGB 432 and PCA 123 were found superior as distinction of the different classless was better enabled. As most of the study area is covered with vegetation of varying density, discrimination of vegetation had paramount importance in the classification process. Since vegetation has a uniquely high reflectance in ETM+ band 4 and low one in band 3, relative to soils and rocks, component that has a high eigenvector for band 4 and a high value with the opposite sign for b and 3 is c learly expressing variations in vegetation density (Drury, 2001). As can be seen from table 4.1 eigenvectors of PCA 3 demonstrate such characteristics and color composite using this component; PCA 123 has also yielded distinct variation in the different classes (Figures 6 & 7).

Table 4.1: Principal Component Analysis - Eigenvectors

Eigenvector	Band 1	Band 2	Band 3	Band 4	Band 5	Band 7
1	0.527544	0.478797	0.496367	-0.132945	-0.434873	0.198196
2	-0.055947	0.044884	-0.002440	-0.723123	-0.109282	-0.678233
3	-0.276794	0.296026	***-0.606056***	***0.055540***	-0.675634	0.094250
4	0.263373	-0.505728	0.117734	0.466401	-0.463461	-0.478212
5	0.059037	-0.652169	-0.006563	-0.484305	-0.272399	0.512245
7	0.754388	0.004719	-0.610250	-0.065212	0.231225	-0.027449

Figure 6: Color composite 432 image map of the study area

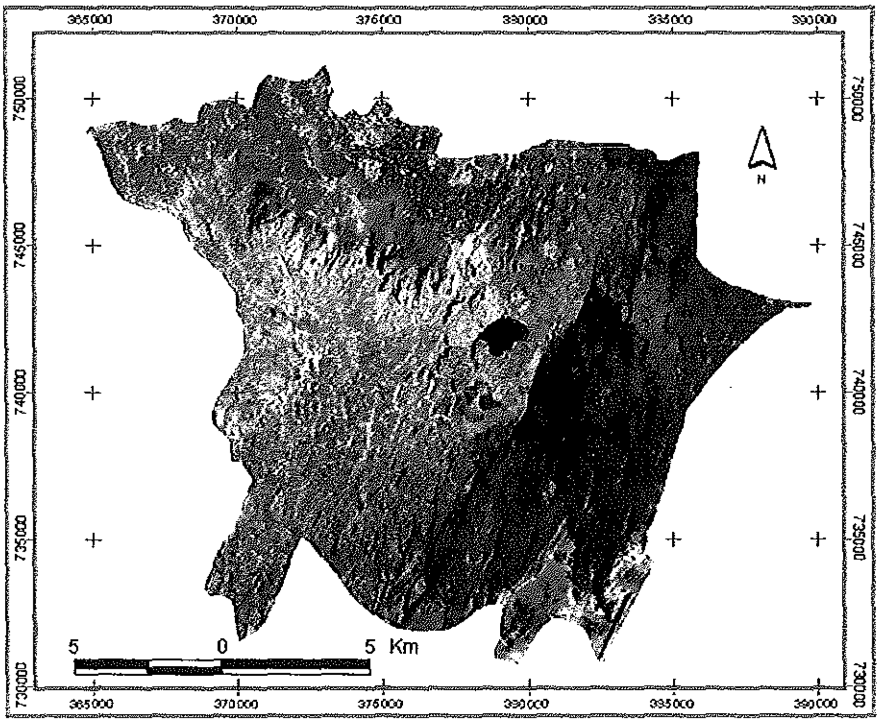
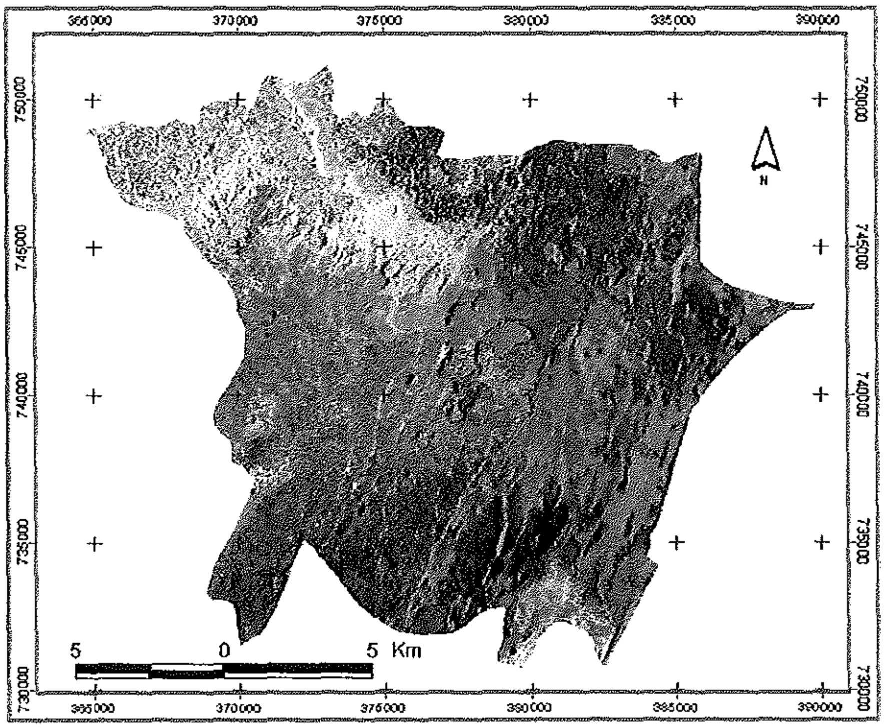


Figure 7: Color Composite PCA 123 Image Map of the Study Area



About 8 major classes were identified in the area. These include, intensive annual cropland, open bush land, mixed annual and perennial cropland, mixed annual and bush land, thick bush land, shrub, degraded bush land and wetland in their order of coverage. (Fig. 8)

Figure 8: Land use/ land cover map of the study area-(year 2001)

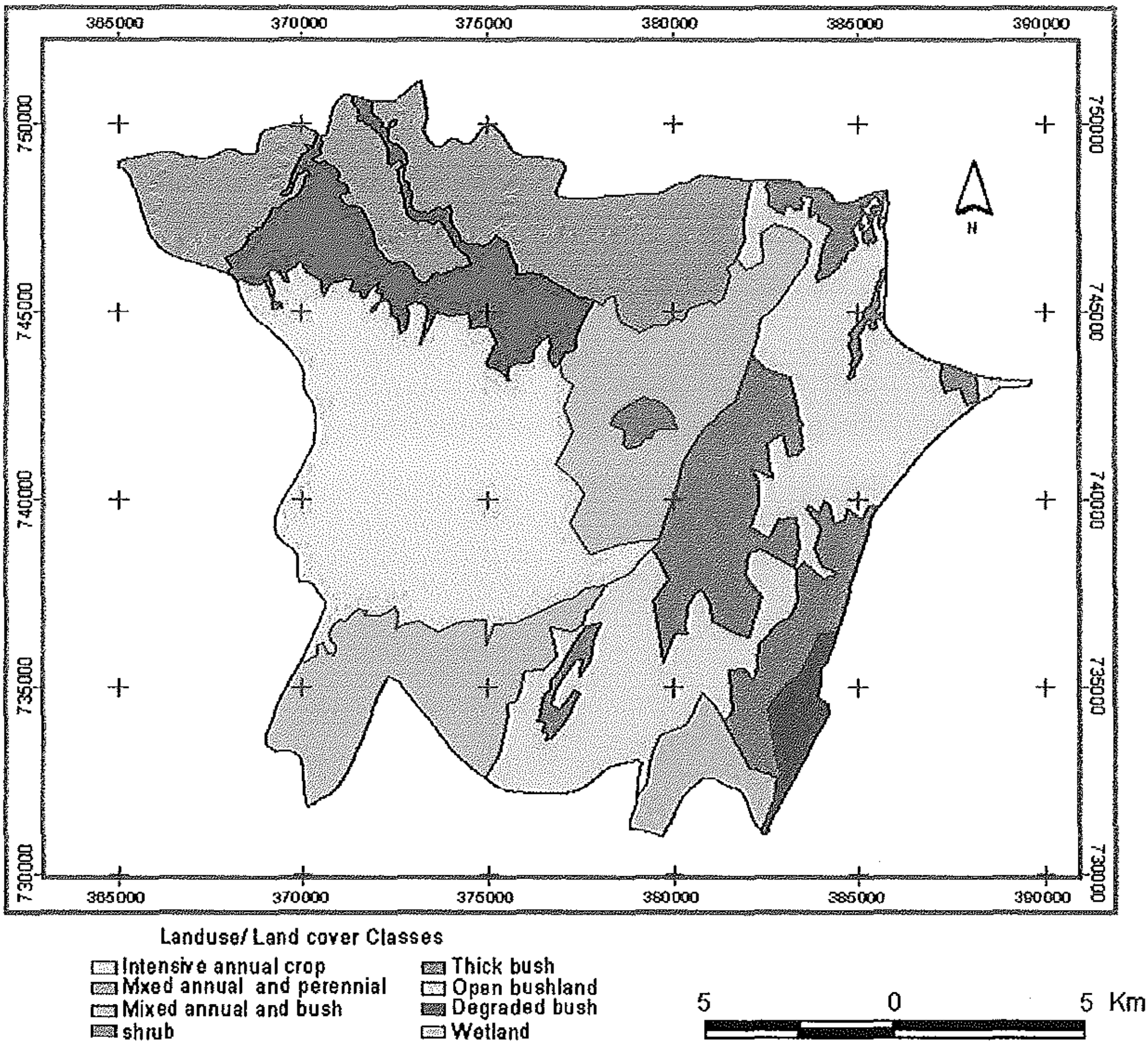
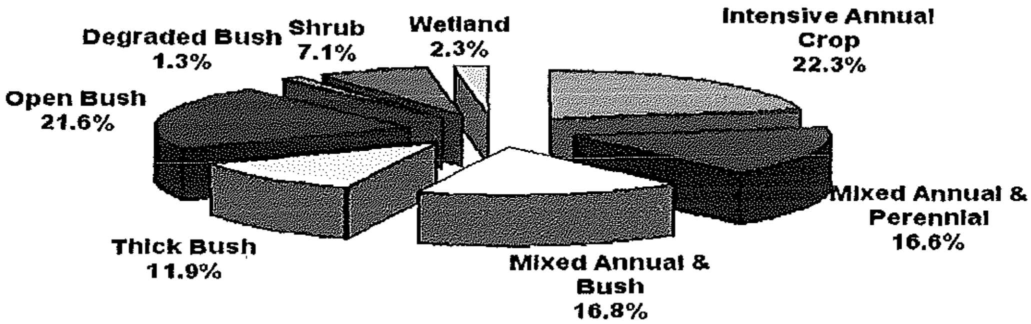


Figure 9: Land use/ cover classes in the study area (year 2001)



Intensive annual cropland: It is found in the western and central part of the study area exclusively in kola parts. It has a continuum of greater than 50% of cultivated annual crop fields of and annual crops such as maize, sorghum, sweet potato and cotton are the major crops that are cultivated. The class accounts for about 22.3 % of the total study area

Mixed annual & perennial cropland: It is found in the northern part of the study area mostly n woinadega areas. It accounts for16.8% of the coverage. Cereals such as maize, barley, sorghum, haricot bean and perennials like coffee, avocado, false banana, mango and eucalyptus tree are common in the area and they are planted intermixed or close by.

Mixed annual crop & bush land: It is a transitional area between intensive annual cropland and bush land classes, covering about 17% of the study area. It is found in kola parts of the study area and scattered/ isolated maize crop fields with 10 - 20 percent coverage are found amidst the dominating open bush.

Thick bush land: it is found in the western kola part of the study area in the Zelan Chewkore Peasant Association. It is very dense and with about 50% woody covers. It also harbors wild life such as lions, different species of bush buck and baboon. It accounts about 11.9% of the study area.

Open bush land: It is found in the western and southern part of the study area mostly in Zelan Chewkore and Abela Gefeta Peasant Associations respectively. It is much less denser than the thick bush with about 25-30% woody cover and it accounts for 21.6% of the study area. During rainy season it grows herbaceous succulent forage that can be used for livestock feed.

Shrub/ scrub: this class is identified exclusively in northern part of the study area on Hobicha Ridge dividing woinadega and kola areas. The area covers about 7.1% of the study area and short and low to moderately dense vegetation covere is found in it. The area serves as grazing and browsing of livestock for the households found in near by areas. According to the residents in the area, cultivation of crops in the hilly and steep foots of the ridge is progressively increasing and flood risk and associated erosion and sediment deposition on agricultural fields down in the flat lands is becoming a serious problem.

Degraded bush land: it is found in Zelan Chewkore Peasant association around d a specific area called "Arat kilo" along the dirt road to Blatte military camp. The bush density is very low and bare and degraded lands are observed especially along the road and drainage lines. The area covers very small area with about 1.3 % of the study area.

Wetland: The wetland, which accounts for 2.3% of the coverage, is found in Zelan Chewkore Peasant Association just at the tip of Lake Abay. The lake and small hot springs found in the area has created moist and swampy area which serves as good grazing land especially for the livestock of the pastoralists in the area and to households in the neighboring areas. People from neighboring areas traveling 3-4 hours collect feed from the area for their own livestock or for market. Apart from the pasture, the area has also salty mineral soil locally called "Bole" that is much liked by the animals.

4.2 Land use/ land cover change in the area

Though it was initially anticipated to undertake land use/ cover change analysis using remote sensing techniques, due to unavailability of recent satellite image of the area, it can not be accomplished. However, from the information gathered through the undertaken agricultural sample survey, the classification of land use/ land covers of the area for year 2001, from field observation and accounts of the residents; it is clear that no significant land use/ cover change has taken place in the study area as a result of the project intervention over the study period. This is strongly justified by the following points:

1. Settlement situation in the area was assessed by overlaying the location of the 168 households that were sampled for the agricultural survey on the prepared year 2001 land use/ land cover map of the area. Accordingly, it was possible to see that about 80% of them are found in the land use/ land cover classes of annual intensive, mixed annual-perennial and mixed annual - bush land classes, which are fully or partly settled areas where agricultural activity has been going on even before year 2001. On the other hand, the remaining 20% of the households are found in the other very sparsely settled areas classes. In relation to this, almost 99 percent of the households, including those found in the later group, have confirmed that they were not newly settled and they were living in the same area at lest for the past 10 years and that they haven't witnessed major land use/ cover change in their area in the past 5 years.

2. Assessment of migration situation in the study area shows that there was almost no recent in migration in to the area. As shown in table 4.2, out of the 60 households who claimed to have come from other areas, those who have settled very recently i.e., between 2001 and 2003, account for only 1.7%t while about 15 percent of them came between 1990 and 2003 and the rest before year 1990.

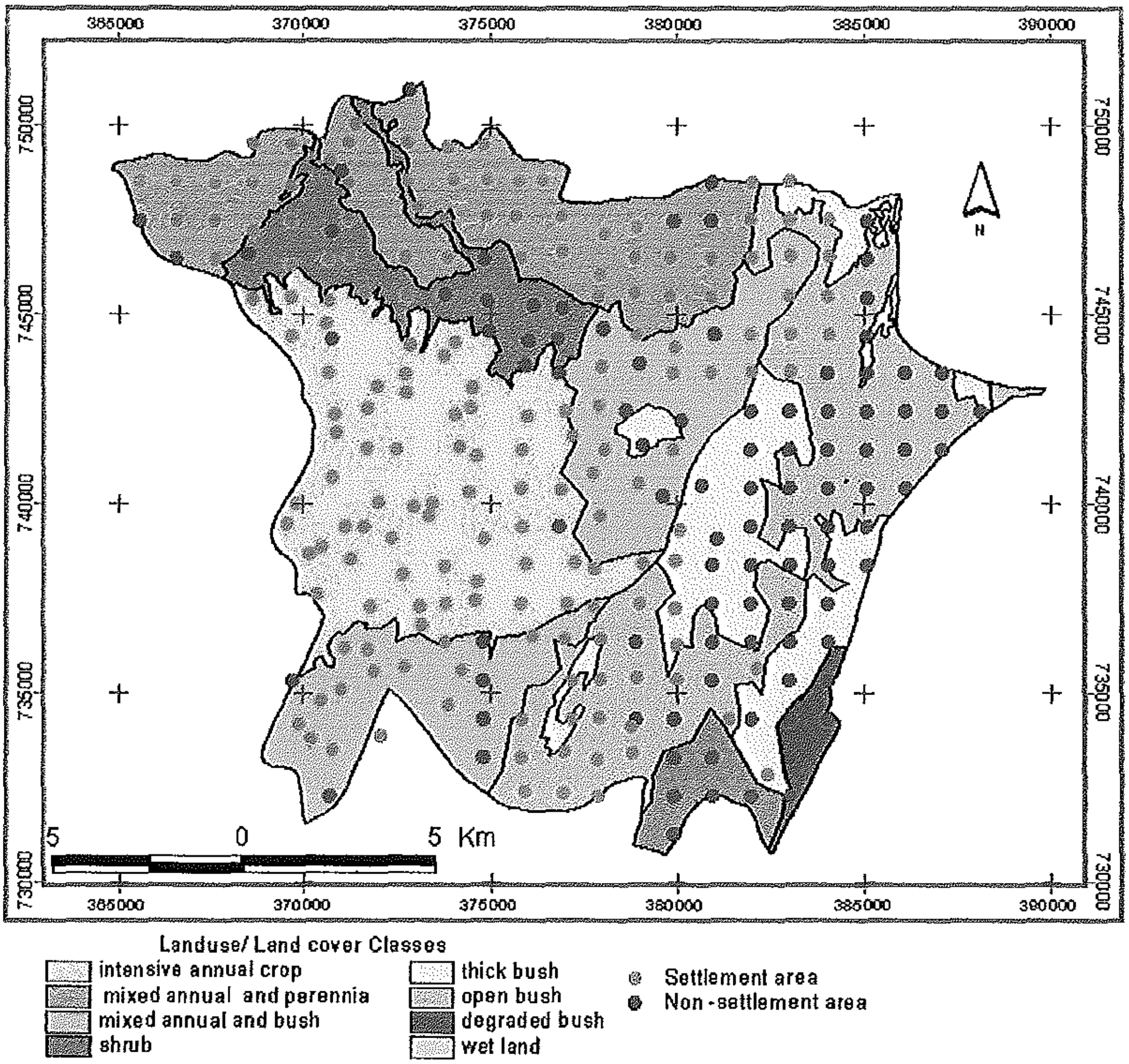
3. As it will be discussed in detail in the following sections, there was no change in the overall average cultivated annual cropland size in the area and the average livestock holding in the area has also been declining. Hence there was no or little demand for expansion of crop and grazing land over the study period.

4. In line with the above justifications, the presence of plenty inhabited areas that are amidst and adjacent to settlement areas and in far by areas as depicted in fig.10, shows that there was no significant settlement expansion in the area. In addition to these justifications, discussions made with elders in the study area and experts in the Agriculture and Rural Development Bureau of Humbo Woreda and the Southern Tsetse Eradication Project have also confirmed that there was no significant change in land use/ land cover in the specific area.

5. In addition to these justifications, discussions made with some key resident informants in the study area and pertinent experts in the Agriculture and Rural Development Bureau of Humbo Woreda and the Southern Tsetse Eradication Project have also confirmed that there was no significant change in land use/ land cover in the specific area.

However, in spite of the above justifications, it is believed that there would be some minor local changes such as changes in size of individual crop fields, density of vegetation cover, and size and quality of individual grazing land. However, as the changes are very subtle and an internal one it is very difficult to discern them with simple visual assessment of the area without undertaking detail survey and analysis involving physical quantification of the parameters. Application of remote sensing and GIS techniques would have paramount importance in undertaking such detail change analysis. Change detection using multi-temporal remote sensing data by employing techniques such as image subtraction and image ratioing would enable change analysis at pixel level.

Figure 10: Settlement Situation in the Study area



Settlement situation in the area

Although a lot of other socio-economic and political factors affect the migration and settlement situation in any area, one of the expected changes in relation to tsetse control is expansion of new settlements and increased human migration into recently cleared and sparsely settled or totally inhabited areas where agricultural potential is high. However, as discussed earlier, there was almost no recent human migration into the area following the reduction of tsetse and trypanosomiasis problem in the area. Apart from independent settlement initiative in the area, a government sponsored resettlement preprogram under the framework of the federal food security program was undertaken in the southern part of the study area. In year 2000, about 616 households who are from other drought prone woredas of Wolaita zone were settled in the Zelan Chewkore peasant association, in the specific area called Bilbo. At present only 73 households are living in the area, while most of the settlers were relocated to some other places and some returned back to their native places.

Table 4.2: Human migration situation in the study area

PEASANT ASS.	Before 1974	1974-1983	1984-1993	1994-2000	2001-2003	Total
A. FARICHO	6	2				8
A. GEFETA	5	3	2	4		14
A. KOLSHOBO	3		1			4
A. LONGENA	2	5	3			10
A. SHOYA	4	1	1			6
BOSA WANCHE	2		1			3
BUKE DONGOLA	10	1	1	1		13
Z. CHEWKORE	1				1	2
Total	33	12	9	5	1	60
Proportion (%)	**55**	**20**	**15**	**8.3**	**1.7**	**100**

4.3 Assessment of change in tsetse and trypanosomiasis situation

Previously conducted surveys have permitted to assess changes in tsetse and trypanosomiasis situation in the study area. The project had undertaken a tsetse and trypanosomiasis baseline surveys at the beginning of the project. The entomological survey was done by deploying at least 20 traps in each grid of 10 km by 10 km for the length of 72 hours in a three month cycle for one complete year to observe seasonal changes. The parasitological baseline survey which is done in two rounds was undertaken by examination of blood samples collected from over 9000 animals from 61 sampling points in block one of the project area.

The mid-term review of the project has reported that tsetse population has dropped from 4.1 flies/trap/day to 0.9 flies/trap/day and prevalence of bovine trypanosomiasis dropped from 27% to 6% in certain places where suppression is successfully going on (ESTC, 2004). However, the same report has also indicated that other independent assessments have revealed disease prevalence up to 30% and the random sampling method employed by the project might have excluded some of the hotspots (ESTC, 2004).

Attempt was made to see the picture in the study area by considering data specifically collected from the study area. A total of 44 entomological trap sites and 3 parasitological test sites were considered in the study area with the baseline survey. The compiled result of fly catches and positive cases is presented in tables 4.3 and 4.4. Apparent fly density calculated for each cycle showed that the relative highest apparent fly density in the area was recorded in the second cycle from January -March 1999 with 0.45flies/ trap/ day while the lowest was in the third cycle from April-June 1999.

Table 4.3: Entomological Baseline data of the study area (only with fly catch)

Peasant Ass.	Longitude	Latitude	Cycle 1	Cycle 2	Cycle 3	cycle 4
Abela Gefeta	37.85	6.65		1		
	37.88	6.62		2		
	37.85	6.65				1
Abela Koleshebo	37.84	6.68	2			
Abela Longena	37.89	6.72		2	5	
	37.89	6.73		2	1	
	37.88	6.73		9		4
	37.88	6.72		1		
	37.88	6.71		2		
Bola Wanche	37.83	6.78		8		
	37.83	6.78		2		
	37.83	6.79		1		1
	37.83	6.77		4		
	37.83	6.77	2	4		
	37.84	6.77				1
	37.82	6.78		1		
	37.82	6.78		1		
	37.81	6.78		3		
	37.81	6.77		1		
Hobicha Beda	37.84	6.79		1		
	37.84	6.79		3		
Hobicha Bongota	37.90	6.75		3		
Zelan Chewkore	37.93	6.63		2		1
	37.93	6.64		3		
	37.93	6.64		1	1	
	37.93	6.63		3	2	
Total flies			4	60	9	8
No of days			3	3	3	3
AFD			0.03	.45	0.068	.03

Note: Cycle 1 = from Oct-Dec 1998, Cycle 3 = from Apr-June 1999, Cycle 2 = from Jan-Mar 1999
Cycle 4 = from Jul-Sep 1999, AFD= Apparent Fly Density (fly/ trap/ day)

Source: extracted from STEP baseline survey records

On the other hand, the parasitological test done in the area for the dry and wet seasons presented in table 4.4 shows that highest parasite prevalence had occurred in wet season and more anemic animals in dry season.

Table 4.4 Parasitological baseline data in the study area and its surrounding

Peasant Ass.	Season	Sampled		Positive			Anemic			PCV>25%
		1st	2nd	1st	2nd	Average	1st	2nd	Average	
Bola Wanche	dry	150	150	17	8	12.5	65	28	46.5	30
	wet	150	150	17	17	17	65	11	38	64
Abela Gefeta	dry	150	150	5	0	2.5	60	37	48.5	37
	wet	150	150	5	5	5	60	3	31.5	60
Zelan Chewkore	dry	150	150	1	3	2	100	72	86	72
	wet	150	150	1	1	1	100	1	50.5	99
Average	dry	150	150	7.67	3.67	5.67	75.00	45.67	60.33	46.33
	wet	150	150	7.67	7.67	7.67	75.00	5.00	40.00	74.33
Proportion (%) (from sampled)	dry			5.11	2.44	3.78	50.00	30.44	40.22	30.89
	wet			5.11	5.11	5.11	50.00	3.33	26.67	49.56

Source: computed from STEP survey records

Very recently, in May 2005, an entomological and parasitological monitoring was conducted by the project in the study area and its surrounding to assess the current situation of fly population and trypanosomiasis prevalence in the area. Four villages from the eastern Humbo in Abela Faracho, Abela Sipa, Ella Kebela and Bosa Wanche peasant associations were identified for the purpose and a total of 15 NGU traps were deployed in selected sites for 72 hours to assess the fly presence and distribution, while a total of 206 cattle from these identified sites were randomly selected and bled for detection of trypanosomes in the blood samples (STEP, 2005). Despite its small sample size and limited spatial coverage of the study area, it is believed that the findings of this monitoring survey would give some reflection. Summary of the entomological and parasitological monitoring survey result is presented in tables 4.4 & 4.5.

Table 4.5: Trap sites of the recent entomological monitoring survey

Peasant Association	Location	Altitude	Tsetse files caught			Other biting flies	
			G.pallidipes			Stomoxs	Tabanus
			M	F	Total		
Elkebela	6 45' 06" 37 48' 22"	1680	0	0	0	3	0
	6 45'07" 37 48' 29"	1675	0	0	0	1	0
	6 45' 00" 37 48' 23"	1664	0	0	0	7	0
	6 45' 05 " 37 48' 33"	1656	0	0	0	1	0
	6 45' 05" 37 48' 38"	1635	0	0	0	5	0
Abela Gefeta*	6 45' 06" 37 48' 22"	1680	0	0	0	3	0
	6 45'07" 37 48' 29"	1675	0	0	0	1	0
	6 45' 00" 37 48' 23"	1664	0	0	0	7	0
	6 45' 05 " 37 48' 33"	1656	0	0	0	1	0
	6 45' 05" 37 48' 38"	1635	0	0	0	5	0
Bossa Wanche*	6 37' 17" 37 52' 27"	1309	0	0	0	8	15
	6 37'16" 37 52' 21"	1311	0	0	0	6	10
	6 37' 24" 37 52' 26"	1310	0	0	0	7	7
	6 37' 26 " 37 52' 34"	1312	0	0	0	0	7
	6 37' 30" 37 52' 52"	1311	0	0	0	5	3
Total			0	0	0	60	42

* in the study area
Source: STEP, 2005

Table 4.6: Prevalence of trypanosomiasis in the sample areas

Peasant Ass.	Location	Altitude	Sample size	Positive cases	% positives
Bossa Wanche*	6^0 45' 49" 37^0 48' 09"	1757	72	0	0
Ella Kebala	6^0 41' 48" 37^0 47' 02"	1543	38	1	2.6
Abela Sipa	6^0 40' 05" 37^0 47' 29"	1442	48	0	0
Abela Faracho*	6^0 39' 52" 37^0 47' 21"	1377	48	0	0
Total			**206**	**1**	**0.48**

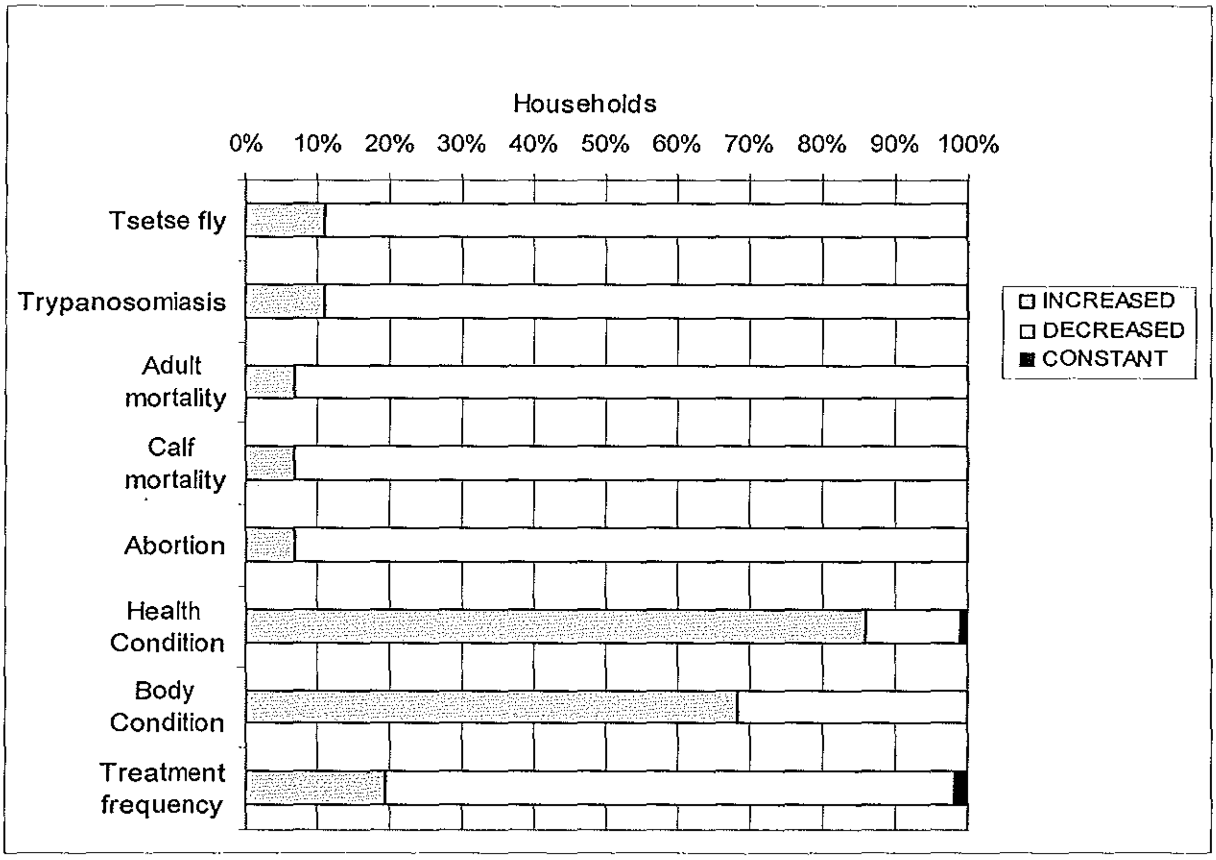
* in the study area

Source: STEP, 2005

Results of the monitoring survey are in conformity with findings of the current survey on problem situation comparison in which about 88.4 of the households confirmed that the magnitude of the problem is decreasing (Fig. 11). Accordingly out of the total 206 animals sampled only one animal was found positive, i.e. infected with Trypanosome congolense in Ella Kebela. Thus the overall infection rate with the parasite was only 0.45% (less than 1%) and 2.6% in that particular sample site (Ella Kabela). No trypanosomes were detected in other animals sampled in the rest of the sampling sites

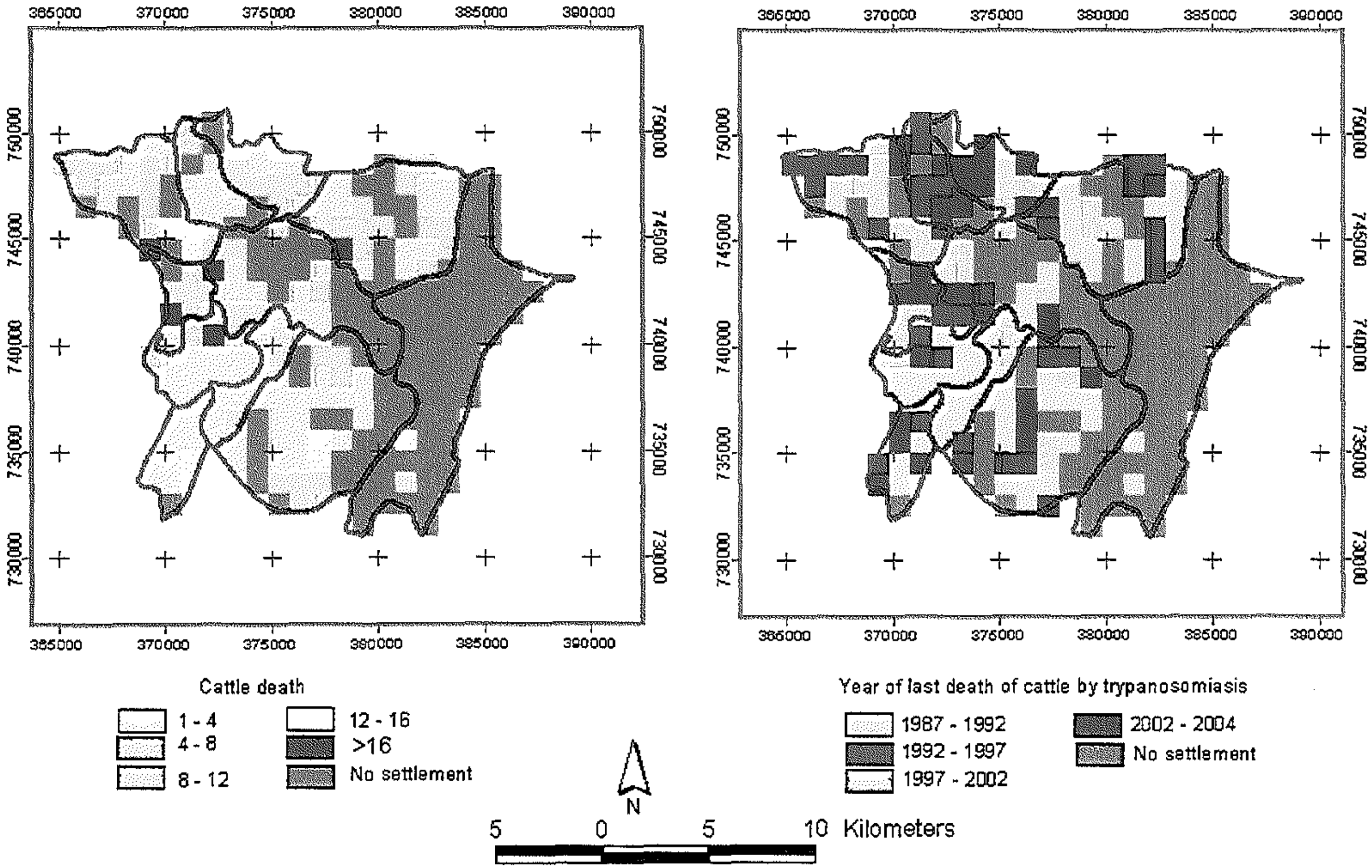
Feedback of the studied households has also shown that tsetse population and prevalence of tsetse transmitted trypanosomiasis in the area is declining. (Fig.11) However, the assessment also indicated that though the magnitude of the problem is declining; some farmers are still losing animals for the disease even in the recent years. Figure 12 shows the claimed total number of cattle died due to the disease and the reported period of last death. In relation to this, the suspect forwarded by the project mid-term review report that random sampling method employed for the monitoring might have excluded some of the hotspots, seems valid.

Figure 11: Tsetse & Trypanosomiasis situation comparison



Findings of both the mid-term review of the project, the recently undertaken monitoring survey as well as the feedback of the studied households have shown that the tsetse population and prevalence of tsetse transmitted trypanosomiasis in the area is declining. However, it would be difficult and premature to conclude that the problem is removed based on the limited observation.

Figure 12: Cattle death due to trypanosomiasis and period of last death



4.4 Project impact on agriculture

4.4.1 Impact on livestock production

In the study area, cattle and small ruminants are commonly raised livestock while donkeys, mules and horses are reported. Despite the aridity of the area, camels are not found. Except for the Sidama ethnic group which are pastoralists in origin and leaving in eastern and south eastern part of the study area, livestock are generally raised in small number. Change in total and livestock number average livestock holding in the area are presented below in tables 4.7, 4.8 and figure 13.

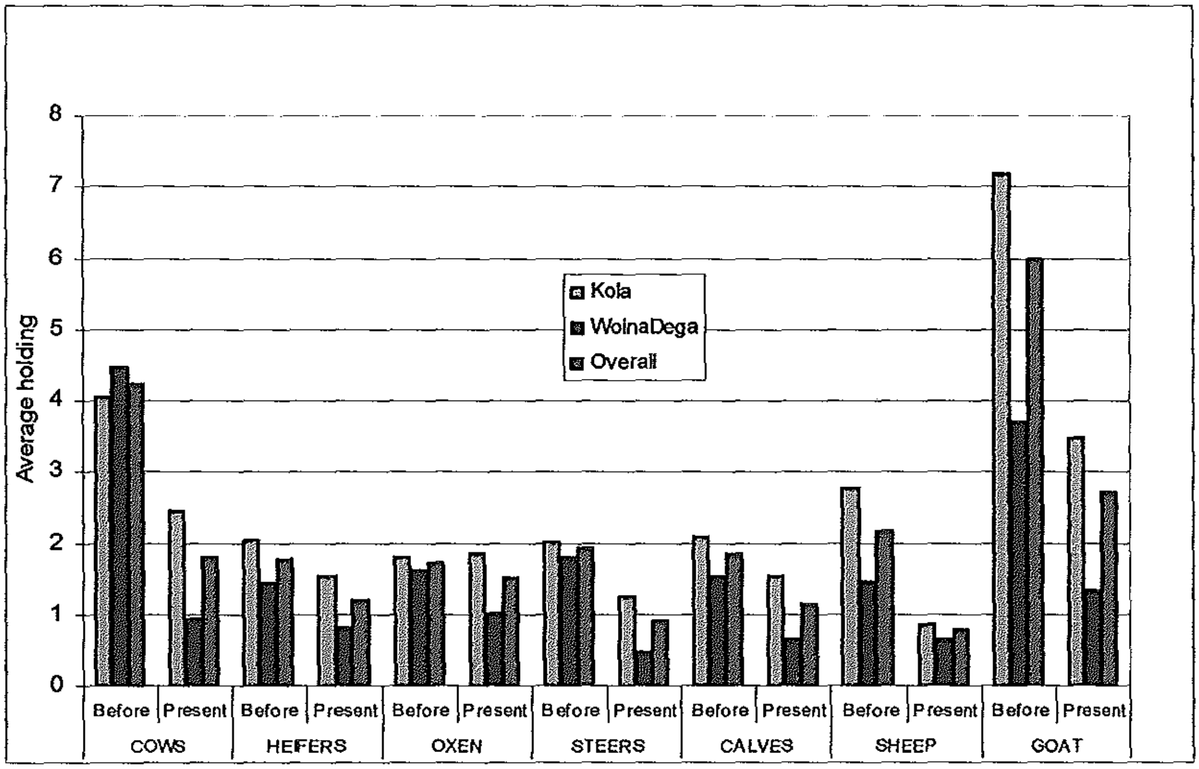
Table 4.7: Change in Total Livestock Number (%)

Agro ecology	Cow	Heifers	Oxen	Steers	Calves	Sheep	Goat	Donkeys
Kola	-38.6	-24.5	4.6	-38.3	-26.7	-68.8	-51.9	-23.9
Woinadega	-78.2	-45.0	-37.5	-73.1	-57.1	-54.3	-64.0	-25.9
Total	-56.5	-31.9	-12.4	-51.9	-37.4	-64.3	-54.5	-24.7

Table 4.8: Comparison of average livestock holding

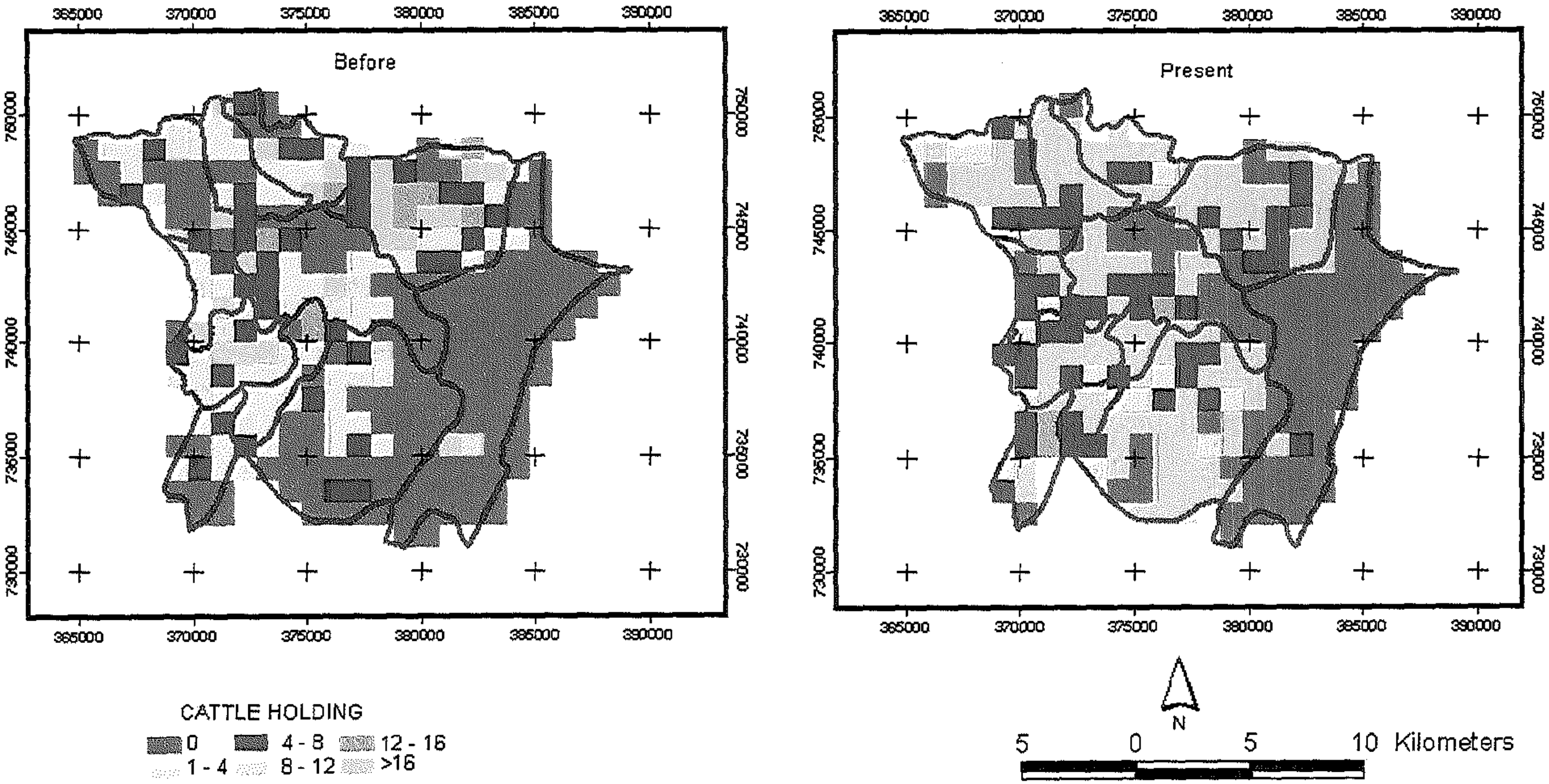
Type	Period	Kola	Woinadega	Overall
COWS	Before	4.06	4.46	4.23
	Present	2.46	0.95	1.81
HEIFERS	Before	2.04	1.43	1.77
	Present	1.54	0.80	1.22
OXEN	Before	1.81	1.63	1.73
	Present	1.87	1.02	1.50
STEERS	Before	2.03	1.79	1.93
	Present	1.25	0.48	0.93
CALVES	Before	2.09	1.53	1.85
	Present	1.53	0.66	1.16
SHEEP	Before	2.76	1.46	2.17
	Present	0.86	0.67	0.77
GOAT	Before	7.20	3.71	5.99
	Present	3.47	1.33	2.72
DONKEYS	Before	1.24	1.00	1.14
	Present	0.95	0.74	0.86

Figure 13: Comparison of average livestock number



In both agro ecologic zones, decline of overall average and total livestock holding has been observed over the study period with the exception of the increment in average oxen number in kola areas (Table 4.7). This result, i.e., reduction in livestock number, is in contrast to the result obtained from the responses gathered on the general questions regarding tsetse and trypanosomiasis situation, livestock health and body condition assessment and livestock population trend in their vicinities. This contradiction is may be due to misreporting of present livestock possessions or memory lapse in case of the previous period. Grid map showing cattle holding situation in the area is presented in Fig.14.

Figure 14: Cattle holding situation in the study area

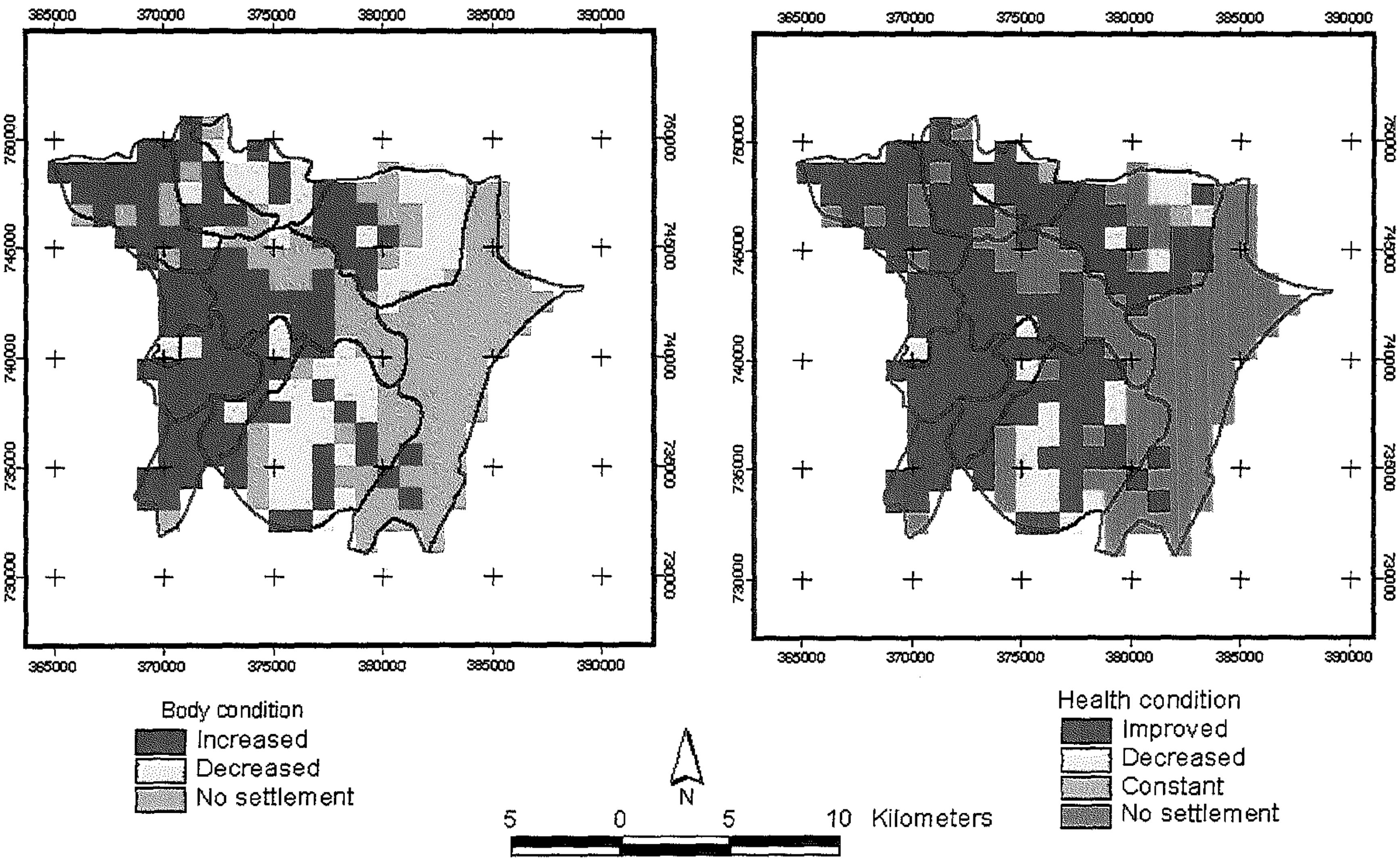


Asked about livestock population situation in their respective vicinities, about 64.67% of the households responded that livestock population is increasing in their area, while the balance asserted the opposite. On the other hand, about 85.45% of the respondents confirmed that there was improvement in the general health condition of their livestock. However, only 67.88 and 68.48% of the households agreed that there was improvement in growth and body condition of livestock. The same assessment at agro ecologic level has also shown similar result but with relatively less percentages of households in woinadega areas asserting the improvement. This is probably due to the underlying difference between the two agro-ecologic zones in the initial severity of the problem as well as the observed change. As the initial magnitude of the problem is relatively higher in kola areas, it is believed that changes in livestock number as well as health and body condition due to the observed improvement in tsetse and trypanosomiasis problem in the area would be relatively higher when compared to woinadega areas with relatively moderate or low tsetse and trypanosomiasis problem. Grid map showing result survey on livestock health and body condition assessment is presented in figure15.

4.4.2 Livestock productivity

Analysis regarding changes in livestock reproduction parameters such as maturity age, age at first calving, calving interval, winning age etc... as well as milk and meat production requires continuous and accurate assessment of the same on specific representative herds. In this study, questions related to these issues were included in the questionnaire and responses were received. However, except oxen hour information, responses given to other parameters are found to be less consistent with each other and in some cases unrealistic. As a result, except for oxen hour analysis it was decided not to undertake other change analysis of livestock productivity.

Figure 15: Body and health situation assessment result



Oxen hour Analysis

One of the expected changes in relation to reduction of tsetse and trypanosomiasis problem is increased availability of oxen. However, unless there is also improvement in oxen output, the expected change in crop production may not be materialized. Assessment of draught power output in terms of oxen hour per day showed that there is a general reduction over the study period. Accordingly, the average oxen hour per day that used to be 5.78 hours before 5 years ago has declined to 4.42 hours at present. As it is shown in table 4.9 about 70.67% of the households had oxen out put of 6 and more hours during the previous period while only 26.49% of the households reported such an output, for the present time. Observed change in oxen hour is presented in table 4.9 and figure 16 below.

Table 4.9: Observed change in oxen output

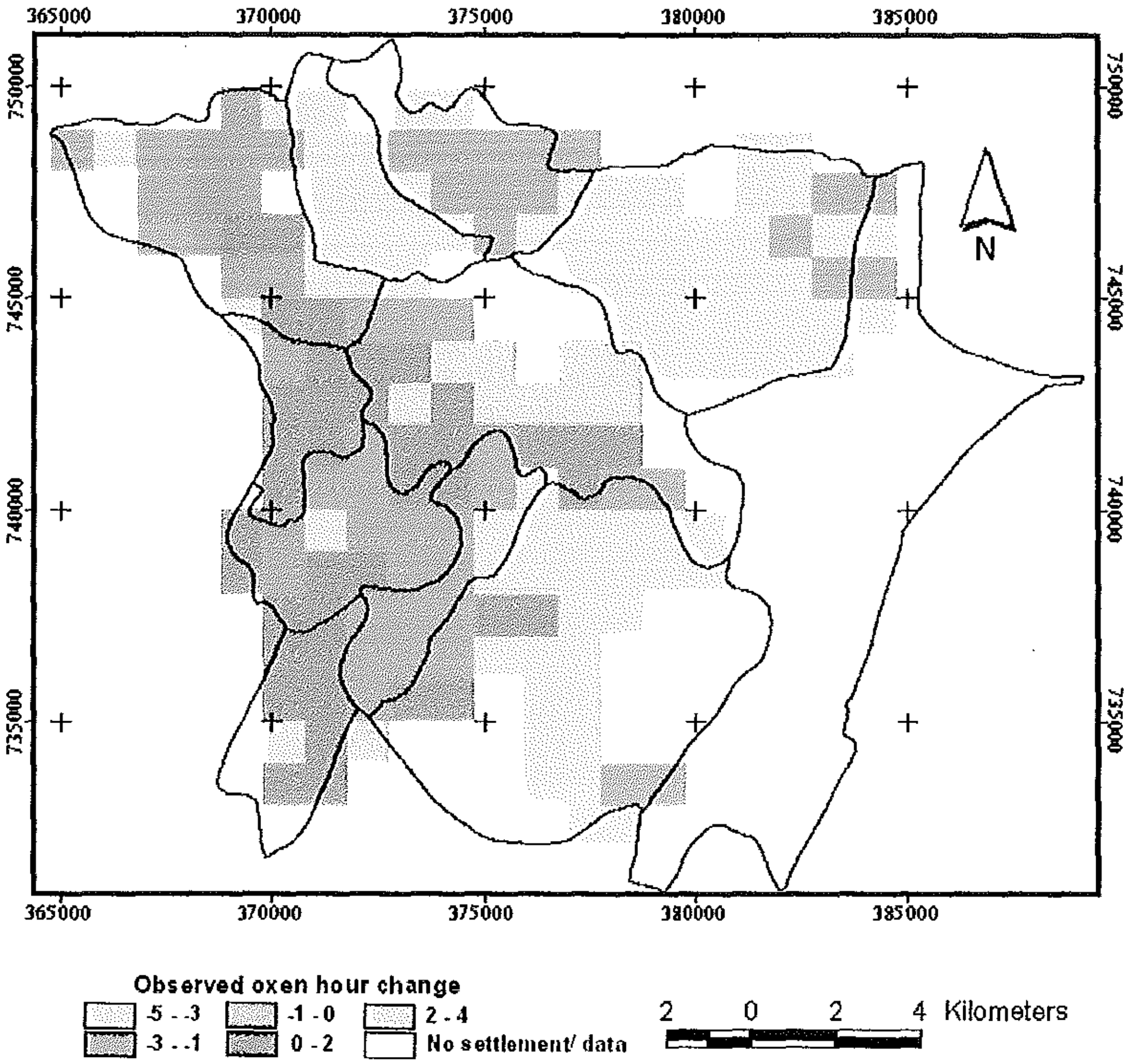
Households		Oxen hour/ day/ pair of oxen								
		2	3	4	5	6	7	8	9	Total
Number	Before	3	16	11	9	57	13	23	1	133
	Present	7	33	44	27	21	6	5	8	151
Proportion (%)	Before	2.26	12.03	8.27	6.77	42.86	9.77	17.29	0.75	100
	Present	4.64	21.85	29.14	17.88	13.91	3.97	3.31	5.30	100

Out of the 141 reasons forwarded by the households as major reasons for the observed oxen out put, feed and water shortage accounts for 56 %, while health improvement and animal disease problem account for 2.4 and 17.73%respectively with health improvement reported mostly by households in kola areas (Table 4.10).

Table 4.10: Reasons for change in oxen output (Proportion of households)

Agro ecology	Health improvement	Feed Improvement	Animal disease	Feed shortage	Other	Total
Kola	20.57	0.00	3.55	24.22	0.71	0.49
Woinadega	2.84	0.71	14.18	31.91	1.42	0.51
Total	23.40	0.71	17.73	56.03	1.00	100

Figure 16: Observed change in oxen hour



4.4.3 Impact on crop production

It has been reported that about 12 types of annual crops are produced in the area as summarized in Table 4.11. Among them, maize, sorghum, barley, teff, sweet potato and cotton are the major crops which are cultivated by more than 20 percent of the households. Maize is produced by almost all and sorghum by half of the households. Except barley all the major crops are grown in both kola and woinadega areas of the study area. Though it is relatively in small quantity, haricot bean, potato, pepper, Godere (yam) ground nut and chick pea are also produced in the area.

As well documented in previous studies, (e.g. Budd L., 1999; Morton and Sutton, 1999, Temesgen, 1994; Getachew et al, 1993) crop production level could be influenced among other things by method of cultivation and oxen holding. Assessment of crop production with respect to these factors was made.

Change In cultivated crop land and production

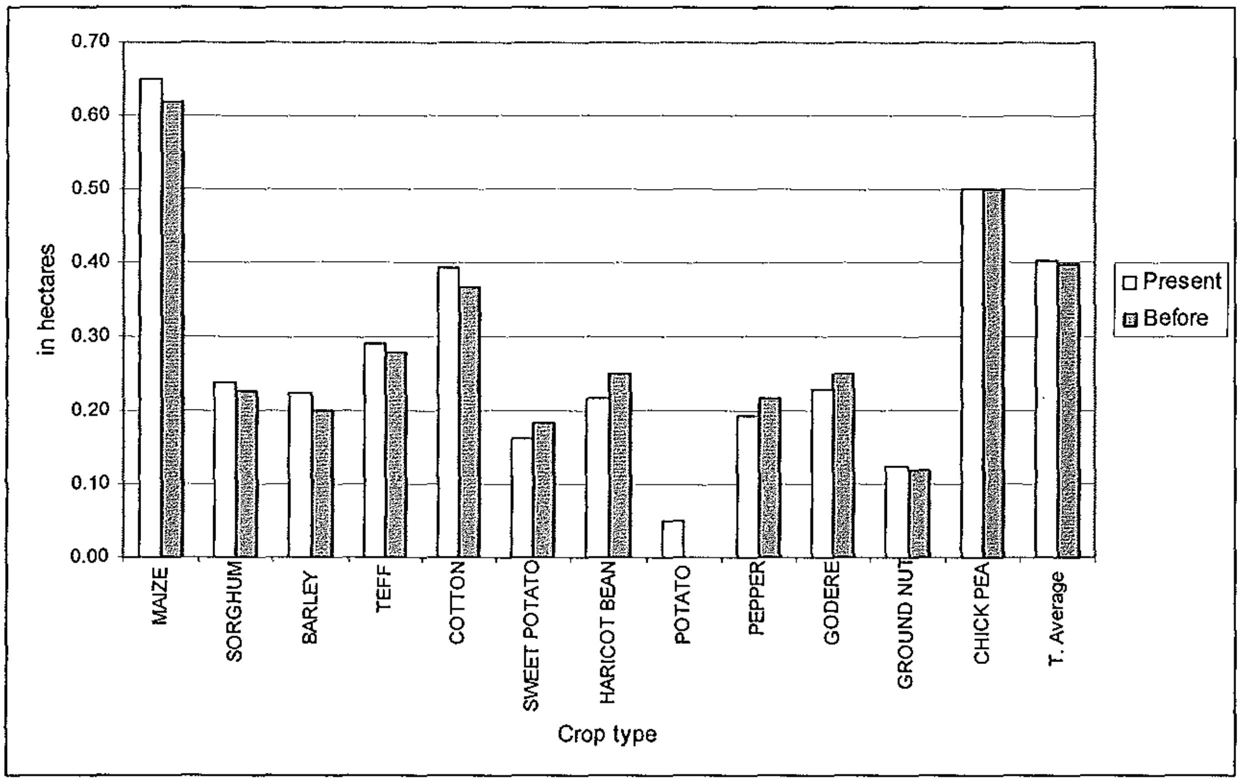
Despite the 8.8% increment in total cultivated cropland, the average cultivated annual cropland size, which was about 0.4 ha, has shown very small change over the study period. However, assessment of individual crops reveals varying changes in average cultivated size and average production. For example, the average cultivated land for maize, sorghum, barley, teff and cotton has shown increment while that of haricot bean and sweet potato declined. On the other hand, average production of maize, teff and cotton has increased while the average productions of sorghum and barley (despite their increased cultivated size), haricot bean and sweet potato have declined. Detail of total and average cultivated cropland and production of annual crops is presented in table 4.11 and Figures 17&18.

Table 4.11: comparison of total and average cultivated land and production

CROPS	CULTIVATED Total (ha)		PRODUCTION Total(q)		CULTIVATED Average (ha)		PRODUCTION Average (q)	
	Before	**Present**	**Before**	**Present**	**Before**	**Present**	**Before**	**Present**
MAIZE	96.69	108.63	874.30	1055.58	0.62	0.65	5.60	6.36
SORGHUM	8.57	9.57	78.88	68.20	0.23	0.24	2.08	1.71
BARLEY	0.60	0.90	5.00	4.00	0.20	0.23	1.67	1.00
TEFF	9.22	9.84	64.35	73.05	0.28	0.29	1.95	2.21
COTTON	15.79	18.46	165.50	193.50	0.37	0.39	3.85	3.23
SWEET POTATO	6.27	5.48	184.25	156.14	0.18	0.16	5.42	4.59
HARICOT BEAN	21.21	20.13	130.28	107.18	0.25	0.22	1.53	1.15
POTATO	0.00	0.05	0.00	1.00	1.00	0.05	0.00	1.00
PEPPER	2.38	2.31	46.00	64.50	0.22	0.19	4.60	5.38
GODERE	0.75	1.38	24.00	42.00	0.25	0.23	8.00	7.00
GROUND NUT	0.24	0.25	0.45	0.75	0.12	0.13	0.23	0.38
CHICK PEA	0.50	0.50	1.00	1.00	0.50	0.50	1.00	1.00
TOTAL	**162.20**	**177.50**	**1574.00**	**1766.89**	**0.397**	**0.403**	-	-

Assessment of aggregated average cultivated size and crop production for different crop categories revealed that crops requiring oxen power for their cultivation have shown improvement in average size of cultivated land and production. Accordingly, the aggregated average cultivated size and production for major cereals (maize, sorghum, barley and teff), have registered respective growth of 6 and 11 percent, while root crops, showed respective decline of 10 and 14.36 percent. Summary of aggregated average cultivated size and production for the major crops is presented below in table 4.12.

Figure 17: Comparison of average cultivated cropland

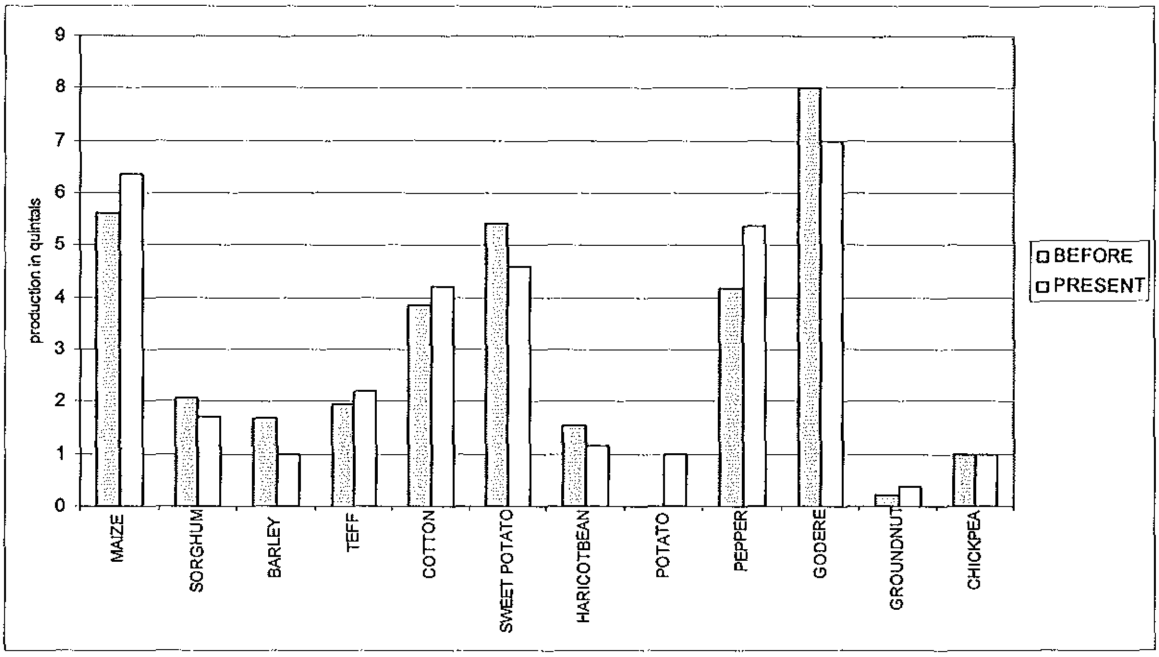


Size of cultivated cropland and production condition has different pictures in the two agro ecologic zones. Average cultivated cereal cropland in kola areas, which was previously 0.7 ha has increased to 0.76 ha at present, while in woinadega areas; the average size which was 0.32 ha has remained unchanged. On the other hand, size of cultivated land of tuber crops decreased in both kola and woinadega areas from 032 to 0.3 ha and from 0.13 ha to .09 ha respectively. Overall average cultivated annual cropland size has increased from 0.52 to 0.54 ha in kola areas, while it has declined from 0.27 ha to 0.25 ha in woinadega areas. On the other hand, average production of cereals which used to be 6.73 quintals in kola areas has increased to 7.9 quintals while in woinadega areas it has declined from 2.46 to 2.2 quintals. Despite the reduction in average cultivated size in Kola areas, tuber production has increased from 6.94 to 7.57 quintals, and in woinadega areas, it has decreased from 5 quintals to 3.29 quintals. From the figures, it can be seen that improvement in size of cultivated land and production is generally observed in kola areas. This is probably due to the fact that kola areas had been with higher degree of problem and where most change is expected in oxen power output as the result of reduction in tsetse and trypanosomiasis.

Table 4.12: Average cultivated cropland size and production (in ha).

Crop	Average	Kola		Woinadega		Overall	
		Before	Present	Before	Present	Before	Present
Maize	Size	0.83	0.88	0.37	0.36	0.62	0.65
	Production	8.02	9.31	2.78	2.60	5.60	6.36
Sorghum	Size	0.23	0.28	0.22	0.20	0.23	0.24
	Production	1.70	1.44	2.41	1.94	2.08	1.71
Barley	Size	-	-	0.20	0.23	0.20	0.23
	Production	-	-	1.67	1.00	1.67	1.00
Teff	Size	0.23	0.25	0.29	0.30	0.28	0.29
	Production	3.10	6.20	1.74	1.50	1.95	2.21
CEREALS	**Size**	**0.70**	**0.76**	**0.32**	**0.32**	**0.50**	**0.53**
	Production	**6.73**	**7.90**	**2.46**	**2.20**	**4.45**	**4.94**
Potato	Size	-	-	-	0.05	-	0.05
	Production	-	-	-	1.00	-	1.00
Sweet potato	Size	0.35	0.35	0.13	0.09	0.18	0.16
	Production	6.58	7.94	5.00	3.39	5.42	4.59
Godere (yam)	Size	0.25	0.23	-	-	0.25	0.23
	Production	8.00	7.00	-	-	8.00	7.00
TUBERS	**Size**	**0.32**	**0.30**	**0.13**	**0.09**	**0.19**	**0.17**
	Production	**6.94**	**7.57**	**5.00**	**3.29**	**5.63**	**4.86**
Haricot bean	Size	0.31	0.27	0.21	0.18	0.25	0.22
	Production	1.84	1.41	1.34	0.97	1.53	1.15
Pepper	Size	0.24	0.20	-	0.06	0.22	0.19
	Production	4.60	5.73	-	1.50	4.60	5.38
Ground nut	Size	0.12	0.13	-	-	0.12	0.13
	Production	0.23	0.38	-	-	0.23	0.38
Cotton	Size	0.38	0.40	0.19	0.19	0.37	0.39
	Production	3.84	3.19	4.00	4.00	3.85	3.23
OVERALL	**Size**	**0.52**	**0.54**	**0.27**	**0.25**	**0.40**	**0.40**

Figure 18: comparison of average annual crop production



Method of cultivation and cultivated size

Method of cultivation along with cultivated size was also observed as it is known to impact on production output. Total cultivated land has increased from 162.21ha to 177.5 ha between pre-project and present time. In addition to this, change in proportion of land cultivated with specific method of cultivation was observed (Table 4.13 and Figure 20).

Table 4.13: proportion of households and cultivated cropland size by cultivation method

Cultivation Method	Households				Cultivated land			
	Number		Proportion (%)		Size (ha)		Proportion (%)	
	Before	Present	Before	Present	Before	Present	Before	Present
Hand	40	12	24.39	7.14	24.30	8.73	14.98	4.92
Hand &oxen	62	64	37.80	38.1	70.01	68.82	43.16	38.77
Oxen	62	92	37.80	54.76	67.90	99.96	41.86	56.31
Total	**164**	**168**	**100**	**100**	**162.21**	**177.5**	**100**	**100**

The proportion of households cultivating their land by hand decreased from 24.39 percent to 7.19 percent while those using hand and oxen and purely oxen increased both from 37.8 percent to 38.1and 54.76 percent respectively.

On the other hand, the proportion of cropland cultivated by hand, hand and oxen and oxen which was 14.98, 43.16 and 41.86 percent respectively, has changed to 4.92, 38.77 and 56.31 percent respectively Implying a clear shift from hand cultivation to the use of oxen that is anticipated with the control of tsetse and trypanosomiasis and the eventual improvement in the availability of oxen power for crop production. Assessment of change in method of cultivation at agro-ecology level showed that the proportion of households cultivating their land by hand has significantly decreased in both categories while the use of oxen power for land cultivation has improved in both agro ecologies. Summary of changes in method of cultivation and size of cultivated land by agro-ecology is presented in table 4.14 and figure 19.

Table 4.14: Change in method of cultivation and cultivated size by agro-ecology (%)

Cultivation Method	Proportion of households			Proportion of cultivated land		
	Kola	Woinadega	Overall	Kola	Woinadega	Overall
Hand	-75.00	-67.86	-70.00	-62.65	-65.08	-64.07
Hand & oxen	-15.38	16.67	3.23	2.50	0.18	1.35
Oxen	33.33	118.18	48.39	35.23	110.21	42.78

Figure19: Comparison of cultivation method by agro-ecology

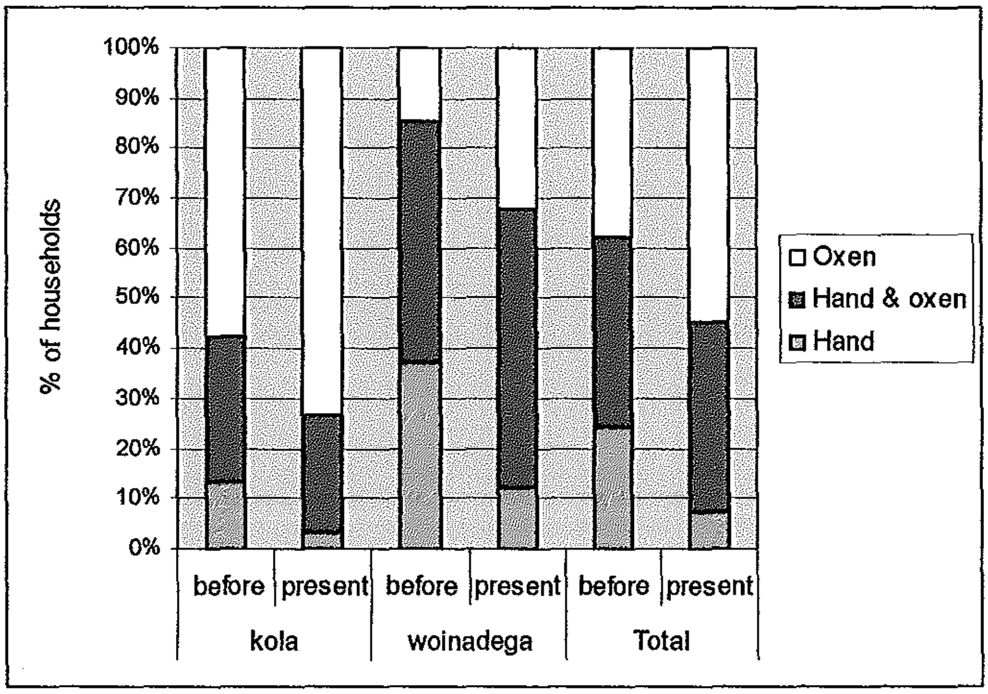
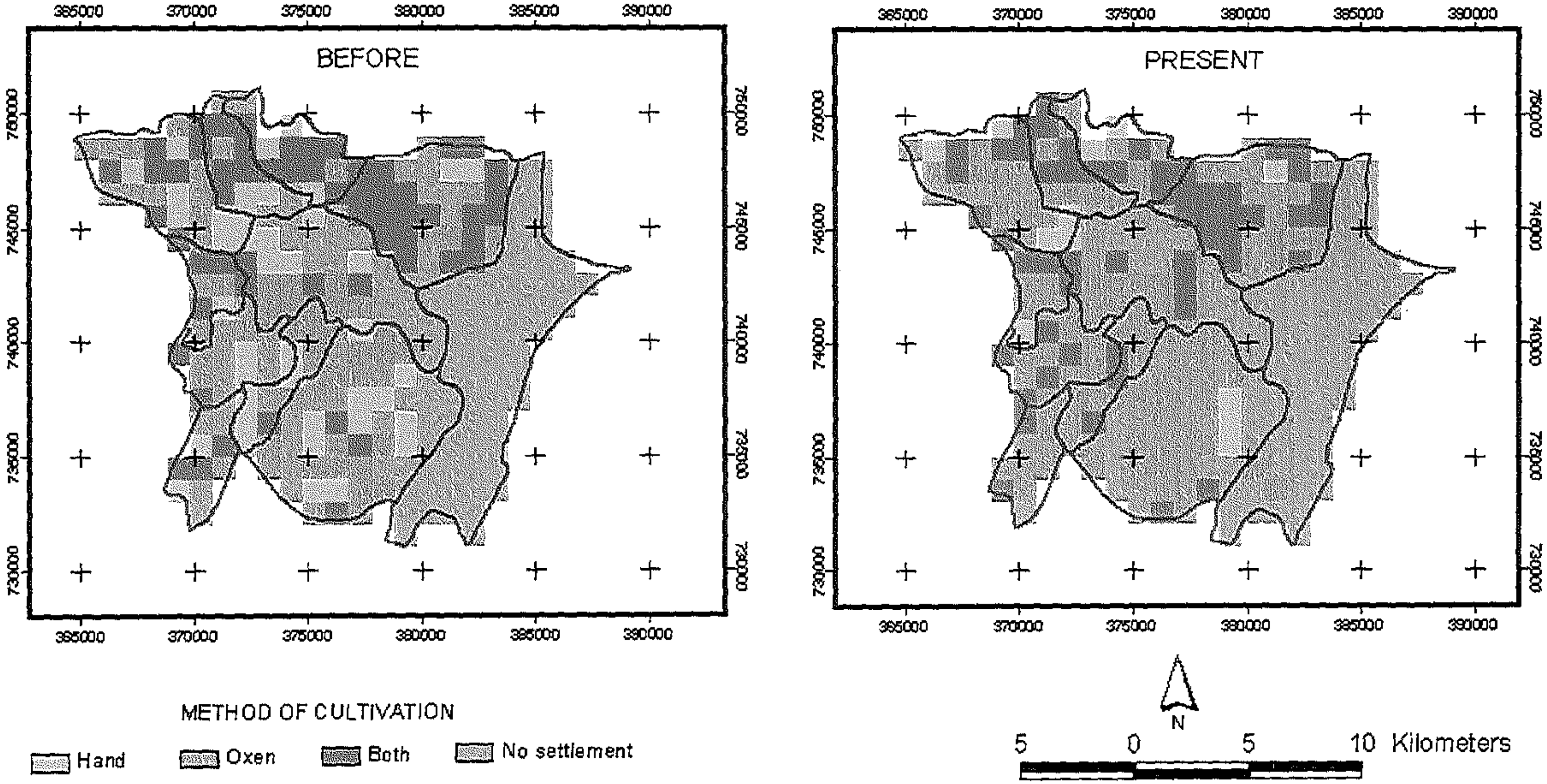


Figure 20: Method of cultivation



Oxen holding and cultivated size

Proportion of households and cultivated cropland size in relation to number of oxen holdings is presented in table 4.15. As depicted in the table, the number of households with out any oxen and with those with one ox has shown significant change, Accordingly, the former has shown a 36.6 percent reduction and the later a 127.27 percent increment. On the other hand the proportions of households with two and more oxen, when compared with the case before the project have shown a decline. Map of the observed change in oxen holding over the study area is presented in figure 21.

Figure 21: Observed change in oxen number

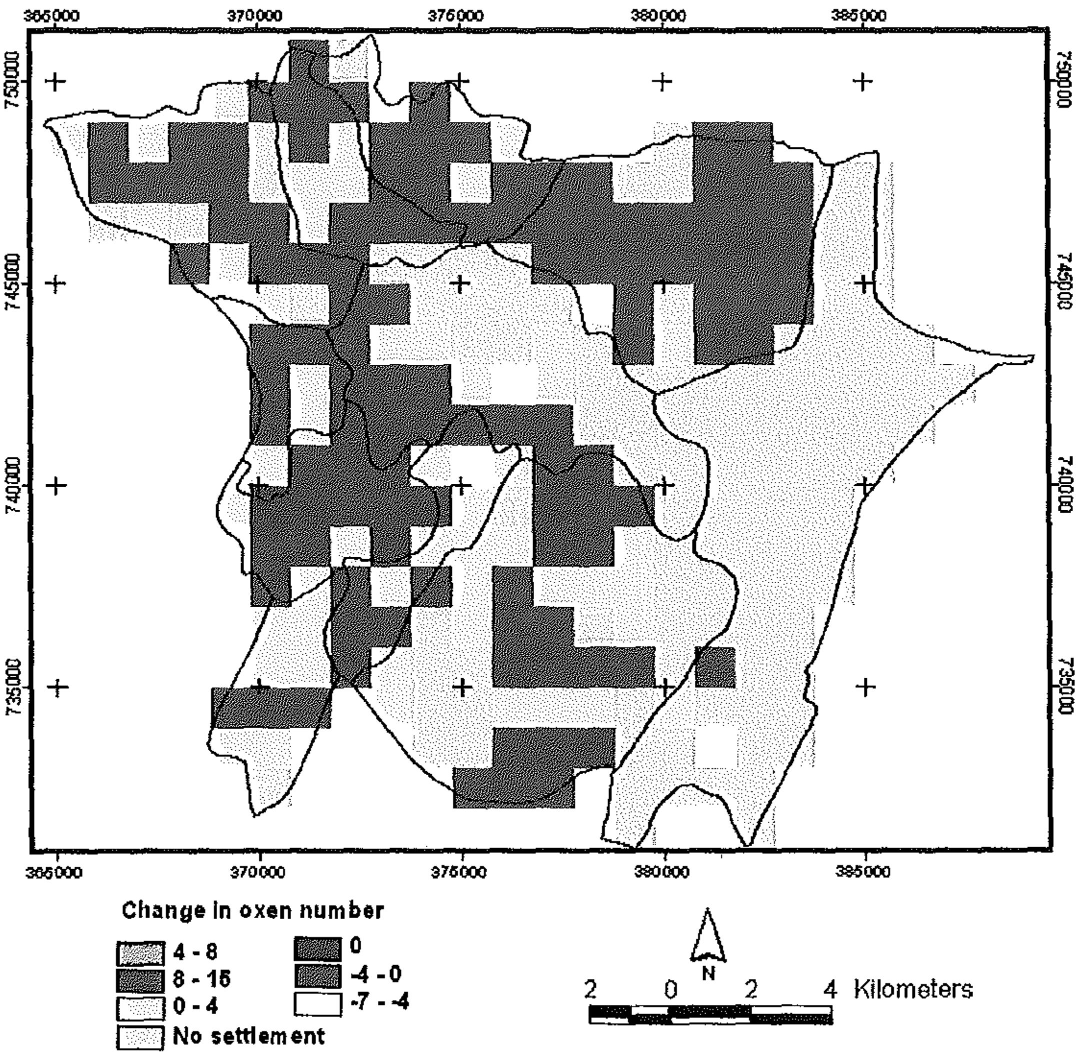


Table 4.15: Oxen holding cultivation method and cultivated size

Status	Households				Cultivated land			
	Number		Proportion		Size (ha)		Proportion	
	Before	Present	Before	Present	Before	Present	Before	Present
No oxen	71	45	42.26	26.79	52.33	40.46	32.26	22.79
One ox	33	75	19.64	44.64	25.31	74.21	15.60	41.81
Two oxen	47	44	27.98	26.19	64.13	58.84	39.53	33.15
≥3 oxen	17	4	10.12	2.38	20.44	4.00	12.60	2.25
Total	168	168	100	100	162.21	177.51	100	100

Oxen holding, cultivated size and production relationship

As depicted in table 4.16, average production of the major crops such as maize, sorghum cotton and to some extent haricot bean has shown positive growth with increase in oxen number up to two holding while in the remaining cases; there is no as such clear pattern.

Table 4.16: Comparison of oxen holding and average production

CROP	BEFORE				AFTER			
	0 oxen	1 ox	2 oxen	≥3 oxen	0 oxen	1 ox	2 oxen	≥3 oxen
MAIZE	5.80	5.75	5.93	6.38	4.61	5.65	9.57	9.25
SORGHUM	1.39	1.97	2.18	4.92	1.25	1.65	1.80	
BARLEY		2.00	2.00	1.00				1.0
TEFF	3.30	0.85	1.64	2.11	0.81	2.85	1.08	0.50
COTTON	2.22	2.80	4.18	5.50		2.39	3.24	5.00
S.POTATO	7.14	5.40	6.57	2.33	5.20	3.78	6.56	14.00
H.BEAN	1.00	1.64	1.85	2.18	1.26	1.20	1.27	2.50
PEPPER	5.50	4.00	4.40	4.50		4.25	5.94	

Since maize is produced by almost all of the households and cultivation of the crop requires oxen power, it was taken as proxy indicator to assess the relationships among number of oxen, size of cultivated cropland and crop production. Total cultivated size for maize in the two periods was 96.69 and 108.63 ha while total production 874.3 and 1055 ha respectively. On the other hand, the respective average cultivated size in the two periods was 0.62 and 0.65 ha and average production 5.6 and 6.36 quintals respectively.

The result of Spearman one-tailed correlation has indicated that there exist a positive but weak relationship between oxen number and size of cultivated land as well as oxen number and production in both periods. On the other hand, cultivated size and production has shown a relatively strong positive relationship in both periods (Table 4.17).

Table 4.17: Spearman One-tailed Correlation Test Result

Relationship	Correlation	Significance level
Oxen before and size before	0.144	0.01
Oxen before and production before	0.137	0.01
Size before and production before	0.717	0.05
Oxen present and size present	0.200	0.05
Oxen present and production present	0.266	0.05
Size present and production present	0.726	0.05

The weak relationship between oxen size and cultivated size as well as production could be attributed to the inability of conversion of the mere oxen number into draught power output, basically due to the drought situation in the area and the associated serious feed and water shortage, sickness and weakness of the animals.

Reasons for change in crop production

Out of the 423 responses given by the households regarding reasons for the change in production of individual annual crops, 59.57% of the cases were given in relation to reduction of production while reasons for production increment account for 37.58%. Out of the 252 cases of reported reasons for reduced production the prevalence of drought situation in the area was found to be the major one accounting for 70 percent while shortage of oxen and shortage of manpower come next with respective percentages of 19.4 and 5.6. In case of maize, which is cultivated almost by all of the households in kola and woinadega areas, about 52.59 percent of the households confirmed production reduction (table 4.18). About 46.38% of households in kola areas and 59.09% in woinadega areas confirmed reduction in maize production and out of the forwarded reasons, respective percentages of 82.5 and 68.63 cases in kola and woinadega areas pointed out the drought situation in the area as reason for the encountered reduction.

Table 4.18: Reasons for changes in maize production

Change	Kola	Woinadega	Total	%
INCREASED PRODUCTION	**40**	**32**	**72**	**40.68**
Access to more land	4	11	15	**20.83**
Availability of more oxen	20	15	35	**48.61**
Good weather	13	2	15	**20.83**
Availability of more manpower	3	4	7	**9.72**
DECREASED PRODUCTION	**40**	**62**	**102**	**57.63**
Shortage of man power	1	4	5	**4.90**
Bad weather	33	37	70	**68.63**
Shortage of land	1	4	5	**4.90**
Shortage of oxen	5	17	22	**21.57**
OTHER		**3**	**3**	**1.69**
TOTAL	**80**	**97**	**177**	**100**

The current average and total maize production of those households who have reported increased production, are about 10.48 and 670.45 quintals respectively, both showing an increment of about 81.8 %, from the respective average and total maize production at the beginning of the study period. On the other hand a 40.58% reduction in the average and total production was encountered by those households reporting reduction in maize production. Hence, despite the production loss sustained by more than 50% of the households, it is evident that there is an overall increase in maize production in the area. Grid maps of cultivated size and average production of maize crop for the study area are presented in figures 22 & 23.

Figure 22: Average cultivated maize land in the area

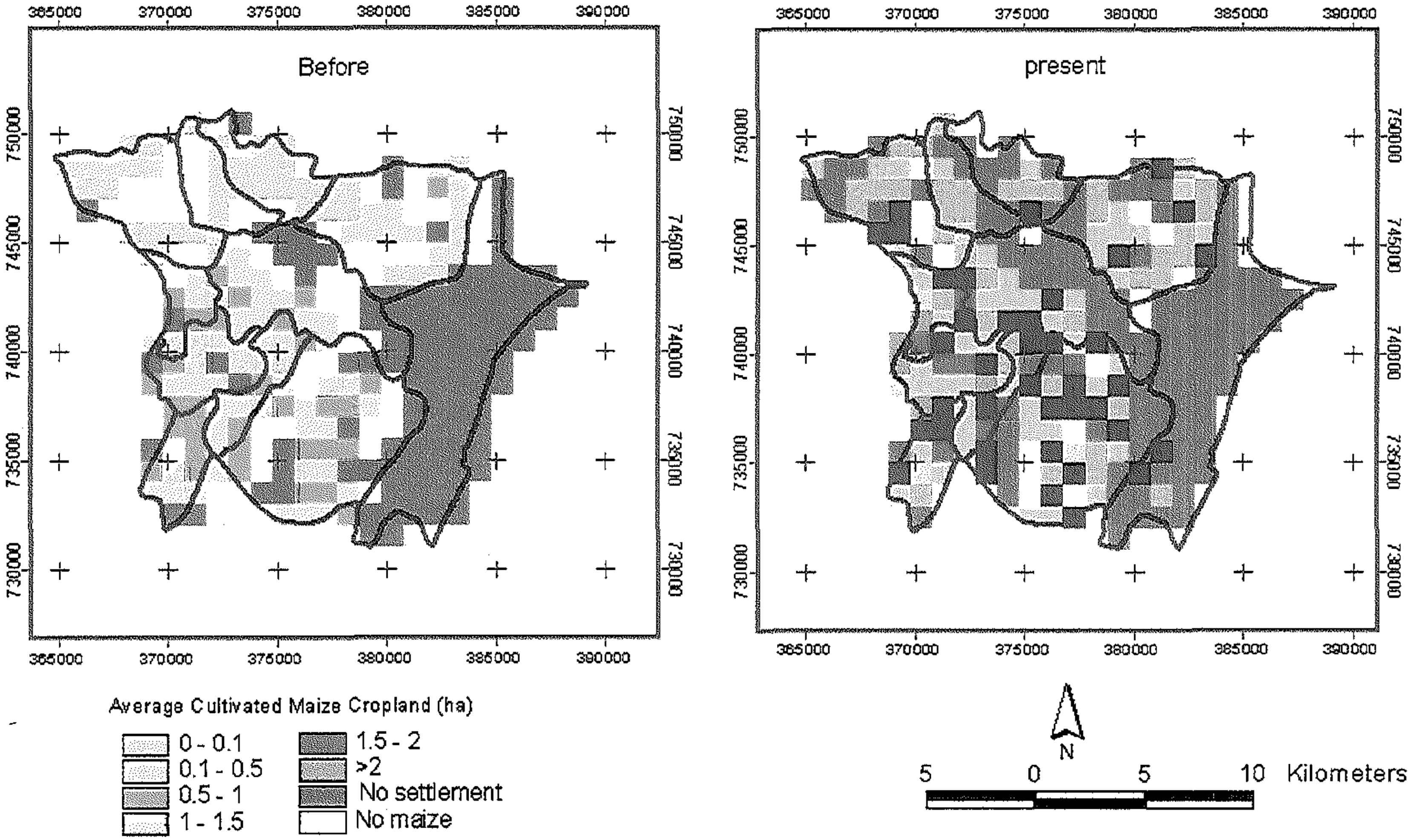
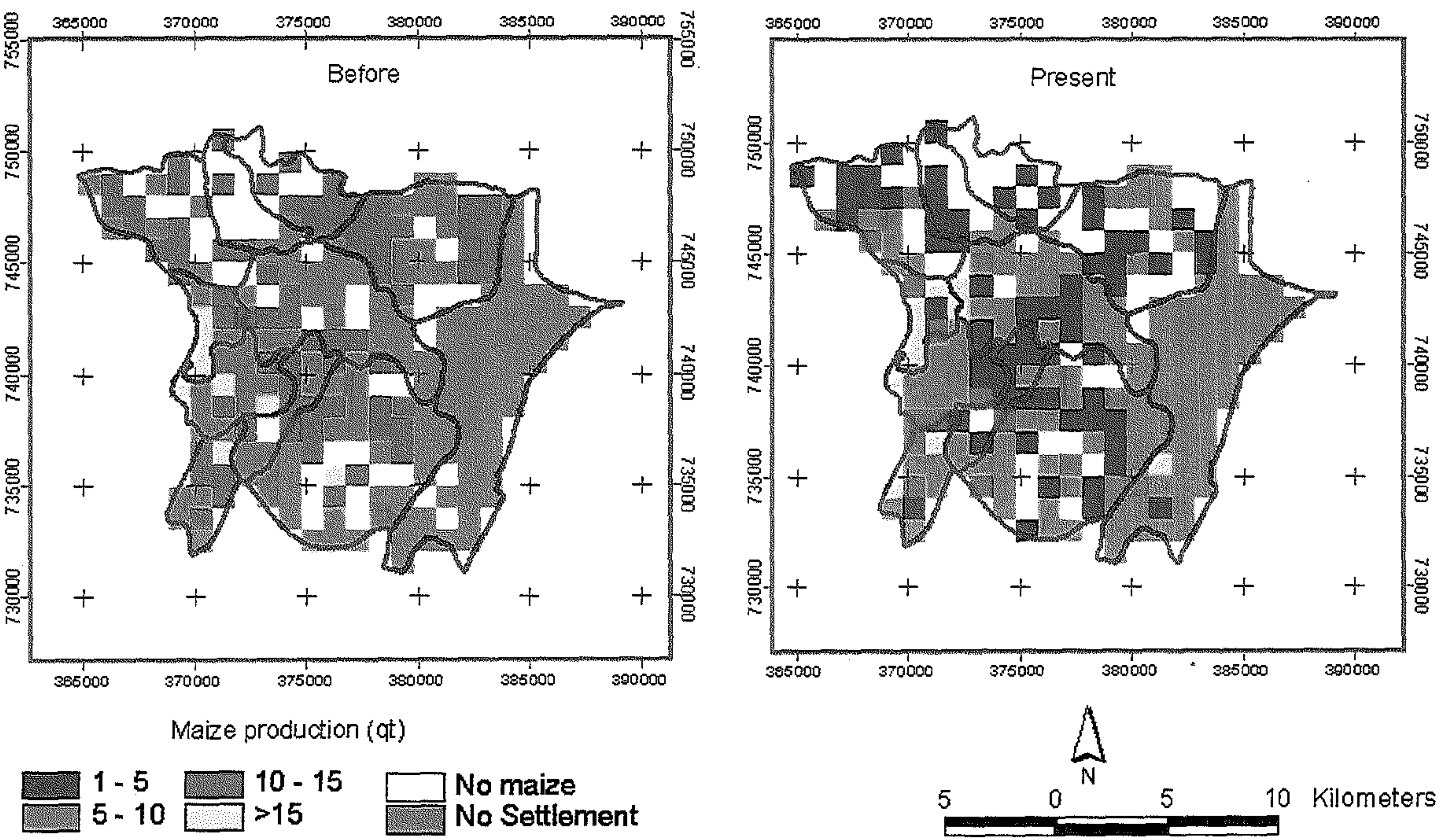


Figure 23: Average maize production in the area



4.5 Environmental situation assessment

4.5.1 General assessment

Tsetse removal could have agro-ecological implications and it is feared that the control of tsetse/ trypanosomiasis could release a pent-up demand for land in neighboring tsetse free areas and cause large-scale agricultural conversion as people and livestock flood into areas as they become free of the fly (Reid et al, 2000), Demands on natural resources often deplete those resources, and, especially when not managed well, disturb the local ecosystems, causing general land degradation (MOFED, 2002).

As a result of STEP intervention, marked change has been observed in reducing the tsetse and trypanosomiasis problem in the area. This was confirmed by both the findings of the conducted agricultural survey and with entomological and parasitological monitoring surveys in the area. How ever, based on the available information, in relation to this new development, no significant land use land cover change and human migration into the area have taken place in the last few years that could have environmental implications. Besides, the assessment made regarding the agricultural activity in the area also revealed that there was no major change in size of cultivated cropland and livestock number in the area.

4.5.2 Environmental situation opinion survey

Environmental situation comparison was made for the study area by considering few parameters in the survey questionnaire that have environmental significance. The respondents were asked to make comparison of the situation and extent of features such as forest/ bush in their area, grazing land size and quality, soil erosion and gully condition as well as availability of fuel wood in their vicinity for the present and for period before the project. Accordingly, 94.6% of the households living in both kola and woinadega areas have confirmed that bush and forest resource in their respective area is decreasing. On the other hand respective percentages of 94.61% and 92.22% have confirmed that grazing land area and grazing land quality are decreasing and deteriorating when compared to the situation during the period before the start of the project. Regarding gully and erosion condition, 56.89% of the households both in kola and woinadega areas confirmed that its extent and magnitude is increasing while 38.92 % believe it is decreasing. As confirmed by 63 percent of the households, fuel wood availability in the area is generally declining. In relation to this, 32.64 and 27.78 percent of the households revealed change in fuel wood availability from plenty to scarce and from plenty to faire respectively, while fair to scarce change accounts for 2.78 percent. Grid maps showing the situation of these parameters are presented in figures 24 & 25.

Serious land degradations in the form of extensive gully formation requiring immediate attention were observed with the field visit of the area. Degraded areas in Abela Shoya and Abela Longena peasant associations along drainage lines and at the foots of Hobitcha ridge, land degradation as in figure 26 in Hobicha Bongota peasant association and those near "Arat kilo" and along the dirt road to Bilatte military camp in Zelan Chewkor peasant association are some to mention (figures 27).

From the discussion, it is possible to infer that environmental changes are taking place in the area. The use of multi-temporal satellite data and also the environmental baseline data of the project are believed to be useful for future systematic and detail environmental change evaluation in the area.

Figure 24: Opinion on grazing land situation comparison

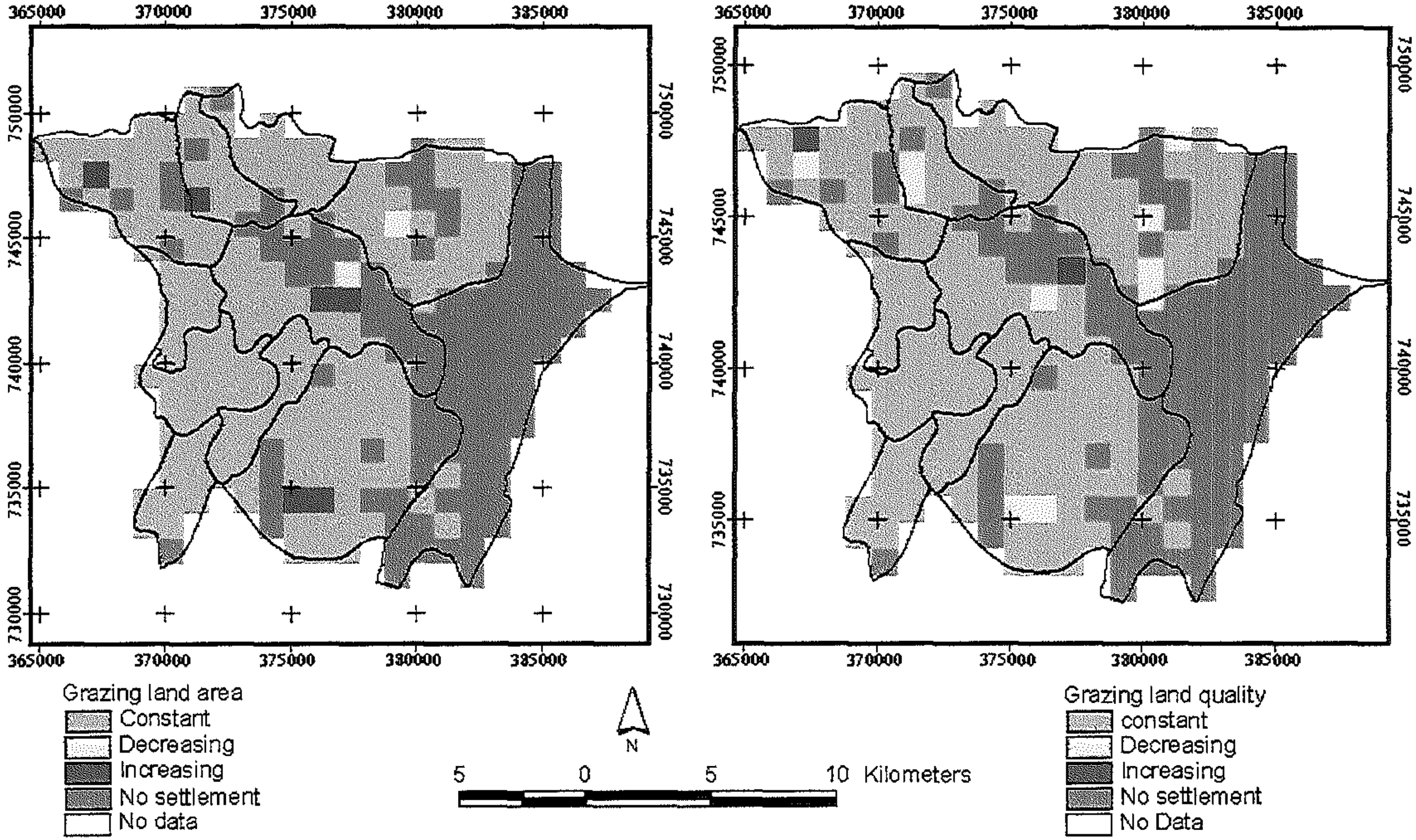


Figure 25: Opinion on erosion/ gully and forest/ bush situation comparison

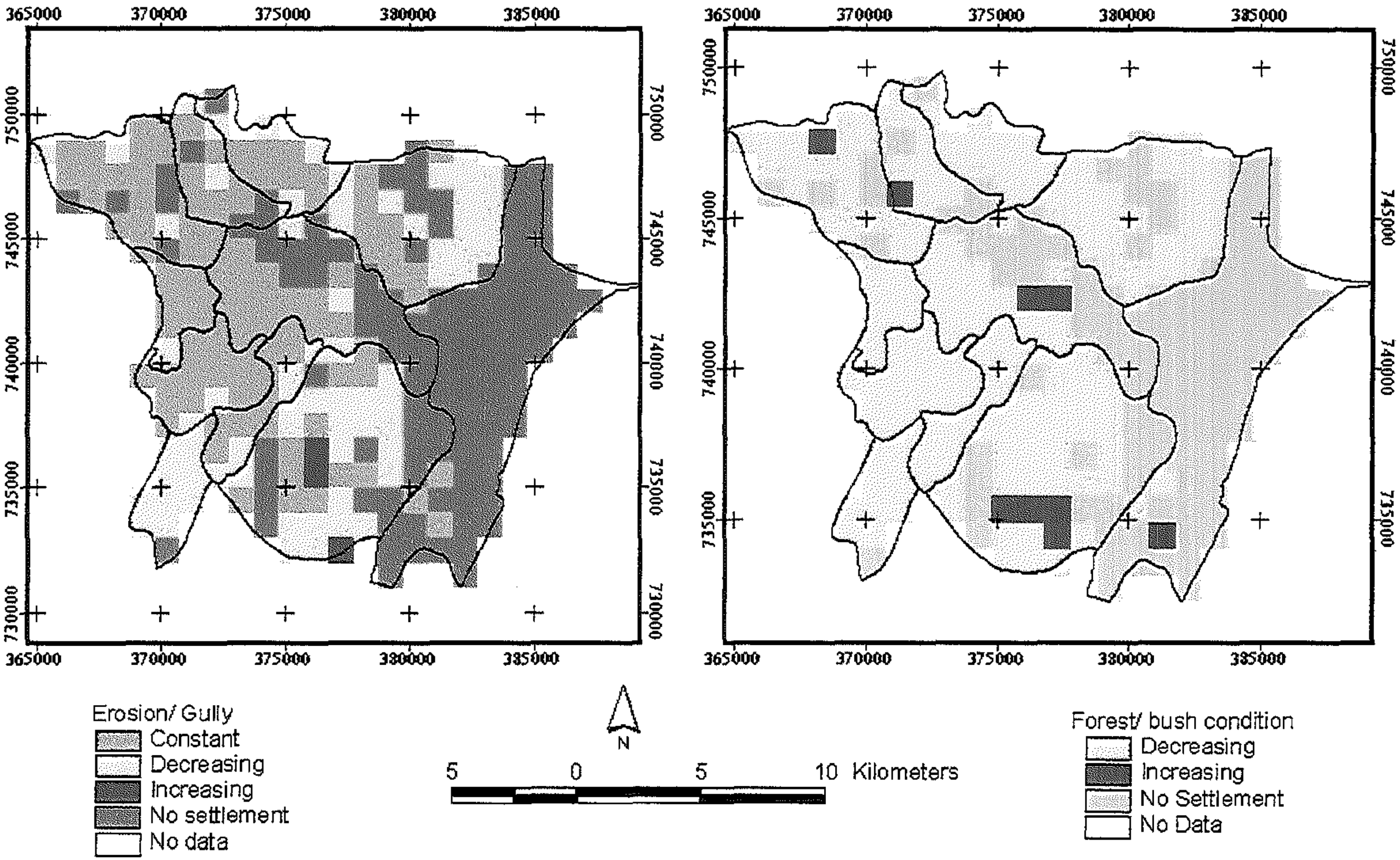


Figure 26: Degraded area in Hobicha Bongota PA.

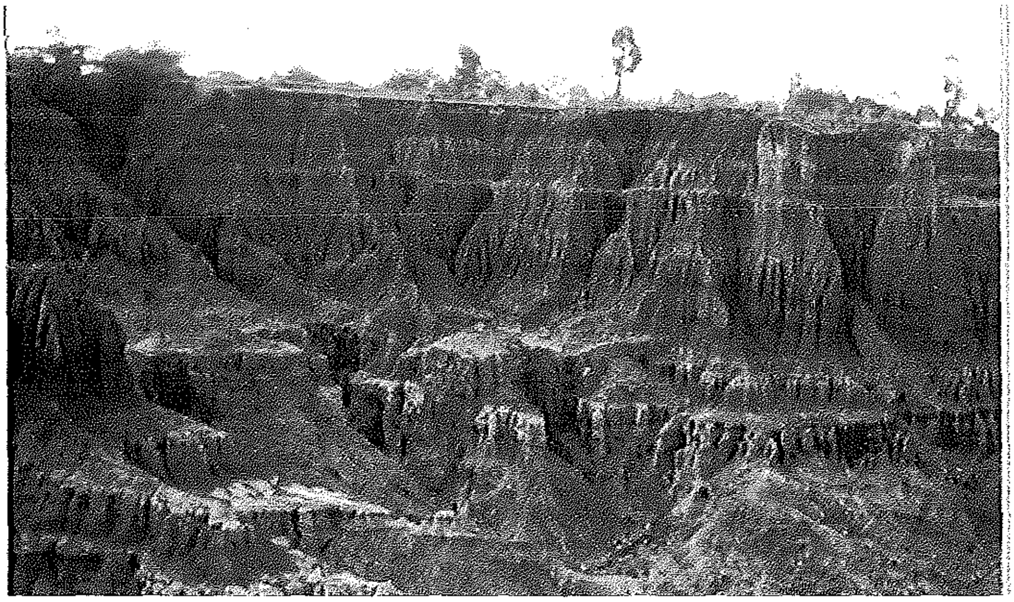
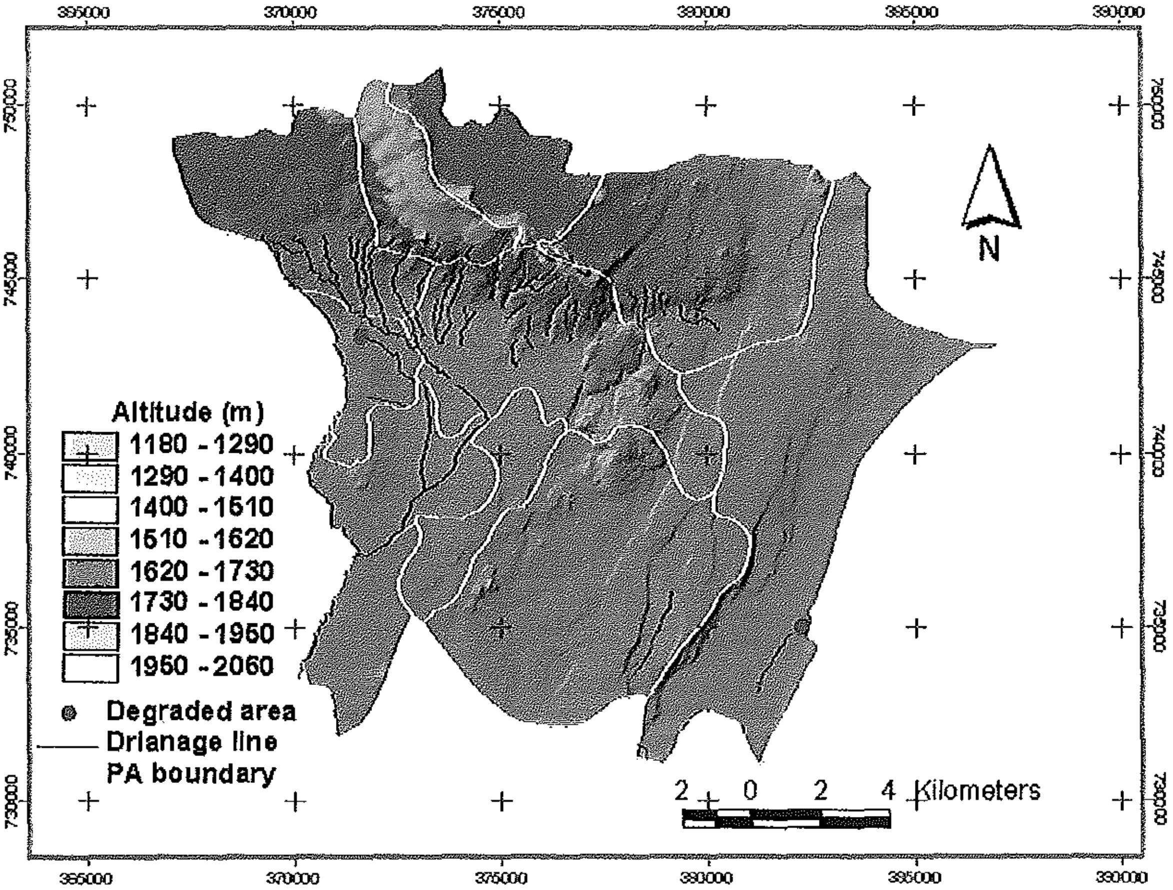


Figure 27: DEM grid map and location of degraded areas



4.5.3 Assessment of the drought situation

Rain fall and temperature time series data of the area in the past 6 years (1999-2004) was scrutinized for change in the amount as well as regularity. Meteorological data of the area on mean monthly temperature and rainfall that was collected by the only meteorological station in the area that was established by the support of World Vision and currently run by Abela Faricho peasant association is used for the analysis. The calculated mean monthly daily temperature of the area is 31.59°c, while the mean total annual rainfall is 854.82mm. As can be seen from figure 29, apart from being scanty the rainfall in the area is highly erratic showing ± 235 mm variations from the mean. High variability in rainfall amount and distribution is a characteristic feature of drought prone areas (Table 4.20).

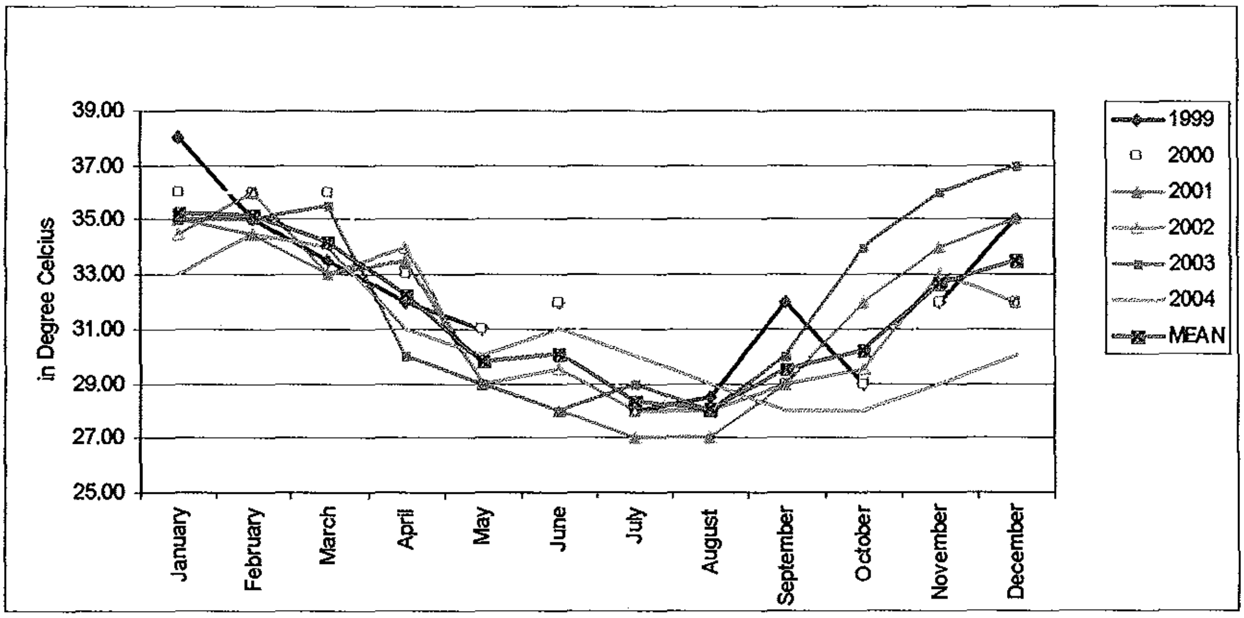
Currently, in Humbo woreda where the study area is found, there are about 32,000 households are chronically food insecure and receiving food aid for the past five years and, about 18,000 households with acute food insecurity receiving temporary food aid. Water and feed shortage especially during the dry season is very serious problem in both kola and woinadega areas. During the dry season people will be forced to buy hay from markets with high prices while others would travel for 3-4 hours to collected hay from the wetland in Zelan Chewkore. Residents in the area confirmed that the feed and water shortage made animals weak, susceptible to diseases and less productive. The observed 23.5% reduction in oxen hour can be explained with this problem.

Table 4.19: Mean monthly temperature of the study area

Month	1999	2000	2001	2002	2003	2004	MEAN	STDEV
January	38.00	36.00	35.00	34.50	35.00	33.00	35.25	1.67
February	35.00	36.00	34.50	36.00	35.00	34.50	35.17	0.68
March	33.50	36.00	33.00	33.00	35.50	34.00	34.17	1.29
April	32.00	33.00	33.50	34.00	30.00	31.00	32.25	1.54
May	31.00	31.00	29.00	29.00	29.00	30.00	29.83	0.98
June	32.00	32.00	28.00	29.50	28.00	31.00	30.08	1.86
July	28.00	28.00	27.00	28.00	29.00	30.00	28.33	1.03
August	28.50	28.00	27.00	28.00	28.00	29.00	28.08	0.66
September	32.00	29.00	29.00	29.00	30.00	28.00	29.50	1.38
October	29.00	29.00	32.00	29.50	34.00	28.00	30.25	2.27
November	32.00	32.00	34.00	33.00	36.00	29.00	32.67	2.34
December	35.00	32.00	35.00	32.00	37.00	30.00	33.50	2.59
Mean	32.17	31.83	31.42	31.29	32.21	30.63	31.59	0.55

Source: A. Faricho local station,May 2005

Figure 28: Mean monthly temperature of the study area



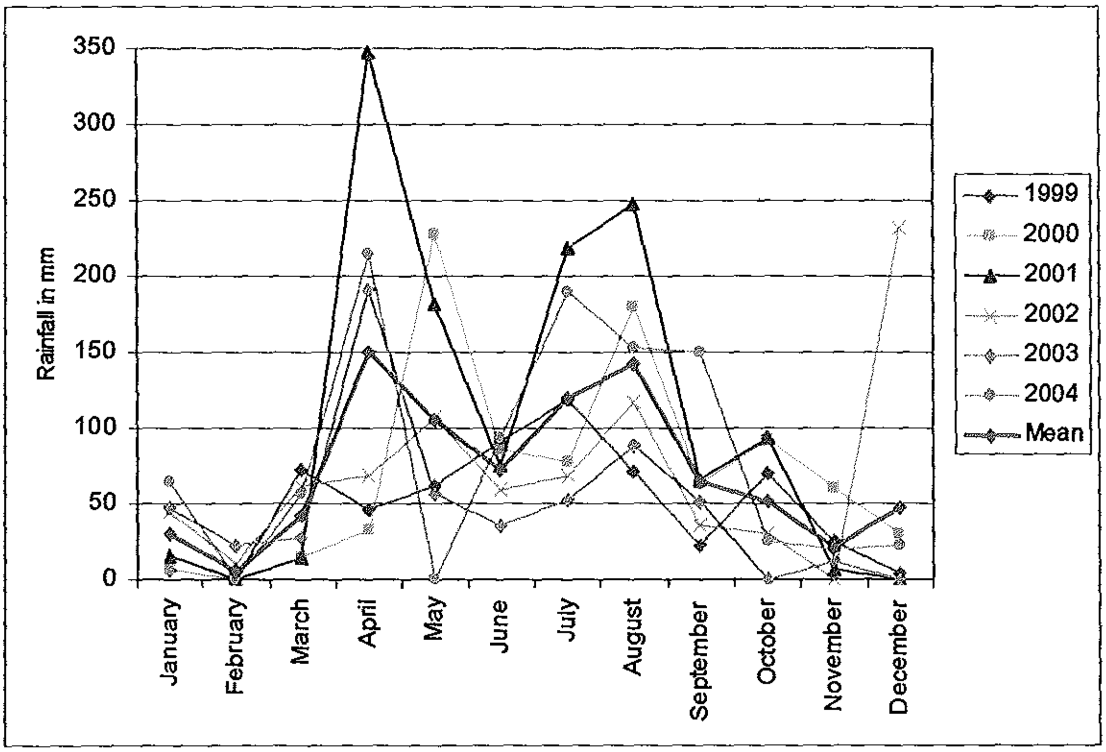
Source: A. Faricho local station

Table 4.20: Monthly rainfall data of the area

MONTH	1999	2000	2001	2002	2003	2004	Mean	STDEV
January	6.00	6.00	16.00	45.00	48.00	64.00	30.83	22.54
February	0.00	0.00	0.00	11.00	22.00	0.00	5.50	8.40
March	73.00	15.00	15.00	62.00	27.00	57.00	41.50	23.34
April	45.80	32.70	347.00	68.00	191.00	215.00	149.92	112.59
May	62.20	227.50	182.00	107.00	56.00	0.00	105.78	77.67
June	91.00	85.00	75.00	59.00	35.00	93.00	73.00	20.46
July	118.00	77.00	218.00	68.00	52.00	189.00	120.33	62.64
August	71.50	180.20	247.00	117.00	88.00	152.00	142.62	59.29
September	22.00	63.80	66.00	35.00	51.00	150.00	64.63	41.17
October	70.10	92.70	94.00	30.00	0.00	25.00	51.97	35.74
November	25.00	60.30	7.00	0.00	12.00	20.00	20.72	19.49
December	4.10	30.00	0.00	232.00	0.00	22.00	48.02	83.06
Total	**588.70**	**870.20**	**1267.00**	**834.00**	**582.00**	**987.00**	**854.82**	**235.69**

Source: A. Faricho local station

Figure 29: Monthly rainfall in the study area



Source: derived from the data of A. Faricho local meteorological station

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary and conclusion

Pertaining to the research questions posed in the objectives of the study, the following major points are generalized and concluded from the results and discussion in the preceding chapter.

- Tsetse fly population and prevalence of trypanosomiasis have been substantially decreased if not removed from the area as a result of the intervention of STEP, the only project engaged in tsetse control/ eradication in the area.

- In relation to this, livestock health condition has been improved while their body and growth condition has not shown similar improvement mainly due to feed and water scarcity in the area.

- With the exception of oxen holding in Kola areas, average livestock holding in the area has decreased. However, the opinion survey indicated increase in livestock population in the area. On the other hand, draught power output in terms of oxen hour/ day/ pair of oxen has been decreased. In relation to these, the possibility that the respondents might refrain from giving the correct number of current livestock holding or memory lapse regarding the past and inability to properly estimate and compare oxen hour are suspected to be the causes for such inconsistencies.

- There have been a clear shift from hand cultivation to the use of oxen power while average cultivated size and production of major cereals that normally require oxen power for their cultivation has increased

- The result of Spearman one-tailed correlation has indicated that size of cultivated land and level of production in both periods has shown positive and moderately strong correlation. However, size of oxen holding and size of cultivated annual cropland as well as size of oxen holding and level of production have shown positive but weak correlation in both periods.

- Based on the available information, in relation to the reduction of tsetse and trypanosomiasis in the area, no significant land use land cover change and human migration into the area have taken place in the last few years that could have environmental implications.

- Signs of environmental degradations as displayed by decrease in size and quality of forest and grazing land, increased soil erosion and gully formations, as well as increased scarcity of fuel wood were visible. This situation is further exacerbated by the recurrent drought in the area.

From the available information and the above generalizations, it is concluded that the so far undertaken tsetse control activity in the area has enabled to significantly reduce the tsetse and trypanosomiasis problem in the area and this in turn has resulted in improvement in the production of major crops that require oxen power for their cultivation. The impact is more visible in kola parts of the study area and this is probably due to the fact that kola areas had been with higher degree of problem and where most impact is expected in livestock health and productivity as well as crop production as the result of increased availability of oxen power.

The prevailing recurrent drought in the area as well as the fact that the very agro-ecologic sub zone in which the study area is found is less suitable for surplus agricultural production due to its short growing period and relatively infertile soil are believed to for conceal the impacts of the tsetse and trypanosomiasis control in the area. Had it not been for the recurrent drought in the areas, which affected the health, reproduction and output of livestock, it is believed that the project impact would have been more visible and similar in all parts of the study area. It is also believed that the project impact would have been more visible had the area been in different agro ecologic zone with better climatic and physiographic make up favoring surplus agricultural production.

A number of other external factors such as the use of agricultural inputs, market conditions, and other socioeconomic factors as well as the level and consistency of project intervention, which were not dealt in this study, could affect the extent of project impact. Besides, the fact that farmer's recall method was employed for data collection and no physical measurement of cultivated size and amount of production was undertaken, could reduce the accuracy of data.

Finally, regardless the outcome of the impact assessment; the process was highly facilitated and benefited from the application of GIS techniques in data acquisition, data analysis and presentation of results. Proper households sampling, in which randomness as well as even distribution of observations was possible. Besides, geocoding of household's positions enabled establishment of spatial database and further flexible spatial analysis. Use of GIS, further enabled change analysis in which magnitudes as well as direction are better displayed.

5.2 Recommendations

Limitations of the study discussed under section 1.6 and the findings of the study, entail further work to be done in refining and strengthening the impact assessment endeavor. Thus, the following general and specific points are recommended.

Baseline data requirement: proper comparison of with and without project situation should be based on, as much as possible, on accurate data. The study was constrained by the absence of baseline socio- economic data in the area and thus, farmers' recall method was applied as alternative source of information. As a result it was not possible to assess the project impact at the desired level. Therefore, it is recommended that any project need to undertake baseline as well as regular monitoring surveys enabling data collection for future project impact assessments.

The need for physical measurements: In such cases where, the study was not complimented with remote sensing data, it is recommended that samples should be taken and physical measurement of cultivated cropland size taken. Similarly, to undertake livestock production and productivity change analysis, regular monitoring of control herds be made.

Environmental degradation; land degradation in the area especially in foothill areas and along drainage lines is very serious. Hence early preventive and mitigation measures such as afforestation and terracing of hilly areas need to be given due consideration by the regional state as well as international organizations operating in the area. The use of multi-temporal satellite data and also the environmental baseline data of the project are believed to be useful for future systematic and detail environmental change evaluation in the area.

Use of satellite data: The use of multi-temporal and real time satellite image of a study area is recommended, as it strongly complements the ground information and enables easy, more accurate and complete land use/ land cover change analysis with GIS.

Consideration of additional factors: To undertake a more complete and all round project impact assessment, it is recommended that other factors affecting the impact are also thoroughly considered. In the case of tsetse control impact assessment, the use of agricultural inputs, market situation, income change etc... need to be considered. In addition to these factors the level and consistency of project intervention need to be assessed as the impact could be affected with it.

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ANNEX : Survey questionnaire

AGRUCULTURAL SURVEY IN HUMBO AREA

An Impact Assessment of the Southern Tsetse Eradication Project (STEP)

Note:

- ***Household head or household decision maker should be interviewed***
- ***The phrase "Before 5 Years" in the Questionaire refers to the period before the start of the Tsetse and trypanosomiasis control activity***
- ***Where space provided in this questionnaire is inadequate use supplementary sheet of paper or the back***
  - Greetings!
  - My name is ________ (tell your name)
  - I work for Addis Ababa University.
  - I am moving around in the village to collect data for a study.
  - The study aims to evaluate the results of the STEP in the area.
  - You and some other households in the village were randomly selected for the study.
  - I would like you to give me answers to some questions regarding STEP.
  - Is it convenient for you if we make the discussion right now?
  - If it is not convenient, when shall I come and talk to you?
  - Thank you!

QUESTIONNAIRE NO.____________

DATE OF INTERVIEW ____________

NAME OF ENUMERATOR ____________________

APPROVAL OF SUPERVISOR________________________

REGION ______________________

ZONE ________________________

WOREDA ______________________

PEASANT ASSOCIATION ___________________________

LOCALITY NAME _____________________

HOUSE NO. ________

STEP GRID NO. ___________

CURRENT E.A. NO. ______________

CSA - E.A. NO. ______ SURVEYED IN 1994 E.C.? ☐

GPS READING OF THE HOUSE

LOCATION (UTM) Lat. ____________ Long. ____________ALTITUDE (mts) __________

SPECIAL LOCATIONAL REMARKS ____

____

SECTION I: HOUSEHOLD CHARACTERISTICS

1. Name of household head ______________________________
2. Sex 1) Male ◻ 2) Female ◻
3. Age __________ (in years) 4)Educational level ____________________
4. Length of stay in this PA in years _____
5. Have you migrated to this area? 1) Yes ◻ 2) No ◻
6. If yes, which year? ___________
7. Name of the previous place: Region ___________ Zone ___________
   Woreda_____________PA ___________
8. List in order of importance the reason that motivated you to migrate to this area?
   ____
   ____
   ____
   ____
9. Family information

	1	2	3	4	5	6	7
No	**Name**	**Sex**	**Age**	**R/ship to Head of HH**	**Period of stay (yr)**	**Educational Level**	**Occupation**

Code: Sex: M= Male, F= Female

R/ship to Head of HH: 1= spouse 2= son 3= daughter 4= parent 5=worker 6 = relative 7= other

Educational level: 1= none 2= literate 3= elementary 4= secondary 5= tertiary 6= other

Occupation: 1= peasant farmer 2= commercial farmer 3= fisherman 4= businessman 5=student 6=civil servant 7= other

SECTION 2: AGRICULTURAL DATA

2.1 Crop Production

10. Type and size of land holding

	1	2	3
No.	Type of land holding	Area (ha)	Remark
1	House and backyard		
2	Annual crops land		
3	Perennial crops (banana, coffee, fruit trees, chat, etc.)		
4	Vegetable garden		
5	Fallow land		
6	Grazing land		
7	Other (wells, threshing field, barns, etc)		
8	Total		

11. Types and size of crops cultivated and total production(main rainy season)

No.	1	2	3	4	5	7
	Type of crop	Current		Five years ago		Reason* for change in production
		Size (ha)	Total Production (Quintal)	Size (ha)	Total production (Quintal)	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

****Code:*** Reasons for change (if more than one reason, indicate all using their codes)
1 = access to more land 2 = shortage of land 3 = availability of oxen power 4= shortage of oxen power 5 = availability of additional labor 6= shortage of labor 7 = bad weather 8 = presence of good weather 9 = other (specify as remark) 10 = nothing special

12. How did you cultivate your land five years ago?

1) by hand □ 2) by oxen □ 3)both □ 4)other means ____________

13. If by oxen 1)with own pair of oxen □ 2) integrating own ox with others□ 3) rental □

4) If more than one answer, list the options ________

14. How do you cultivate your land at present?

1) by hand □ 2) by oxen □ 3)both □ 4)other means ____________

15. If by oxen, how?

1) with own pair of oxen □ 2) integrating own ox with others □ 3) rental □

4) If more than one answer, list the options ________

16. What type of fertilizer do you use currently?

1) Artificial fertilizer □ 2) manure □ 3) compost □ 4) other specify _______________ 5) none □ 6) If more than one answer, list the options ____________

17. Artificial fertilizer and selected seed utilization (quantity in Kg.)

	1	2	3	4	5	6	7
No	Type of Crop	Artificial Fertilizer				Selected seed	
		Current		Five years ago		Current	Five years ago
		Type	T. quantity	Type	T.quantity	T. quantity	T. quantity
1							
2							
3							
4							
5							

Code: Type of fertilizer:1= DAP 2= Urea 3 = Other 4= DAP and Urea 5=Other mix

18. If you are using manure as fertilizer, since when? _________ (year).

19. If you were not using manure, what was the reason?

1) no manure □ 2) manure used as fuel □ 3)no tradition of using it as fertilizer □

2.2 Livestock Production

20. Do you keep livestock? 1)yes □ 2)no □

21. If yes, number of livestock average value in Birr.

No	1 Type)*	2 Number 5 years ago	3 Present Number	4 Reason for change	5 Average unit Value 5 years ago	Average Unit Value At present
1	Cows					
2	Heifers					
3	Oxen					
4	Steers					
5	Calves					
6	Sheep					
7	Goats					
8	Donkeys					
9	Mules					
10	Horses					

*Note: calves 0-2 years heifer/ steers 2-4 years ox/ cow above 4 years

Code: Reasons for change in no: 1 = natural breeding 2 = purchase 3 = sell 4 = natural death, 5 =death due to illness 6 = get/ give as gift 7= temporary holding,

22. Have you ever bought cattle before 5 years ago? If no, what was the reason?

1) had no money ▫ 2)no supply in market ▫ 3) health problem to raise animals ▫

4) no need to buy ▫ 5) If more than one answer, list the options ________________

6) other specify ________________

23. Have you ever or sold cattle before 5 years ago? If no, what was the reason?

1) had no excess animals to sell ▫ 2) no demand ▫ 3) health problem to raise animals ▫

4) no need to sell ▫ 5)If more than one answer, list the options ________________
6) other specify ________________

24. Livestock (cattle) productivity

	1	2	3	4
No	Production parameter	Five years ago	At present	Remarks
1	Age at maturity (yr)			
2	Age at first birth(yr)			
3	Calving interval (mths)			
4	Milking rate (no in a day)			
5	Daily milk yield (liter)			
6	Lactation period (mths)			
7	Cattle finishing period (mths)			

25. If there are changes in the conditions, what are the reasons?

1. ________________
2. ________________
3. ________________

26. How long a pair of oxen can plough in a day 5 yrs ago?__________ (in hours)

27. How long a pair of oxen can plough in a day at present?__________ (in hours)

28. If there is change in output what was the reason?

1. ________________
2. ________________
3. ________________
4. ________________

SECTION 3: TSETSE FLY AND TRYPANOSOMIASIS

29. Is tsetse fly/trypanosomiasis a problem in your area? 1)yes ▫ 2)No▫

30. If yes, since when does it become a very serious problem in the area? ________________ year

31. If no, did you use to take your animals to tsetse infested areas for grazing or watering?

1) yes ▫ 2)No ▫

32. What are the main symptoms of the disease?

1. ________________
2. ________________
3. ________________

33. What are the major consequences of the disease on your animals and farming?

    1. ______________________________
    2. ______________________________
    3. ______________________________

34. Were your animals sickened due to this disease? 1) yes □ 2)no □
35. Are there any animals of yours that have died due to the disease? 1) yes 2)no
36. If yes, how many? _
37. When was the last death from the disease encountered? ______________ year
38. How were you protecting your animals from the disease in the past (five years ago)?

    1) treatment □ 2) keep animals in other free areas □ 3) both □ 4) do nothing □

    5) no problem □
39. If your animals were getting protective or curative treatments in the past (5 years ago), where were you taking them for the service? 1)government animal health clinics □

    2)NGO □ 3) private animal health clinics □ 4)traditional medicine □ 5) self □ 6) If more than one answer, list them ______________________________
40. If they were getting treatment at health centers, how many times were they treated in a year? ______
41. How many of your animals were getting the treatment 5 years ago?

    1) all □ 2) more than half □ 3) half □ 4)less than half □
42. How do you protect your animals from the disease at present?

    1) treatment □ 2) keep animals in other free areas □ 4) both □ 5) no problem □
43. If your animals are getting protective or curative treatments at present, where do you take them for the service?

    1)government animal health centers □ 2)NGO □ 3) private animal health service □

    4)traditional medicine □ 5) self □ 6) If more than one answer, list them ______________

    ____
44. If they are getting treatment at health centers, how many times do they get treated in a year?______
45. How many of your animals are getting the treatment at present?

    1) all □ 2) more than half □ 3) half □ 4)less than half □ 5)none □
46. How is the present situation of the following conditions in the area compared to the situation 5 years ago?

No	Condition	1 Increased	2 Decreased	3 Constant	4 Can't say
1	Tsetse fly abundance				
2	Trypanosomiasis prevalence				
3	Mortality due to trypanosomiasis				
4	Calf mortality				
5	Abortion				
6	Treatment frequency				

47. If there are changes regarding the above conditions, what are the reasons?

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

48. In your opinion, how is the current condition of livestock in the area when compared with the situation 5 years ago?

No	Conditions	1 Improving	2 Decreasing	3 Constant	4 Can't say
1	Health condition				
2	Body condition				
3	Growth				

49. If there are changes regarding the above conditions, what are the reasons?

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

50. Were your crop fields found in tsetse-infested areas? 1)yes □ 2)no□
51. If yes, have you ever evacuated a land due to the problem? 1)yes □ 2)no □
52. If yes, when was that? __________ year
53. If yes, how much was the evacuated area? _______ (indicate the unit)
54. Is there any plot of land that you are able to reintroduce from the land that you had evacuated 1)yes □ 2)no□
55. If yes, how much is its area? ___________ (indicate the unit)
56. Do you know a project called STEP 1)yes □ 2)no □
57. If yes, how did you come to know it?
    1) were project beneficiary 2)heard from other people
58. If you were beneficiary, how do you evaluate the result of STEP in your area?
    1) excellent □ 2) good □ 3) fair □ 4) poor □
59. If you were not beneficiary, do you like to be part of it in the future? 1)yes □ 2)no □

SECTION 4: ENVIRONMENT RELATED

60. How do you evaluate the extent of the following features in your vicinity in the past 5 years?

No.	Features	1 Increasing	2 Decreasing	3 Constant	4 Can't say
1	Extent of new settlement				
2	Human population				
3	Livestock population				
4	Extent of forest / shrub land				
5	Extent of grazing land				
6	Quality of the grazing land				
4	Extent of soil erosion				
5	Extent of new settlement				

61. If you have expanded your farm, which area did you include as new crop area?
1) tsetse abandoned crop land □ 2) grazing land □ 3) bush and forest land □ 4) hill/ slopes □ 5) other areas □ 6)If more than one answer, list the options ________

62. What kind of source of energy were you using for cooking five years ago? Indicate in the order of importance. __Wood, ____charcoal, ____dung (manure), ______crop residue

63. What kind of source of energy do you use for cooking at present? Rank in the order of importance. Wood, ____charcoal, _____dung (manure), ______crop residue

64. If you were using wood or charcoal 5 years ago, from where were you getting it?
1) buy from local market □ 2) collect from forest □ 3)collect from own property□
4) If more than one answer, list the options ______________

65. If you were collecting fuel wood from forest, how do you describe its availability 5 years ago?
1)very plenty □ 2)fairly plenty□ 3) scarce □

66. If you are currently using wood or charcoal, from where did you get it?
1) buy from local market □ 2) collect from forest □ 3)collect from own property □
4) If more than one answer, list the options ______________

67. If you are currently collecting fuel wood from forest, how is its availability?
1)very plenty □ 2)fairly plenty □ 3) scarce □

68. What positive things or changes have you observed as a result of the STEP activities on the environment and in your life in general other than the tsetse and trypanosomiasis control?
1. ____
2. ____

69. What negative things/changes have you observed on the environment and in your life in general, as a result of the STEP activities?
1. ____
2. ____

Thank YOU!!