GRASSLAND COMPOSITION AND CURRENT LIVESTOCK FEEDING SYSTEMS IN NEKEMTE AWRAJA

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A C K N O W L E D G M E N T

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Abstract

In this study, grassland composition and current livestock feeding systems practiced in Nekemte Awraja were investigated. For the investigation of the grassland composition, plant materials from ninteen different sites of this Awraja were collected and identified. For the current livestock feeding systems practiced in the Awraja, representative farmers were interviewed about the current livestock feeding systems practiced in their respective zones.

As the result of this study shows, the vegetation of Nekemte Awraja changes with change in elevation and based on this, the region is divided into three main ecological zones, namely: Highland, Medium altitude and lowland zones. A total of 36 grasses, four legumes, four sedges and 24 tree species were identified for the region. During the survey soil samples were also collected and analysed and the results are included.

Grasses such as Andropogon abyssinicus, Cynodon dactylon, Pennisetum Schimperi and Pennisetum glabrum were dominant in the highland zone of Nekemte Awraja. HYarrhenia hirta, Hyparrhenia rufa and Sporobolus natalensis Commonly occur in the medium altitude zone. Pennisetum Schimperi and Pennisetum glabrum were also frequently found in this zone. In the lowland zone of this region Hyparrhenia species such as Hyparrhenia diplandra, Hyparrhenia anti-stirioides and Hyparrhenia Collina were largely grown. In general, grasses

of good grazing value were found in larger proporation in the highland zone. The proportion of legumes in all of the grasslands studied was very low.

Soils in this Awraja in general are strongly to moderately acidic. Phosphorus in these soils is low to very low, organic carbon and total nitrogen are medium to high.

In Nekemte Awraja, mixed farming is practiced, but farmers are engaged more in the production of cereal crops for family subsistance. Livestock are raised for draft purpose and to provide money in case of emergency. In this region, fire is used as the only tool of pasture management system. Fodder conservation method for the dry season feed is virtually unknown. Cattle in this region mainly feed on natural pastures. 'Atela' (a residue from preparing 'tella' or 'araki'), teff straw, boiled barley and finger millet bread are given mainly to oxen and milking cows as a supplimentary feed.

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INTRODUCTION

For the increased production of food and feed in the tropical areas of the world, it is an immediate need to put more emphasis on the production potential of the grasslands. Ethiopia, with an approximate total area of 1,221,900 sq. km. (U.S.A.I.D. 1968) lies within the tropics. It is a country with favorable environment and wide resource of traditional skill and experience in livestock raising. In addition, the country has also enormous grasslands most of which are for grazing animals. Wherever the grazing lands are exploited by man, they are much often used for raising livestock. The livestock population which is ranking eight in the world and is considered to be the highest of any country in Africa (it is estimated that 20% of the Africa's total cattle population is located in Ethiopia (F.A.O. 1975) represents a considerable part of the country's national income.

Ninty percent of the Ethiopia's population is engaged in traditional livestock farming activities (F.A.O. 1975). Agriculture contributes about sixty percent (F.A.O, 1975) or about fifty percent (10-years development plan of Ethiopia, 1981) to the gross domestic product (G.D.P.) and the lives stock sector about twenty five percent. Although the productivity of cattle and other species of animals is generally low, livestock products are nevertheless, one of Ethiopia's major exports. The agricultural sector contributes about ninty percent of the total export and within the agricultural sector, the livestock subsector contributes about thirteen percent (F.A.O. 1975). Livestock and livestock product exports have been second in importance to coffee. Hence, livestock contributes the single most important industry that can satisfactorily be diversified in a relatively short period of time (Livestock and Meat Board, 1976).

In Ethiopia, cattle are investment in the first place and also provide draft power for the ploughing and cultivation of land. In most parts of Ethiopia, the entire marketed produce of the country from the growing areas to the primary markets and from these markets to the trading centers are carried by pack transport. Camels are used in the low dry areas. Horses, mules and donkeys are used in the highlands. Most of the imported goods also reach the farmers through such means of transport . Hence again these transport animals must be counted as one of the major resources of the country. Inaddition, livestock play a major role in the diet of farmers and their families. Inspite of all these, the livestock products are not fully exploited and utilized because of the low productivity of the cattle.

Low productivity of Ethiopian cattle is a result of many factors among which nutrition is one of the major ones. For the country as a whole the existing feed production could cope up with only about 53% of the requirements (Animal and Fishery Resources Development Authority. A.F.R.D.A., 1978). Within the present supply, a further analysis shows the dominating role of natural pastures. They provide more than 90% of the existing feed of livestock (A.F. R.D.A., 1978).

The natural grasslands of Ethiopia are of varying types on different altitudes and consist of a wide range of grasses, legumes, and other herbaceous species. In many parts of the country, these are utilized in a traditional fashion. They are low yielding and their production is insufficient. In several parts of the country grazing conditions are unfavorable for more than half of the year (F.A.O., 1975). Inaddition, these available grazing areas during the last several decades were continuously and rapidily shirinking allover the country because of a speedy expansion of cultivated land (A.F.R.D.A., 1978)

So, in a country like Ethiopia where the livestock sector contributes a considerable share to the nation's economy and where animal feed is provided almost entirely by natural pastures, it is essential to have basic information concerning make up of the vegetation particularly the botanical composition of the natural grasslands. Such information will aid for efficient utility and maintenance of the grazing land.

Through proper management practices, it is possible to maintain the grass cover at optimal levels of productivity over long periods of time. The management practices develop largely as a result of detailed ecological studies on the knowledge of the botanical composition of the natural vegetation and knowledge of the natural stands of the pasture and the ecosystem aid much in the improvement of grasslands (Rottary, 1960).

Knowledge of the vegetation of a country or of a specific region helps in the selection of sites on which to locate any research program (Shaw and Bryan, 1976). So, it is a pressing need that the first step in planning of any experiment in any field must be a clear understanding of the situation where the work is intended to be done. This understanding is gained only by collecting, recording and properly presenting the information drawn from much wider and reliable source (Shaw and Bryan, 1976).

Based on this fact, this study was carried out in Nekemte Awraja where so far no information is available on the systematic studies of the occurence and distribution of natural forage species. The main objectives of the study were:-

1. To get basic information about the botanical composition of the grassland vegetation of the different climatic zones of Nekemte Awraja and investigate the useful endigenous ecotypes of grasses, legumes and sedges.

2. To asses the current livestock feeding systems practiced in the Awraja and investigate problems associated with it.

Nekemte Awraja is one of the six Awrajas of Wollege Administrative Region. Wollega is located in the western part of Ethiopia at 8-12^{o} latitude and 35-38^{o} longitude. Nekemte Awraja covers eastern and a part of central Wollega. It is borded by Jibat and Metcha Awraja on the East (Showa Administrative Region); Ghimbi Awraja on the west, Horoguduru Awraja on the north and Arjo Awraja and Keffa on the south.

Wollega has a total area of about 71,240 km^{2} and a population of about 1,110,700 (Ministry of Land Reform and Administration, M.L.R.A., 1968). Out of the total area of Wollega, Nekemte Awraja covers about 6500 Km^{2} (10% of the total area of Wollega) and has a population of 212,900 which is about 19.2% of total population of Wollega(M.L.R.A., 1968).

LITERATURE REVIEW

Climate of Nekemte Awraja

Climate which is mainly controlled by the atomosphere and altitude of any area has an influence on the natural vegetation, cropping systems, characteristics of soils and types of crops grown in that particular area (Pratt and Gwynne 1977).

According to Westphal (1975), Nekemte Awraja lies under two types of climatic regions. One of these is the type of climate which also occures in the Eastern Highlands and in the Rift-valley between Lake Shalla and Lake Abaya. The temperature within this climate is lower than that of the surrounding lowlands (monthly average below 18°C) lowest in winter and highest in spring because summers are very cloudy. Usually annual rainfall ranges between 900 mm and over 1500 mm with high maximum in summer and lower minimum in spring.

The other climatic type is the type of climate in which the average monthly temperature is below 18°C. The largest area of this type of climate is found in south west Ethiopia (Keffa, Illubabor and Wollege) at elevations between 1650 and 2250 m.

Rainfall The amount of rainfall that a given area receives depends on altitude, exposure, relief, latitude, longitude, temperature and winds (Amare, 1978). Other things being equal, rainfall increases with an increase in altitude, but exposure and relief have more influence on the precipitation of an area than altitude and the effect of relief varies with slope and elevation (Amare, 1978).

Nekemte Awraja lies in the climatic region where the main rainfall occurs between June and September. But in this region the seasonality of rainfall is such that the heavy rains occur in the three months June, July and August.

Heavy showers appear to start in early May and some times in April and continue upto October. Although the peak of the rainy season is in August, it may occur in July or September. In general, the minimum monthly rainfall is found between November and February (Huffnagel, 1961). The amount of cloud cover is high from the end of May to the middle or end of October. The relative humidity, which affects the rate of transpiration in plants and the rate of respiration in animals, is also high within these months. The cloud cover and relative humidity of the region show a marked decrease from November to February and from time to time the dry easterly winds penetrate and cover the whole region. Hence there are spells of cloudless conditions (Huffnagel, 1961).

Soils:- The geologic formation of Wollega is mostly old crystaline rocks with some tertiary trapean lava (M. L.R.A. 1968). In Nekemte Awraja soils are mainly alfisols, vertisols and inceptisols (Westphal, 1975). In the Eastern part of Nekemte, soils are clay-loams to clays in texture, red-brown to dark-brown (near Nekemte brick-red) in color, strongly to medium acid (PH, 4.9 to 6.3) and have a high organic matter content (6.4 to 13.6%). The availability of phosphorus is very low and that of potassium is medium to high (Westphal, 1975). West of Nekemte to Didessa valley, soils are clay-loams to clays, red-brown to brown, strongly acidic (Ph, 4.9 to 5.9) and their organic matter content is reasonably high (Westphal, 1975).

Vegetation:- The vegetation of any area is the product of plant materials available, land forms, soil, climate, drainage and other factors, such as fire and grazing (Pratt and Gwynne, 1977). The modification of environment

by the vegetation through transpiration, circulation of minerals and plant decay and altitude have the primary influence on the vegetation (Breitenbach, 1963).

As stated by Pratt (1977) all species of plants cannot occur at all sites because each taxon has only one center of origin with limited time and opportunity for extending its geographical range. Thus each species has its own adaptability. Adaptability is the function of specific morphology and physiology of the species which permits it to grow under some environmental conditions. Within one geographic region, species of different morphology and physiology occupy different habitats while similar habitats in different geographic regions can be occupied by species of similar morphology and physiology eventhough the floras may differ.

According to Shaw and Bryan (1976), a knowledge of the vegetation of a country or region in relation to other major factors of environment helps to define the area as to what type of farming practice or agricultural activity the area is suited. It also helps in selecting sites for conducting experiments to solve problems.

When people are intending to study the vegetation of any area, they follow different sampling systems based on the type of plant community they want to study. In plant commnity studies, samples are taken and the vegetation of the area is evaluated or determined based on the samples taken. Usually it is difficult to count or measure all the members of a community and even if this could be done, the information obtained would not be useful or significant than an adequate set of data aquired by proper sampling (Oosting 1954).

As stated by Jhones and Hargreaves (1979), botanical composition expressed as proportion of above ground biomass is an important measure of vegetation

particularely in pasture studies. There are several ways by which percent composition of species occupying a grassland can be known. T'Mannetje and Haydock (1963) and Brown (1954) have distinguished four methods for a quick and accurate botanical analysis of a grassland on dry matter weight basis These are:-

a) Hand separation and weighing of cut herbage.

b) Estimation of percentage weight in cut herebage.

c) Estimation of percentage weight in the field.

d) Estimation in units of weight of each species in the field.

Among these methods the first one is the most accurate if sufficiently large number of samples are used. Nevertheless, the method is time consuming and requires drying facilities.

Generally, weight of plant material is expressed on the dry matter basis rather than on fresh (green) basis; because dry matter is a solid substance which is not subject to daily flactuation in moisture content as fresh weight (F.A.O., 1980).

In the study of grasslands where individual plants are not clearly distinguished, number has a limited use in estimating percent composition. As stated by Thotill (1978), number is often expressed as the density or abundance of a component. It represents the count of one or all of the species or parts of plants such as tillers, flowering tillers, vegitative tillers etc., in a given area. Because of the difficulties in clearly defining plant units in grasslands, number is often estimated. The estimation of a number in a stand of plants of mixed form is very difficult and sometimes has been found erronous. So, where large forms or habit differences exist in the vegetation, it is better to stratify the sampling into catagories or species without bias.

In vegetation studies, samples are taken by the use of sample units or plots known as quadrats and the method of sampling by the use of plots is commonly called the quadrat method. Although quadrats are often used forms of sampling units in grassland studies, they vary considerably in size and shape (Oosting, 1954).

By definition quadrat is a square, but various shapes, from rectangular to circular, are now referred to as quadrats. Both the size and shape of quadrats have an effect on the sampling efficiency of any type of vegetation. In grassland vegetation, since community is rarely homogenous, it is necessary to have large samples to include all the variation and to have it fairly represented in the data (Oosting, 1954).

According to Oosting (1954), small plots require less work than large plots, both in layout and in obtaining data eventhough more small plots are needed than large ones for complete sampling. As far as shape of quadrats are concerned, rectangulars are useful in the grassland vegetation studies since they tend to include better representation of vegetation.

Ecological Classification

Ecological classification generally indicates the type of vegetation which exist naturally at each zone regardless of the present effects of human action such as clearing and cultivation (F.A.O., 1980).

When carrying out surveys, different individuals describe ecological zones differently according to various characteristic features such as:-

- Climatic differences with especial reference to the degree of humidity or aridity (Pratt and Gwynne, 1977).

- General appearance of existing or potential plant communities, such as the height and growth forms of the dominant plants (Edwards and Bogdan, 1951).

- The taxonomic identity of the dominant genera (Edwards and Bogdan, 1951).

- Different types of habitats such as deserts semidesert, seasonal swamp etc.

- Physiographic descriptions such as highlands, lowlands and coastal (F.A.O., 1980).

According to Amare (1978), Westphal (1975) and Breitenbach (1963), three traditional climatic and vegetational zones are recognized in Ethiopia based on elevation and temperature:-

1) Kola (semiarid or hot zone) - with average monthly temperature above 20°C, below 1800 mm above sea level.

2) Woinadega (Semi highland or temperate zone) with an average monthly temperature during the warmest month at most 20°C, between 1800 m - 2400 m above sea level.

3) Degga (Highland or cool zone) - 2400 - 3500 m above sea level.

According to Breitenbach's division, Kola (hot zone) is below 1600 - 1900 m with an average temperature of 20-29°C; Woinadega (temperate highland) is from 1600 - 1900 m to 2400-2600m with an average temperature of 16-20°C and degga (cold mountains) in altitudes above 2400 - 2600 m with an average temperature of 10-16°C. According to Amare (1978), among the climatic and vegetational zones of Ethiopia, Woinadega is the largest zone which supports the largest human and livestock population. The Kola zone except in the south and south-west is an escarpment on low plateu system with lower rainfall. Degga zone is the coolest zone where frost commonly occurs particularly at higher elevations and in depressions.

Nekemte Awraja has extensive areas which lie under the three traditional climatic and vegetational zones (Hailu, 1963). According to Hailu (1963), the

deg.ga zone of this region is limited to the Tuka: area and the Kola Zone includes areas such as Didessa, Anger and Wam[illegible]a valleys.

Report of land tenure survey of Wollega Administrative Region (Wollega province, 1968), indicates that Wollega is mostly covered with decideous woodland along the western regions and savanna in the north-western and central parts. The north-eastern part is covered with mountain scrub and thicket. Tropical rain forests are scattered in the south-western, centeral and south-estern parts. Mountain grasslands and swamps cover only a small portion of the north eastern and western parts.

According to FAO (1973), Wollega has the following vegetation zones depending on the dominance of existing plant communities. These are:- Savanna, bushed-grassland , scattered tree grassland and forest. These vegetation types have the following definitions according to Pratt et al (1977), FAO (1975), and FAO (1980):-

Savanna:- land dominated by grasses and occassionally other herbs sometimes with widely scattered or grouped trees and shrubs, the canopy cover of which does not exceed two percent. The number of plant species occuring in savanna is greatest in the most favorable environmental conditions and typically in situations in which the influence of man is least imposed.

Bushed-grassland:- Grassland with scattered or grouped shrubs which have a conopy cover of about 2-20%.

Wooded-grassland :- Grassland with scattered or grouped trees. The trees are always conspicous, but having a canopy cover of less than 20%.

Forests:- Land covered by a closed stand of tall trees of one or more story with an inter-laced upper canopy rising to 4-7m or more in hieght as found along rivers or in high rainfall areas. In the forests, the ground cover is dominated by herbs and shrubs and lianes. The grass cover is sparse.

Open - wooded - grass lands are intermidiate zones occuring between the savanna and the forest with the main woody species belonging to the genus Terminalia, Albizzia, Cordia, Combretum and Ficus. The dominant grass species are mainly Hyparrhenia. The potential of this type of grassland is good for livestock development (FAO, 1975). Forest zones are the most extensive in the highland areas. The vegetation in the forest zones is mixed broad-leafed forests of Albizzia, Pygeum, Schefflera, Croton, Eckebergia Syzygium species and coniferous forest. Through the forest zones there are extensive grasslands which have good potential for livestock development particularly sheep production. The area has also good cropping potential especially for cereals (FAO, 1975).

According to Hailu (1963), forests are rare in Nekemte Awraja and are usually observed at Tuka region on areas where the land is too steepy for farming and/or along river banks. The species of trees found in the resparian forest include trees such as Cordia abyssinica, Proteria ferruginia and Syzzgium guineense. The species which are found in the upland forest are:- Juniperus procera, Podocarpus gracilos , Haginia abyssinica and Croton machrostachys. At Kola zone of the region, trees such as Ficus Brachypoda and Acacia abyssinica are found.

As indicated by Hailu (1963), thinning out of the stand of trees in the Kola zones of this region is the result of burning practice which can be traced back for generation. The scattered trees found might be the remenants of what at one time was dense forest. As further indicated by Hailu (1963), the inhabitants of this region intentionally burn grasslands to clean old forages, to control insects and ticks and sometimes to expand farmlands. Periodic burning practices are often advisable in grassland management programs to check bush growth and accumulation of dead herbage which hinders fresh growth. So,

it is essential that pastures which are not closely grazed should be burnt periodically to maintain palatability and nutritive value of the herbage (Van Rensburg, 1969).

According to Brockington (1961), for a grass, fire to be of maximum benefit in preventing colonization by woody plants, must occur late in the dry season when the woody plants are actively growing and when the grasses are still dormant and when there is maximum accumulation of dry grass to burn. Early dry season burning before the grass gets dry, is generally slow, incomplete and discontinous. So, it is determintal to grasses which often shoot after burning and then die back with continued and prolonged dry weather (Van Rensburg, 1969). Generally, early dry season burning is more advantageous in the forest and woodland conservation except in main forest areas where total protection from fire is essential.Late dry season burning is good for pasture management (FAO, 1964).

The use of fire in the grassland management program is of advantage if it is combined with correct grazing practices. If cattle are allowed to graze on recently burnt grasses, they would prefer the most palatable species (FAO, 1964). Grazing influences the structure and function of grasslands in several ways depending upon the vegetation type, rainfall and the period and intensity of grazing.

Natural pasture communities are very complex consisting of a large range of grasses, shrubs and herbaceous species among which only few species are palatable. Livestock are able to selectively graze a small propertion of the palatable herbage available and ignor the undesireable ones. If the grazing pressure is high, then a decline in the quality and productivity of grassland occurs (Coupland, 1979, Lazenby and Swain, 1969).

When a grassland is overgrazed, the most palatable species are selected first and closely defoliated. This causes reduced vigour, less seed production and eventually plant death. Overgrazing can also lead to extensive sheet and gully erosion (Heady, 1975, Pratt and Gwynne, 1977).

As reported by Barnard (1966), grazing reducesleaf area of plants and this has a direct effect on their storage of carbohydrate, tiller developement, leaf and root growth. In addition, grazing can also alter the environment of plants introducing factors such as trampling and modifying the dispersal of seeds and fruits.

Reduction of vegetation cover by overgrazing and compacting of soil by trampling affects the depth to which the moisture penetrates the soil. This results in the dominance of vegetation by surface-rooted species than deep-rooted species and marked changes in life form may commonly result, i.e. usually perennial species are replaced by undesirable annual species (Barnard, 1966).

Since the whole of plant organism, leaves, stems and roots react to the amount of trampling or grazing which it receives,a weakening of the top growth results in a lighter and shorter root system that dies back from the bottom. Grass roots continue normal growth when not more than about 40-50% of the vegetative parts are removed (grazed) during periods of active growth. But it start to diminish sharply in size if much more than this amount is removed (FAO, 1980). Smaller root system means lower drought resistance especially if the shortened roots do not reach the zone of stored moisture, lower energy reseves, and slow recovery after draught.

Effects of over grazing can be overcomed if grasslands are properly managed. Grassland communities differ widely in their ability to withstand grazing depending on the vigour of their component species as determined

by climate, soil fertility and other factors (Innes, 1977). As further stated by Innes (1977), the ability of grassland to support livestock indefinetely without deterioration is known as carrying capacity and this usually refers to the number of animals of stated average weight that can be maintained per unit area in a year long basis. Since grassland management is a system of manipulating plants and livestock in such a way as to produce a maximum sustained yields of acceptable nutritious herbage on the one hand and of the animals on the other hand, it involves the keeping of animal population within the carrying capacity of the grassland so that the animal is given a scope for survival and a recovery period for the grass especially during the dry season (Innes, 1977).

According to Lazenby and Swain (1969), grasses naturally need certain rest periods to develop, to grow, to seed and to be able to build reserves for the next growing season. So, pasture management involves the allowing of pasture lands certain rest periods by subdividing the land to enable more uniform grazing of the area available and the adoption of certain deffered grazing techniques where necessary to let grasses to build up adequate growth before grazing.

MATERIALS AND METHODS

For determining the grassland composition at different ecological zones of Nekemte Awraja, ninteen representative sites were selected ranging in altitude from 1200 m to 3000 m. The selected sites were: Didessa (two sites). Anger Didessa, Wamma Kusaye (two sites), Anno Gambella, Watto Kechema, Kedjo, Bilo Boshe, Gisho Torbe, Wamma Hagello, Jere, Adiya, Dergae, Digga, Komto, Juka Abbo, Hidebu and Kuye. Samples of species of grasses legumes and sedges at each representative site were taken by using 1/4 m x 4 m quadrats.

Depending upon the uniformity of the stand of vegetation at each site, five to ten quadrats were sampled by cutting. At sites where vegetation stand appeared uniform (based on visual observation), samples were taken only from five places. Whereas at a site where the vegetation stand was not uniform, samples were taken from six to ten spots depending on the digree of variation of the stand.

Samples from a site were mixed after collection and taken to the laboratory in plastic bags for separating and classifying the grasses, legumes and sedges into their different respective groups. Where the sites were far from the laboratory, separation of the plant groups was done right in the field. After the species of each plant group were separated, total fresh weight of each group was taken by the use of spring balance (Anant, 5 kg Capacity). Then, composite sub-samples of each plant group (by species) were weighed and oven (Hearaeus. 330/22, V-2800W and 30-330^{o}C) dried at 100^{o}C for 48 hours for dry matter determination. This was done for all of the selected sites. Based on the dry matter weights obtained; percent composition of each species of grass, legume and sedge for each site was computed. The following procedure was adopted for computing percent composition of each species.

$$\frac{\text{Tfw of a species}}{\text{Sfw of a species}} \times \text{Sdw of a species} = \text{Tdw of that species.}$$

$$\frac{\text{Tdw of a species at a site}}{\text{GTdw of all the species at a site}} \times 100 = \%\ \text{composition of one species at a site.}$$

Tfw = Total fresh weight

Sfw = Subsample fresh weight

Sdw = Subsample dry weight

Tdw = Total dry weight

GTdw = Grand total dry weight

To help in identifying the collected species, representative plants with full flowering head and other vegetative parts from each species were taken and dried under presses. After drying, the specimens were mounted. The commonly known species were identified right in the field and those which were difficult to identify in the field were given code numbers and taken to the National Herbarium at Addis Ababa University for identification. The identification of the specimens was done by the guide of books entitled, An Illustrated Guide to the Grasses of Ethiopia; by Fromann and Persson (1974); A Revised List of Kenya Grasses, by A.V. Bogdan (1976); An Illustrated Guide to the Grasses of Uganda, by K.W. Harker and D. Napper (1960) and by comparing them with previously identified specimens in the herbarium.

During the sampling process, local names of the dominating trees and shrubs around the sampling areas were recorded for each site and their scientific names were taken from books such as the Indigenous Trees of Ethiopia; by Van Frederich Breitenbach (1963) and A Glossary of Ethiopian plant names by Wolde Michael Kelecha (1977). Altitudesof the sampling sites were measured by the use of altimeter (Thommon 2000, Switzerland). Inaddition to the plant samples

collected soil samples were also taken from each site using a procedure given by Tisdale and Nilson (Soil Fertility and Fertilizers, 1966). Forty soil samples were taken from all the selected sites. Color at the moist and dry conditions, texture, PH, and CEC were determined and organic carbon, total nitrogen and phosphorus content of each sample were also analysed.

Rainfall and temperature data from nearer town to the selected sites were taken from the land use planning and soil survey office at Addis Abebe. However, weather data were not available for all selected sites.

For the study of the livestock feeding systems currently practiced by the farmers of this region, two to three representative farmers were selected from each site and were interviewed about the type of grazing management practiced in their respective areas and previous history of the grassland from where the samples were taken. The survey was made from October to mid-December 1980. This period was particularly chosen because it was a period at which the plants sampled reach their full flowering stage and the roads start to dry up and became more accessible for transportation.

Although the sites were selected as being a representative to the Awraja, there might be areas which may not be covered due to inaccessibility by car.

RESULT AND DISCUSSION

Ecological Classification

Ecological zones can be described in different ways based on different characteristic features. According to Edwards and Bogdan (1951), ecological zones are described based on the general appearance of the existing or potential plant communities such as the height and growth forms of dominant plants; the taxonomic identity of the dominant genera and different types of habitats such as desert, semidesert and swamp. Physiographic descriptions such as highlands, lowlands and coastal are also used for the classification of zones (FAO, 1980).

A total of 36 species of grasses, four legumes, four sedges, and 24 species of trees were identified at Nekemte Awraja. A close examination of the vegetation, particularly grasses, indicated that certain species fall within certain altitude ranges (Table 1 and 2). This finding is in close agreement with Pratt et al (1977) and Brietnbach (1963) where they stated that altitude as expressed in temperature and precipitation has the primary influence on the vegetation.

Based on the distribution of vegetation , mainly grass species, Nekemte Awraja was divided into three traditional ecological Zones. These were:

I. Highland (Degga) .....2000 -3000 m above sealevel

II. Medium altitude (Woinadega)... 1500-2000 m above sealevel and

III. Lowland (Kola) ..... 1200 - 1500m. above sea level.

Although the areas studied at Nekemte Awraja did not cover altitude ranges below 1200m and above 3000m above sea level, the lowland could be interprated as being below 1500m and the highland as being above 2000m above sealevel.

The number of species of grasses at Nekemte Awraja was much greater than the number of species of legumes, sedges, or trees. The total percent

palatable grasses, 22.2 was very low suggesting that pasture improvement is essential if livestock production is to be considered in the area.

Table 1. Division of Ecological zones of Nekemte Awraja Depending On the Occurrence of Grass Species.

Grasses	Highland zone 2000-3000m	Med. Ald. zone 1500-2000m	Lowland zone 1200-1500m
Digitaria abyssinica	____		
Digitaria ternata	____		
Eragrostis panciformis	____		
Eragrostis tenuifolia	____		
Exotheca abyssinica	____		
Festuca abyssinica	____		
Hyparrhenia arrhenobasis	____		
Hyparrhenia tuberculata	____		
Snowdenia polystacha	____		
Aristida adoensis		____	
Hyparrhenia anamesa		____	
Setaria phragmitoides			
Sporobolus pyramidalis		____	
Andropogon Canaliculatus			____
Beckeropsis uniceta			____
Digitaria velutina			____
Hyparrhenia collina			____
Hyparrhenia diplandra			____
Leersia hexandra			____
Melinis machrochaeta			____
Pennisetum polystachyon			____
Rhynclytrum repense.			____

____: Shows occurence.

(Table 1 continued)

Grasses Common to Highland and Medium altitude Zones

Andropogon abyssinicus
Brachiaria Semindulata
Pennisetum adoense
Pennisetum glabrum
Pennisetum schimperi

Grasses Common to Highland, Medium altitude and Lowland Zones

Arthraxon quartianus
Brachiaria brizantha
Cynodon dactylon
Hyparrhenia anthistirioides
Hyparrhenia rufa
Paspalum commersonii
Sporobolus natalensis

Grasses Common to Medium Altitude and Lowland Zones

Hyparrhenia hirta
Pennisetum ramosum

Legumes Common to Highland and Medium altitude Zones

Alysicarpus rugosus
Indigofera atriceps
Trifolium Simense

Sedges Common to Highland, Medium altitude and Lowland Zones

Cyperus longus
Fimbristylis dichotoma
Kyllinga aurata
Scleria Schimperiana

Table 2. Division of Ecological Zones of Nekemte Awraja Depending on the Occurence of Tree Species.

Trees	Highland Zone 2000-3000 m	Medium alt.Zone 1500-3000 m	Lowland Zone 1200-1500 m
Albizzia gummifera	———		
Apodytes dimidiata	———		
Bosqueia phoberos	———		
Eckebergia rueppelliana	———		
Embelia schimperi	———		
Maginia abyssinica	———		
Myrica salicifolia	———		
Pitosporum ripicolum	———		
Pygeum africanum	———		
Schefflera abyssinica	———		
Acacia abyssinica	———	———	———
Cordia africana	———	———	———
Croton machrostachys	———	———	———
Syzzgium guineense	———	———	———
Combretum molle		———	———
Entadopsis abyssinica		———	———
Ficus brachypoda		———	———
Ficus thonningii		———	———
Ficus Vasta		———	———
Gardenia lutea		———	———
Grewia mollis		———	———
Lannea schimperi		———	———
Piliostigma thonningii		———	———
Stereospermum kunthiamum			———

———: Shows occurence.

Highland Zone (Degga)

The topography of the highland Zone of Nekemte Awraja varies from slopy mountains to steep slopes and plains. Among the sites selected for this study, Jere, Adiya, Dargae, Digga, Komto, Kuye, Tuka Abbo and Hidebu lie within this ecological zone. According to Hailu (1963), the highland zone of this region is limited only to the Tuka area.

The altitude of the highland zone varies from 2000m (Jere) to 3000m (Hidebu). According to Amare (1978), and Westphal (1975), the highland (Degga, cool) zone in Ethiopia is a zone that lies between 2400-3500 m based on the relation between elevation and temperature. According to Brietenbach (1963), the highland zone is above 2400-2600 m with an average temperature of 10-16^{o}C.

Forests are dominant in the highland zone particularly at Tuka Abbo, Hidebu, Kuye and Komto. At these places around river banks and mountain tops thick forests of different species of many storied are observed. The upper storey consists of taller trees and the lower storey, with thick growth of bushes and sparse grasses. Dominant trees of these forests were Albizzia gummifera, Myrica salicifolia, Pygeum africanum, Eckebergia rueppeliiana, pitosporum ripicolum, Schefflera abyssinica, Apodytes dimidiata, Maginia abyssinica and Embelia schimperi (tables 2 and 3). As one of the FAO reports show , the vegetation in the forest zone of Wollega Administrative Region consists of broad-leafed forests of Albizzia, Pygeum, Schefflera, Croton, Eckebergia and Syzzgium species and coniferus forests. According to Hailu (1963), forests are rare in Nekemte Awraja and are usually observed at Tuka region on areas where the land is too steep for farming and in areas which are low in elevation mostly along river banks. The species that are found in the resparian forests include trees such as Cordia abyssinica, Pouteria feruginia, and syzzgium guineense and the species which are found in the upland forest are Juniperus procera, podocarpus gracilos,

Haginia abyssinica, and Croton machrostachys.

In the highland zone of Nekemte Awraja soils were dark-reddish-brown to very-dark-brown in color particulary in wet condition and silty-clay to clay in texture. In this zone pH of the soils ranged from 5.15 (Adiya) to 5.6 (at Hidebu) which shows that the soils were strongly acidic except at Hidebu where were moderately acidic. Total nitrogen in these soils was high to very high ranging from 0.22% (at Kuye) to 0.52% (at Hidebu). Organic matter ranged from medium to very high, that is from 3.67% (at Digga) to 5.82% (at Hidebu). Available phosphorus in these soils was low to very low except at Jere and Hidebu where it was 21.10 PPM and 19.48 PPm respectively.C.E. C. ranged from 36.7 Meq. 100g of soil (at Adiya) to 50 meq/100g of soil (at Hidebu) which was generally high (table 6).

A total of 21, one, four and 14 species of grasses, legumes, sedges, and trees, respectively, were identified in the highland zone. Nine species of grasses and ten species of trees were found only in this zone.

Among the dominant (based on dry matter weight) grasses that were grown in highland zone of Nekemte Awraja, Exotheca abyssinica and Eragrostis panciformis were common in the edaphic grassland. Edaphic grassland is a grassland developed as a result of impeded drainage and periodically water logged areas (Alemayehu, 1975). These grasses are of low palatability and grazing value.

In derived grassland area of the highland zone, grasses such as Hyparrhenia tuberculata , Digitaria abyssinica, Snowdenia polystacha, Eragrostis tenuifolia, Digitaria ternata, and Festuca abyssinica were found. Derived grassland is a grassaland that is developed largely as a result of clearing, burning, cultivation and grazing (Alemayehu, 1975). Among these grasses, D. abyssinica and S. polystacha are of good grazing value. H. tuberculata and H. arrhenobasis are of low to medium grazing value because they are readily grazed only when

young and become unpalatable when old. E. tenuifolia, D. ternata, and F. abyssinica are of low grazing value. E. tenuifolia has wirely leaves and most of the time occurs in overgrazed pastures. D. ternata also frequently invades pastures particularly when overgrazed and/or wrongly managed.

Digga, Adiya, and Dergae are found at the lower extreme of the highland zone. These areas consisted mainly of open grasslands. Grasses that predominantly occur in these areas were:- Andropogon abyssinicus, Pennisetum adoense, Pennisetum schimperi, pennisetum glabrum and Brachiaria semmindulata (table 3). Among these grasses A. abyssinicus has good grazing value and is also good for making hay. P. adoense also has some value for grazing and hay making. Whereas P. globrum and P. schimperi are coarse grasses with tough leaves of low grazing value. B. semindulata is a small grass of no importance for grazing. Grasses such as Arthraxon quartianus, Hyparrhenia rufa, Brachiaria brizantha, Hyparrhenia anthistirioides, paspalum commersonii, Sporobolus natalensis and Cynodon dactylon were also widely found in the highland zone of Nekemte Awraja (table 3). Among these grasses B. brizantha, P. commersonii and Cynodon dactylon are grasses of good grazing value. H. rufa and H. anthistiriodes as the other species of Hyparrhenia are of low to medium grazing value. Smithia elliotii was the dominant forage legume in the highland zone of Nekemte Awraja. The percentages of good, medium to low and poor quality of grasses in grazing value in this zone were found to be 26.7, 20.0 and 53.3 respectively.

Table 3. Dominant Grass and Tree Species in the Study Sites that Lie within the Highland Zone of Nekemte Awraja.

Location	Range In altitude	Dominant Grasses and % comp. by wt..of each Species	Dominant Trees
Jere About 12 km. North of Bako.	2000-2190m	A. abyssinicus (17%) C. dactylon (16%) H. tuberculata (6%) P. adoense (9%) P. glabrum (5%) P. Schimperi (32%)	A. gummifera C. machrostachys S. guineense
Adiya 10 km East of Nekemte	2000-2150m	A. abyssinicus (10%) C. dactylon (14%) E. abyssinica (23%) E.Paneiformis (9%) H. anthistirioides (5%) P. adoense (5%) P. glabrum (9%)	A. abyssinica C. machrostachys M. Salicifolia S. guineense
Dergae About 15 km South-western Side of Nekemte.	2000 m	A. abyssinicus (6%) E. abyssinica (35%) E. Panciformis 20%) P. glabrum (24%) S. natalensis (7%)	C. africana C. machrostachys E. Capensis P. africanum S. guineense
Digga About 20 km West of Nekemte On the way to Ghimbi.	2100-2200m	A.abyssinicus (15%) C. dactylon (17%) D. ternata (10%) E. Panciformis (5%) H. arrhenobasis (25%) P. adoense (17%) S. natalensis (8%)	C.africana C.machrostachys E. Capensis P. africanum S. guineense

(Table 3 continued)

Location	Range in altitude	Dominant Grasses and % comp. by wt. of each Species	Dominant Trees
Komto About 10 km to the north-eastern Part of Nekemte	2200-2300m	A. abyssinicus (8%) E. panciformis (34%) H. arrhenobasts (8%) P. glabrum (43%)	C.machrostachys P. africanum
Kuye About 20 km north of Sire.	2200-2300m	A.abyssinicus (20%) C.dactylon (30%) E.panciformis (5%) H. arrhenobasis (10%) P. adoense (9%) S.polystacha (19%)	C. machrostachys P.africanum P. viridiflorum
Tuka Abbo About 25 km to the north-eastern part of Sire	2400-2600m	A. abyssinicus (26%) F. abyssinica (8%) P.adoense (13%) P. glabrum (20%) P. schimperi (31%)	A. dimidiata H. abyssinica M.Salicifolia P. viridiflorum
Hidebu About 25 km north of Sire	2500-3000m	A. abyssinicus (50%) C dactylon (30%) P. glabrum (15%)	A. dimidiata F. schimperi H. abyssinica M. Salicifolia P. viridiflorum

Medium altitude zone (Woinadega).

Among the investigated areas, Anno Gambella, Watto Kechema, Kedjo, Bilo Boshe, Gisho Torbe, and Wamma Hagello lie within the medium altitude ecological zone. The topography of this zone ranged from hills and steep slopes to plain fields. The altitude ranged from 1500 m at Anno Gambella to 1980 m at Wamma Hagello.

According to Amare (1978) and Westphal (1975) this zone in Ethiopia is a zone with an average monthly temperature in the warmest month at most 20°C, between 1800-2400 m. According to Brietenbach (1963), medium altitude zone is from 1600-1900 m to 2400-2600m with an average temperature of 16-20°C. Trees such as Gardenia lutea, Ficus ovata, Grewia mollis, Stereospermum Kunthiamum, Ficus vasta, Lanea Schimperi, Ficus brachypoda, Combretum molle, Acacia abyssinica, Cordia africana, Syzzgium guineense and Croton machrostachys (table 4) are widely grown in the medium altitude zone of Nekemte Awraja.

In this zone the soils were strongly acidic to moderately acidic(pH.5.29-5.62) clay-loam to clay in texture and dark-reddish-brown in color particularly in wet condition. Total nitrogen in these soils ranged from high to very high, the lowest (0.17%) at Kedjo and the highest (0.28%) at Bilo Boshe. Organic carbon content was medium (2.11%) to very high (5.48%). Available phosphorus in these soils ranged from very low to low except at Bilo Boshe where it was 24.7 PPM. C.E.C. was generally high in these soils.

Two types of grasslands were observed at this ecological zone. The first and the dominant one was the scattered tree grassland. This type of grassland predominantly occured in all of the areas. The second one was seasonally water-logged grassland. This type of grassland was mostly observed at Anno Gambella, Wamma Hagello and Bilo Boshe. In the scattered tree grassland, tall trees and shrubs were found scattered within the middle of tall and short grasses

and in seasonally waterlogged grasslands, only few trees were observed. The land was mostly occupied by grasses and sedges.

Eighteen species of grasses, four species of legumes, four species of sedges and thirteen species of trees were identified in this zone. The grass species found to grow only in the medium altitude zone were: Sporobolus pyramidalis, Setaria phragmitoides, Aristida adeonse and Hyparrhenia anamesa (table 1) which are of low grazing value. Grasses that commonly found at the upper extreme of the medium altitude zone were, palatable grasses such as A. abyssinicus, grasses of medium grazing value such as P. adoense and unpalatable species such as P. schimperi and B. semindulata.

The trees and grasses that grow at the upper extreme of the medium altitude zone were transitional species between the highland and medium altitude zones. Hyparrhenia hirta and Pennisetum ramosum were grasses that commonly occured at the lower extreme of medium altitude zone. H. hirta is of low to medium grazing value and P. ramosum is low in palatability. These were transitional species between the lowland and medium altitude zones. Grasses which were common in the highland and lowland zones but widely grown particularly in this zone were, palatable grasses such as B. brizantha, C. dactylon, and P. commersonii; grasses of low to medium grazing value such as H. rufa and H. anthistiricides and grasses of low palatability such as S. natalensis and A. quartianus (table 4). Legumes such as Trifolium simense, Indigofera atriceps and Alysicarpus rugosus were also commonly found in the medium altitude zone of Nekemte Awraja.

In general, the dominant species that occured at the upper extreme of this zone were species that were widely grown at the lower extreme of the highland zone and species that were dominantly grown at the lower extreme of this zone were those species which were widely grown at the upper extreme

of the lowland zone. Based on the grazing value, good, medium to low and poor quality of grasses were 26.7, 26.7 and 46.6 percent respectively.

Medium altitude zone as compared to the other two ecological zones has more areas suited for farming. Because of this, the large human population is concentrated here. This is in agreement with Amare's (1978) findings. Several types of crops are grown in the areas lying within this ecological zone and the vegetation is more diversified than highland and lowland zones. Medium altitude zone has the influence of both the highland and lowland zones at its extremes. Since most of the land was under cultivation of food crops, in this region, livestock were allowed to graze only on areas that were not suited for farming.

Table 4. Dominant Grass and Tree Species in the Study Sites that Lie within the Medium altitude zone of Nekemte Awraja.

Location	Range in altitude	Dominant Grasses and % Comp. by wt. of each Species	Dominant trees
Anno Gambella About 15 km to the south-western Side of Bako Research station.	1500-2000m	B. brizantha (7%) H. hirta (13%) H. rufa (34%) P. glabrum (9%) S. phragmitoides (9%) S. pyramidalis (11%)	G. mollis S. Kunthiamum
Watto kechema About 15 km south of Sire.	1650-1750 m	A. abyssinicus (10%) H.hirta (31%) H. rufa (20%) P. ramosum (5%) S. natalensis (20%)	C. molle F. brachypoda L. schimperi P. thonningii S. guineense S. kunthiamum
Kedjo Around Bako Research Station.	1700-1800m	B. Semindulata (8%) H. hirta (8%) H.rufa (20%) P. glabrum (5%) P. schimperi (5%) S. natalensis (48%)	
Bilo Boshe About 30 km to the South-eastern part of Sire.	1700-1800m	H. anthistirioides(5%) H. hirta (50%) S. natalensis (39%)	C. machrostachys C. molle F. brachypoda S. guineense S. Kunthiamum

(Table 4 continued)

Location	Range in altitude	Dominant Grasses and % Comp. by wt. of each Species	Dominant trees
Gisho Torbe	1900 m	H. anamesa (19%)	C. machrostachys
About 10 km to		P. adoense (5%)	G. lutea
the northern		P. schimperi (49%)	S. guineense
side of Bako		S. natalensis (23%)	S. Kunthiamum
Research station			
Wonna Hagello	1930-1980 m	C. dactylon (5%)	C. africana
About 30 km		H. amthistirioides (10%)	C. machrostachys
South of Sire.		H. hirta (15%)	F. brachypoda
		P. adoense (10%)	S. guineense
		P. glabrum (15%)	F. Ovata
		P. Schimperi(20%)	S.Kunthiamum

Lowland zone (Kolla)

Didessa, Anger Didessa, and Wamma valleys were among the sites selected for this study. The result of this study shows that these areas lie within the lowland zone of Nekemte Awraja. This agrees closely to the report of Hailu (1963). The topography of these valleys varies from steep slopes to plains and the altitude ranges from 1200 m at Didessa to 1500 m at Anger and Wamma. According to Amare (1978) and Westphal (1975), this zone in Ethiopia is a zone that has an average monthly temperature of more than 20°C and below 1800 m above sea level. According to Brietenbach, this zone is below 1600-1900 m with an average temperature of 20-29°C.

In the lowland zone tall and short trees and shrubs such as S. kunthiamum, F. vasta, L. schimperi, C. africana, S. guineense, F. brachypoda, A. abyssinica, C. molle, and Piliostigma thonningi were found scattered within the middle of tall grasses especially Hyparrhenia species. Most of the tree species investigated in this ecological zone were similar to those reported by FAO (1975) and Hailu (1963).

As shown in table 6, in this zone the soils were strongly acidic to moderately acidic, the pH ranging from 4.35 (at Didessa Site I) to 5.85 (at Wamma Kusaye Site II). The texture of these soils ranged from sandy-clay loam to clay. Total nitrogen in these soils was high to very high (0.38%-0.34%). Organic carbon was medium to very high (2.69% - 4.28%) and phosphorus was low except at Didessa Site II where it was found to be unusually high (49 ppM). C.E.C. in these soils was also high as in the other soils.

In general, when the soils of all the three zones of Nekemte are considered, in this region soils were strongly to moderately acidic. Thus in these soils there is phosphorus fixation, Mn and Al. toxicity and low base exchange percentage. C.E.C. is indicative of 1:1 Kaolinitic clay since the high clay

values would have rise to high C.E.C if 2:1 montimorilonitic involved. This result is in close agreement with results reported by Westphal (1975).

Most of the lowland zone areas were consisting of scattered tree grasslands; but there were also some areas of seasonally waterlogged grasslands. These were especially common at Wamma. In these grasslands Hyparrhenia species such as Hyparrhenia diplandra, Hyparrhenia Collina etc. were dominant, but as shown in tables 1 and 5, other grasses such as Pennisetum polystachyon, Digitaria velutina, Leerisia hexandra, Andropogon Canaliculatus, Melinis Machrochaeta, Rhynchlitrum repens and Beckeropsis uniceta were also found to grow particularly in this zone. Among these grasses B. uniceta and A. canaliculatus are grasses of good grazing value where as all the others are unpalatable. At the upper extreme of the lowland zone grasses such as P. ramosum, H. hirta, C. dactylon, B. brizantha, and P. commersonii commonly occurred. Furthermore, sedges such as Scleria schimperiana and Cyperus longus were also widely grown in the lowland zone.

A total of 18, three, four, and 14 species of grasses, legumes, sedges and trees were identified in this zone, respectively. Moreover, only nine species of grasses and one species of tree were found to grow only in this ecological zone. The percents of good, medium to low and poor grazing value of grasses were 13.3, 33.3 and 53.4, respectively.

Most of the lowland areas of Nekemte Awraja are occupied by the state farms for the production of maize, sorghum and few other crops. Excluding those who were working in the state farms, settled human population in this zone was low as compared to the other ecological zones.

Although there are several areas in Nekemte Awraja which lie within these three ecological zones, it was difficult to include all of these areas in this study. It is believed that the areas studied can fairly represent the Awraja as a whole.

Table 5. Dominant Grass and Tree Species in the Study Sites that Lie within the Lowland Ecological Zone of Nekemte Awraja

Location	Range in altitude	Dominant Grasses and % Comp. by wt. of each Species	Dominant trees
Didessa Site I From Centeral part of Didessa State farm to Didessa River.	1200-1330 m	B. brizantha (10%) H. anthistirioides (20%) H. diplandra (50%) H. rufa (10%) P. polystachyon (5%)	C. africana F. vasta L. Schimperi P. thonningii S. guineense S. kunthiamum
Didessa Site II Dimtu-about 45 km. on the way to Ghimbi, 5 km to the north of the main road.	1330-1370 m	B. brizantha (10%) H. anthistirioides(20%) H. diplandra (40%) H. rufa (15%) P. polystachyon (10%)	C. africana S. guineense S. Kunthiamum
Wamma Kusaye Site I about 3 km from the centeral part of Wamma State farm to the north-west	1450-1500 m	A. quartianus (15%) D. adscendens (10%) H.Collina (30%) H. rufa (30%)	A. abyssinica C. africana F. brachypoda F. vasta S. uineense
Wama Kusaye Site II Near Centeral part of Wamma State Farm.	1450-1500 m	A. quartianus (5%) B. brizantha (15%) H. rufa (54%) L. hexandra (5%) P. commersonii (5%) P. ramosum (5%) S. natalensis (5%)	A. abyssinica C. africana F. brachypoda F. vasta S. guineense

(Table 5 continued)

Location,	Range in altitude,	Dominant Grasses and % Comp. by wt. of each Species,	Dominant trees.
Anger Didessa	1450-1500m	A. Canaliculatus (16%)	C. africana
About 40 km,		B. brizantha (6%)	C. machrostachys
to the north-		D. Velutina (9%)	C. Molle
western side		H. anthistirioides (30%)	F. vasta
of Nekemte,		H. hirta (13%)	S. guineense
		M. machrochaeta (10%)	S. Kuntiamum
		P. polystachyon (7%)	

Table 6. Results of Soil Samples Colected from the three ecological zones of Nekemte Awraja

Location	PH	Textural class	COLOR		% total Nitrogen	% total OC.	Phosphorus PPM	C.E.C. Meq/100g	Ecological Zone
			Dry	Wet					
Jere	5.48	Silty-clay-loam	Dark-reddish brown	Dark-reddish brown	0.31	4.34	21.10	39.80	
Idiya	5.15	Clay	Yellowish-red	Dark-reddish-brown	0.30	3.87	2.49	36.7	
Jergae	4.95	Clay	Dark-reddish-brown	Dark-reddish-brown	0.39	3.99	3.82	34.5	Highland
Jigga	5.18	Clay	Reddish-brown	Dark-reddish-brown	0.32	3.67	3.56	35.5	(2000-3000m)
Komto	5.30	Silty-clay to clay	Dark-brown	Dark-reddish brown	0.40	4.59	0.77	40.0	
Kuye	5.5	Clay	Reddish-brown	Dark-reddish-brown	0.22	4.45	12.60	37.5	
Lidebu	5.60	Clay-loam	Dark-yellowish-brown	very-dard brown	0.52	5.82	19.48	50.0	
Limo Gambella	5.49	Clay	Dark-reddish brown	Dark-reddish brown	0.27	4.09	3.82	35.8	
Matto Kechema	5.40	Clay	Dark-greyish brown	Dark-reddish brown	0.23	2.39	Trace	37.3	
Medjo	5.62	Clay-loam	Dark-yellowish-brown	Dark-yellowish-brown	0.17	2.11	8.53	32.67	Medium altitude (1500-2000m)

ble 6 Continued

ocation	PH	Textural class	C O L O R		% total Nitrogen	% total OC.	Phosphorus PPM	C.E.C. Meq/100g	Ecological Zone
			Dry	Wet					
ilo Boshe	5.60	Clay	Dark-reddish-brown	Dark-reddish-brown	0.28	3.48	24.66	44.3	
isho Torbe	5.29	Clay	Dark-reddish-brown to yellowish-red	Dark reddish-brown	0.25	3.71	Trace	37.2	
ma Hagello	5.58	Clay	Dark-brown	Dark-reddish-brown	0.27	5.48	1.53	42.5	
idessa Site I	4.35	Clay	Dark-reddish brown	Dark-reddish brown	0.19	3.73	Trace	30.0	
idessa Site II	5.76	Clay	Dark-reddish brown	Dark-reddish-brown	0.34	4.28	49.64	40.5	Lowland
ma Kusaye	5.45	Clay	V. dark-reddish brown	black	0.18	2.72	19.48	40.0	(1200-1500 m)
ma Kusaye Site II	5.85	Sandy-clay-loam	v. dark-reddish brown	black	0.18	2.69	19.48	32.0	
ger Didessa	5.25	Clay	Dark-reddish-brown	Dark-reddish-brown	0.22	3.70	Trace	43.0	

Current Livestock Feeding Systems in Nekemte Awraja

Nekemte Awraja is a region where mixed farming is practiced and is so included in the centeral part of Ethiopian Highlands which is a region of highly developed mixed agriculture (Westphal, 1975). Mixed farming is a system of farming in which farmers obtain their livelyhood in varying proportions from both crops and livestock (Huffnagel , 1961). Farmers in this region are mainly engaged in cereal production for family subsistence and to a smaller extent for cash. The practice of livestock raising is also widespreaded. The number of cattle was a symbol of status in this region before the revolution. So, social status was determined by the number of cattle one owns. From farmers, point of view, objective reason for keeping cattle was less important although the whole farming system depended on draft oxen. But after the revolution, cattle are mainly kept for draft purpose (ploughing and threshing) and help at the same time to maintain a small breeding herd to replace old draft oxen and to get some fresh milk (particularly for small children) ghee and butter. Oxen are sold or occasionally slaughtered when they are old or injured and are no longer able to work. Milking cows are sold when they are too old for giving birth or injured. Farmers sell heifers or bulls in case of emergency i.e. when animals are sick or in case cash is needed for medication, marriage and for compensation of harvest defficiencies i.e. to buy grain if the harvest obtained on the farm does not cover subsistence requirements. In general, cattle are sold only when the farmer needs more money than he normally needs.

Study on livestock development of Wollega Administrative Region (LMB, 1972) indicates that nearly all of the farm holdings in Nekemte Awraja are engaged in livestock production. But in a number of instances livestock production is

not responsible for the main part of their income. As reported by LMB (1972), farmers whose income depend primarly on livestock are predominant in Wamma Hagello, Sibu Sire, Bilo Boshe, Gobu Sayo, and Gudaya Billa Woredas. About 60% of the ninteen sites selected for this study were found in these woredas. Farmers whose income depend primarily on coffee, where livestock and livestock products are used as secondary source of income, were found in Sasiga and Digga woredas and in part of Guto Gida Woreda (LMB, 1972).

In all of the investigated areas cattle were mainly fed on natural pastures, weeds of arable land, fallawland and on residues left in the fields after cereals, pulses and other crops were harvested. The practice of cultivating forage crops for animal feed was virtually unknown.

The farmers in most of the study sites used fire as a tool of management of pasturelands especially during the dry seasons. Except this no other system of management was practiced. This system of management was wide spread in almost all of the areas studied, but was more widely practiced at mid-altitude areas such as Gisho Torbe, Anno Gambella, Kedjo, Watto Kechewa, Bilo Boshe, Wama Hegello, and lowland areas such as Gibe, Wamma, Didessa and Anger valleys. The main reason why the farmers burn grasslands was to get rid of accumulated litter which can hinder the emergence of young shoots so that their cattle get palatable and nutritious regrowth that appearsafter the fire and at the same time to destroy undesireable insects, ticks, and other creeping creatures. The farmers in the highland areas used fire for expanding farmlands.

As indicated by Brockington (1961), and Delorit et al (1967), burning pasture and rangelands as a tool of management has both advantages and disadvantages.

Burning of grasslands helps to destroy dead forage produced during the

previous season which might interfere with the grazing of new growth. When grasslands are burnt, unpalatable grasses, that otherwise replace desireable forages, are controlled. As a result of burning, new growth starts sooner and cattle are able to get young palatable forage with high nutritive value. Burning also helps to destroy some parasites.

On the other hand, there are also certain disadvantages that can occur as a result of burning pasture and range lands. When pasture lands are burnt, accumulation of organic matter is reduced and soil erosion is induced. Burning also increases soil temperature because of greater exposure to the sun, and this increases evaporation. As a result, the vigour of plants and yield of forage may be reduced. In general, indiscriminate and uncontrolled burning is harmful. So when fire is used as a tool of pasture management, much care should be taken to prevent its spread to wooded areas and farm-steads (farm places). With careful control, burning is necessary at infrequent intervals to maintain the palatability and nutritive value of the herbage (Van Rensberg, 1969); because at younger stage forages are more palatable and with high nutritive value. The problem with the study sites where fire was used as a tool of management was that controlled burning was not practice. In these areas, trees, bushes, shrubs and grasses were indiscrimenately burnt. If this practice continues with the present rate of burning it is more disadvantageous in these areas.

Natural pastures are considerably inferior to sown pastures in quality, quantity and seasonal distribution of growth (Lazenby and Swain, 1969). This makes them more susceptible to unfavorable conditions caused by uncontrolled grazing. Controlled grazing serves as an essential tool in grassland management. This system was not known in Nekemte Awraja. Grazing in this region takes place where ever edible herbage was available.

Grazing creates relatively open canopies and if grazing pressure is sufficiently high, a decline in the quality and productivity of grassland occurs. Prolonged overgrazing decreases the basal cover of plants thus stripping the soil of its plant cover and exposing it to extensive sheet and gully erosion (Coupland, 1979), because when foliage is eaten down too hard and too often, food synthesis is reduced and the stored energy reserves which are used for regrowth slow down. If overgrazing continues too long, the plant may die of exhausition (FAO, 1980). All of the above indicated effects which are caused as a result of overgrazing have been observed in some of the areas during the survey. The effect of overgrazing was more prevailing at high altitude areas of the region such as Tuka Abbo, Hidebu, Komto and Kuye, where there was great competition of space between cropping and grazing lands.

In general, grassland and pasture management is the way of manipulating plants and livestock in such a way as to produce the maximum sustained yield of acceptable nutritious herbage on one hand and of the animal products on the other, without damage to either resources (Innes, 1977). This is attained by keeping the animal population within the carrying capacity of the grassland and by allowing the grasses certain rest periods, to be able to develop or grow and to build-up reserves for the next growing season (Meyn, 1970). This is practically unknown in all of the areas studied.

As stated by the farmers in most of the areas, there was no practice of allocating certain area of land for grazing purpose. Cattle were allowed to graze only on areas that have no potential for arable farming. The main grazing areas were separated from cultivated land to reduce the possibility of damage to crops by livestock and include places like hilltops, swamps, forest-margins, roadsides, stoney or infertile land. Fallowland and other stubble areas were grazed only in the mornings before cattle were taken to the areas where they were allowed to graze during the day time and in the evenings before

they were taken into their night enclosures or if the animals were tethered due to sickness or any other cause. These grazing areas were most of the time grazed by small calves which cannot go to distant areas with the bigger cattle.

It was only in the highland areas such as Tuka Abbo, Hidebu, Komto, Kuye and Digga that farmers leave a small area of ley around the arable land by fencing. The ley is a field withdrawn from crop production because of declining soil fertility and decreasing yields and on which grasses are allowed to grow (natural species of grasses in the case of the above indicated places). These small areas were grazed only by oxen during the time of ploughing and was also used for green feeding of small calves. Leys have two advantages of greatest importance. One is building up of soil fertility which is readily available to succeeding crops and the other is to meet the requirements of livestock. The end products of ley are then, heavier crop yield after the ley and prevention of soil erosion and productive livestock (Innes, 1977 and Van Rensburg, 1969). But unless the ley is correctly managed, full economic production cannot be expected. The leys observed at the above indicated places during the survey were poorly managed and the areas were also very small.

In the highland areas of Nekemte Awraja, there was strong competition of space between cropping and grazing lands and in most cases grazing areas were shrinking because of high agricultural (crop) activities and human settlements in these regions. Although the availability of grazing land was not a limiting factor, human settlement concentration and agricultural activities were also high at midaltitude areas such as Watto Kechema, Bilo Boshe, Wamma Hagello, and Gisho Torbe. Grazing lands were more abundant in lowland areas of Nekemte Awraja such as Gibe, Wamma, Didessa and Anger valleys. However, state farm agricultural activities were high nowadays at these valleys except Gibe. These zones are potentially rich due to their fertile soil and sufficient water sources, but

since they are infested with trypanosomasis (Hailu, 1963 and LMB, 1972) these potentials are not efficiently utilized.

In contrast to many other places in Ethiopia, it seems that there is no problem of water for livestock in Nekemte Awraja. Due to the availability of numerous rivers and streams water is plenty in all of the areas studied and cattle were watered everyday without a distant walk.

Fodder conservation method as such for a dry season feed was not practiced in the areas investigated. Let alone silage, even hay making was practically unknown. The only thing some of the farmers reserve for dry season feed was teff straw at highland areas. This was given to oxen only on priority basis during the time of ploughing in the dry season.

'Atella' the residue from preparing 'tella' (local beer) or'araki' (local alcohol) mixed with salt was given to milking cows and plough oxen whenever available. Salt alone was given to all of the herd once or twice a week. As stated by the farmers at Tuka Abbo, Kuye, Gisho Torbe, Digga, Komto, Adiya, and Dengae, finger millet (Eleucine Coracana) bread plus salt was given to oxen during the dry season as a supplimentary energy feed and boiled barley mixed with salt was given to milking cows to increase the production of milk. As farmers in two of the study sites (Gisho Torbe and Digga) indicated, leaf of a tree known as 'aebicha' in Oromegna and 'grawa' (Vernonia amygdalina) in amharic plus salt was given to milking cows during the dry season to increase milk production.

In most of the areas studied, cattle in the day time were herded under a traditional organization known as 'terra' or 'deberae' in which a group of farmers living in the same locality look after their cattle turn by turn. In some of the areas cattle were kept individually, i.e. each farmer tended his own cattle. During the nights, cattle were kept in a fence or rectangular

enclosures constructed near the farmers' house as a security from wild animals and theft. Small calves, sheep and goats, donkeys , mules and horses if available were separately tethered in rooms particularly made for them. Uaually small calves, sheep and goats were kept together whereas donkeys, mules and horses were given separate rooms.

The enclosure (fence) for the cattle was mostof the time put on a field which the farmer wants to manure to grow crops. This was especially true in the high altitude areas of the region; whereas at mid and low altitude areas, the manured plots were most of the time used for growing pepper, potatoes etc. If the manured plot was large enough can also be used for growing grain crops. Even if the land to be manured was far from the house, the enclosure was constructed there and the farmer puts a small hut near the enclosure in which he passes the night and look after his cattle. The cattle spend ten to fifteen nights in the enclosure and then the position is changed. Such method of constructing fences for animals on arable land and the shifting of their position periodically permits the accumulation and spread of dung and urine. If the cattle population the farmer owns is too low to get enough dung and urine to manure the plots of land he wants to cultivate, he gets a number of cattle from the neighbouring farmers or from his friends.

SUMMARY AND CONCLUSION

As reported by several individuals and many organizations such as FAO, the productivity of the Ethiopian cattle is low mainly due to poor nutrition and exposure of the animals to several livestock diseases. Inspite of the many problems affecting livestock production in Ethiopia, results from several studies have concluded that due to large number of livestock; availability of large areas of relatively unused range lands; a human population well adapted to livestock production and a very high potential to integrate crops in rotation with cereals, Ethiopia has the greatest livestock producing potential in Africa and in the world at large. FAO studies show that the existing trend of livestock and livestock products in the national and international markets are very promising. In the recent years,the domestic demands of meat and milk in the urban centers has expanded. On the international markets, prospects for exports to Middle East and some other European countries are very good. In this prospect, Ethiopia is one of the few countries which can offer large quantities of livestock products, relatively, in short run. It is believed from the result of this study that Nekemte Awraja with its present livestock potential can also contribute a considerable share to the national income. This will prove true only if the farmers change the present atitude they have towards the livestock production. Due to the increasing population pressure and their natural tendency to give priority to the production of subsistence crops, farmers in this region at present overlook the advantages obtained from livestock and their products and give more priority only to the production of food crops. This was observed during the study period that at highland and mid altitude zones the area under crops wes greater than the pasture land due to high human population. Farmers in Nekemte Awraja like farmers in the other mixed farming areas of Ethiopia do not take livestock as an integral part of the whole farming operation which can provide the same return as food

crops. To demonstrate this fact to the farmers, well organized and sufficient extension service is required.

Any development strategy concerning the improvement of livestock must be considered from the view point of the existing livestock feed resources and to what extent these resources are utilized and what production increase can be expected from their utilization. In this study palatable grasses such as B. brizantha, P. commersonii, C. dactylon, A. abyssinicus, D. abyssinica, S. polystacha, and B. uniceta were observed to grow in Nekemte Awraja . The proportion of the palatable grasses of good grazing value were very low(22.2%) compared to the proportion of the unpalatable grasses (51.1%). This could be mainly due to mismanagement of the grasslands. So, from this it can be concluded that the grasslands of Nekemte Awraja in the present condition and under the present method of utilization produce much below the potential of their productivity. In this respect to increase the productivity of the grasslands, good management is an essential tool. Systems of rotational grazing should be adopted i.e. grazing by dividing pasturelands into different paddocks or ranges and when one paddock or range of the field is grazed for certain period of time the others are rested. In this system of grazing, after the time allocated for grazing in one paddock or range is completed, the animals are moved to the next section, and the cycle continues like wise. In this way the grasses in the previously grazed area will get time to recover until the animals graze all the other sections. Thus, the palatable grasses will not disappear by overgrazing.

As it is previously indicated, several species of Hyparrhenia are growing in the different ecological zones of Nekemte Awraja. As it has been observed, the potential of these grasses is not exploited. These grasses give nutritious and palatable herbage at the young growth stage. So, in the Hyparrhenia

dominated grasslands, the adoption of continuous grazing systems is necessary, so that the grasses are always kept short to provide young growth. This can also be achieved through periodical burning or mowing.

The percent of palatable grasses for each of the highland and mid altitude zones was 26.7 whereas it was 13.3 percent for lowland zone. However, the observed grasslands at the lowland zone were much higher than the grasslands either of the highland or midaltitude. Hence, the total palatable grasses at the lowland could be higher than the other two zones.

In the case of mixed farming areas like Nekemte Awraja the basic problem is the maintenance of the livestock population during the dry season. From this study it is understood that livestock in Nekemte Awraja suffer a lot from the lack of available feed during the peak of the dry season. Farmers in this region do not seem exposed to the practice of conserving the surplus grass that occurs in the wet season for dry season. Yet without hay and introduction of leys to utilize fallows, it will be impossible to avoid the present seasonal weight losses among all classes of livestock and/or to introduce any sort of breed improvement. To overcome this problem, allocation of some area of land where native species of grasses grow in the respective zones is essential.

In the different ecological zones of Nekemte Awraja, different crops are grown. The residue of these crops if efficiently utilized can provide a considerable part of the livestock feed especially during the dry season when there is shortage of pasture. Once the crops are harvested, livestock can be put on the stubble fields to feed on the grain fallen on the ground and also on some straw and weed.

Small cereal straws are major by-products of grains. These by-products can provide the bulk of the ration of many animals if efficiently utilized.

The three major cereals of Ethiopia, teff, barley, and wheat are grown in Nekemte Awraja. Teff is grown largely at the mid-altitude zone, but also grow to some extent in the other two ecological zones. Farmers in this region feed teff straw as a supplimentary feed especially to oxen during the dry season. Teff straw is composed of fine stems and can be considered as equivalent of fair quality hay. Wheat and barley grow largely in the highland zone. Even if not in large amount, wheat and barley straws are also used as animal feed in some of the areas lying within the highland econological zone. Since the utilization of these straws is not yet fully exploited, it is expected that if they are properly handled they can also provide a reasonable share to the dry season feed.

At the low and medium altitude zones of Nekemte Awraja, a large acrage of maize and sorghum are produced every year. Farmers in Nekemte Awraja as farmers in the other maize growing parts of Ethiopia consume maize ears at early stage of maturity as green cobs especially during the months of August and September. At this stage the plants are still green and the residue if harvested and is made into silage can be valuable feed to the livestock.

Silage making can be difficult on an individual farmer basis. But nowadays since the farmers are being organized under the farmers cooperative; it is easier to make silage on the cooperative basis.

For feeding the increasing population of Ethiopia, extra food is required and for the production of the extra food, more land has to be cultivated. This trend of expanding cropland, was evident in the lowland zone of Nekemte Awraja where large areas are occupied by maize and sorghum crops. So, in the future as more and more land is allocated only to the production of food crops, the livestock interprise will evidently get into a difficult position. If the present practice of range and fallowland grazing continues, acute shortage

of feed is inevitable because there is a distinctive upper limit beyond which further improvement in the native pastures can be hardly achieved. To overcome this problem, an introduction of cultivated forage and pasture crops is necessary.

The establishment of high yielding cultivated species of grasses and legumes has been successful in different ecological zones of Ethiopia where forage and pasture research is conducted. Nekemte Awraja being one of the regions which receive adequate rainfall, it will be suitable for the production of high yielding forage and pasture crops. So, it is of greatest importance that grass and legume species which can do well under the environmental conditions of this region are selected and introduced to the farmers so that they plant them and get maximum output from their livestock.

Due to the major diversity of the climate and vegetation, a well defined division of ecological zones has not yet been established for all the regions of Ethiopia. So, in this aspect it is believed that this study has helped in classifying Nekemte Awraja into three main ecological zones, vis highland, medium altitude and lowland.

APPENDIX

MORPHOLOGICAL CHARACTERISTICS OF COLLECTED PLANTS

Reference of the morphological characteristics of the specimens was made from the following sources:-

Alemayehu (1975), Mcilory (1972), Skerman (1977), Hepper (1972), Stanfield (1972),Jenkins et al (1974), Clayton, Philips and Renvoize(1974), Innes (1977), Napper (1964),Sprague (1975), Gohl (1975, Eggling (1947), Degener (1946), Bor (1960), Makansson (1968), Froman and Persson (1974), Algren (1956), Whyte, Moire and Cooper (1959), Jackson and Wiehe (1958), Bogdan (1977), Edwards and Bogdan (1973).

I ANDROPOGONEAE

Andropogon abyssinicus R. Br. ex Fresen

Loosely tefted perennial upto 85 cm long. Tillers with prostrate to rhizomatous culms 10-75 cm long. Inflorescence consists of two racemes with greenish, whitish, or violet or brownish color. Sessile spikelets with more than 15 mm long awns. Mostly occurs in open grassland where the soil is too waterlogged and sometimes occurs in grasslands after cultivation. The species seems to be moderately palatable to grazing animals. Occurs at altitude from 1500-3000 m.

Andropogon canaliculatus Schumach

Tuffed perennial upto 90 cm (sometimes more) long. Apex of leaf-sheaths often bristly hairy and with two auricles upto 2 mm long; ligule 2 mm long. Inflorescence of one or more pairs of racemes, 3.2-5 cm long. Sessile spikelets with glume deeply grooved, glabrous. Pedicelled spikelets 4.5-5 mm long ; awns about 1 cm long.

A. canaliculatus frequently occurs in open grassland or tree savanna and also usually occurs in seasonal swamps. It provides good acceptable grazing but not in a great bulk.Occurs upto 1500 m altd.

Arthraxon quartianus (A. Rich) Nash.

Slender annual upto 30 cm high, with small ovate leaves and culms rooting at the base. Leaf-blades lanceolate, 6-12 mm. wide. Inflorescence 2-9 culstered, glabrous and 1.5-3 cm long. Sessile spikelets 3-4 mm long with 6 mm long awns near the base. No pedicelled spikelets.

A. quartianus is mostly found in shady and swampy ground, rocky places and rarely in grasslands. It is of little importance for grazing. Can grow upto 3000 m altitude.

Exotheca abyssinica (A.Rich) Andress.

Densely tuffed perennial upto 90 cm high with narrowly linear leafblades upto 30 cm long. The inflorescence is usually a single raceme pair, green or purplish, glabrous. Raceme bases unequal. Spikelets 14-16 mm long, with 70-100 cm long awns.

E. abyssinica is common in grasslands often on seasonally waterlogged grounds. It has tough leaves and so is of low grazing value. Occurs upto 3000 m altitude.

Hyparrhenia anamesa Clayton

Densely tufted perennial upto 120 cm high. Leaf-blades upto 40 cm long and 4 mm wide but often shorter. Panicle loose upto 45 cm long. Spatheoles linear 4.6 cm long. Peduncles slender and flexuous usually exceeding the spatheoles, with or sometimes without spreading white hairs above. Racemes not deflexed, 1.5-2.5 cm long, 4-6 awned per pair, villous and terminally exserted. Raceme bases very unequal, palatable when young. Occur from 1500-2000m altitude.

Hyparrhenia anthistirioides (A. Rich.) Stapf

Synonym. H. Pseudocymbaria (Steud.) Stapf

Tufted annual upto 150 cm long. Culms slender. Leaf blades linear, acuminate at the apex, upto 8 cm long, slightly tough all over. Panicles very

scanty, 1.2-2.5 cm long, glabrous. Spatheoles boat shaped during flowering. Racemes pale reddish or olive-green, about 1-2 cm long, 2-5 awned per pair, pubscent and densly bearded with hairs. Awn Staut, 3.4-7.5 cm long.

This grass is common in grasslands upto 2000 m. At its early stage of growth, this grass is palatable and if kept short prduces leafy herbage which is readily grazed by cattle. Occurs from 1200-3000 m altitude.

Hyparrhenia arrhenobasis (Hochst ex. Steud.) Stapf.

Tufted perennial upto 160 cm high. Glaucous leaf-blades 10-30 cm long and upto 5mm wide. Panicle of 2-10 raceme pairsbut rarely more. Spatheoles narrowly lanceolate, 4.5 cm long, yellowish or tinged with purple. Racemes not deflexed, 1.5-2.5 cm long, 7-17 awned per pair, branched but occassionally unbranched types occur. Dominant in high altitude grasslands. Readily grazed when young.

Hyparrhenia Collina (Pilger) Stapf.

Loosely tuffed perennial 30-130 cm high but occassionally upto 200 cm long, with erect, Slender Culms. Leaf-blades upto above 30 cm long and 2-5 mm wide. Panicle Scanty and narrow 30-40 cm long. Spatheoles narrowly lanceolate, 2-4 cm long and peduncles about half of the Spatheoles, pilose with yellowish hairs above. Racemes 1- 2 cm long with 4-7 awns per pair of racemes. Spikelets 5-6 mm long. Sessile Spikelets with 1.5-2.5 cm long awns. It predominantly occurs in seasonally waterlogged places and stream banks but also common in grassland and bush in drier areas. Occurs upto 1500 m altitude.

Hyparrhenia diplandra (Hack) Stapf.

Tufted perennial upto 400 cm high with linear leaf-blades upto 60 cm long and a little over 1 cm broad, rather rigid and with long hairs at the base. Inflorescence form open panicles 20-60 cm long, usually purplish. Spatheoles

2-5 cm long, sometimes broad at the middle, papery, reddish, glabrous. Racemes upto 2 cm long. Spikelets 3-8 cm long, sparsely hairy, some of the scales with sharp tips but scarcely awned. Usually 5-6 main awns to each pair of raceme, 3-4.5 cm long, occassionally more.

It usually occurs on swampy grassland on clay soils. Readily grazed when young. It grows between 1200 -1500 m altitude.

Hyparrhenia hirta (L.) Stapf.

Tufted perennial with slender stem 30-120 cm high, but usually upto 60 cm high with narrowly linear and glabrous leaf blades 2-15 cm long and 1-4 mm wide. Panicle, loose, rather scanty. Spatheoles 3-5 cm long, becoming reddish. Peduncles about as long as spatheoles. Racemes 3-4 cm long with 8-16 awns per pair of racemes. Spikelets 3-7 mm long. Pedicelled spikelets awnless.

It is common in grasslands, rocky places and open woodland. It is a stemmy grass of medium grazing value, but is extremely drought resistant. It occurs from 1200-2000 m altitude.

Hyparrhenia rufa (Nees) Stapf.

Tufted perennial or sometimes annual 30-250 cm long with rigid, 30-60 cm long and 2-8 mm wide leaf blades. Leaf sheaths glabrous. Spatheoles linear-lanceolate, 3.5 cm long and 1-3 mm wide. Peduncles sometimes shorter than the spatheoles but usually exerted. Racemes not deflexed, 1.5-2.5 cm long, 7-14 awned per pair. Raceme bases unequal the lower 1-2 mm long, the upper 2-4 mm long. Spikelets nearly glabrous, 3.5-5 mm long.

H. rufa is typically a tall savanna grass common in swamps, woodland and rocky places. Dwarfed types may be found by road sides. It is usually palatable to stock at an early stage and grows coarse and stemmy later on. Occurs from 1200-3000 m altitude.

Hyparrhenia tuberculata Clayton

Tufted perennial upto 60 cm high with leaf blades 10-15 cm long and 2.3 cm wide and panicles of 2-4 raceme pairs. Spatheoles narrowly lanceolate, 5-9 cm long, membranous, brown. Racemes not deflexed, 1.5-2 cm long, 6-8 awned per pair Raceme bases bearded with yellow hairs. Spikelets 7-12 mm long. Common on dry grasslands. Palatable when young. Occurs in altitude from 2000- 3000 m.

II ARISTIDEAE

Aristida adoensis Hochest.

Tufted perennial upto 75 cm high with leaf blades 25 cm long. Panicle spike like often interupted at the base, upto 20 cm long and above 1 cm wide. Spikelets subsessile, 10-13 mm long with awns 20-25 mm long. The awns arise directly from the lemma without articulation.

A. adoensis commonly occurs on poor sandy soils in natural grasslands mainly in overgrazed areas. Unpalatable grass of low grazing value, common at 1500-2000 m altitude.

III CHLORIDEAE

Cynodon dactylon (L.) Pers.

Variable stoloniferous perennial upto 100 cm high, but usually not more than 30-40 cm long. Leaf sheaths overlapping, leaf-blades upto 8 cm long and 3 mm broad, tappering leaf blades from base to tip, blue green. Inflorescence of 2-12 racemes usually arising from a single point at the top of the culm. Spikelets 2 mm long, lying flat and closely crowded and overlapping along the whole length of underside of the branches, awnless, upper glumes about the length of the spikelets.

C. dactylon is found in different types of grasslands but is more common in valleys, in flats on gentle slopes, around lakes and is locally abundant

in farms, in fallows, paths and roadsides trampled and overgrazed areas. It is very much preferred by grazing animals. It commonly occurs from 1200 - 3000 m altitude.

IV ERAGROSTIDEAE

Eragrostis panciformis (A.Br.) Steud.

Tufted perennial upto 60 cm high. Leaf-blades linear, accuminate, 5-12 cm long, usually glabrous. Panicle loose, with grayish, elliptic-lanceolate spikelets, laterally compressed. Branches solitary, thread-like, divided from near the base. Spikelets evently distributed on the branches.

E. Panciformis is common in swamps, moist grassland and on stream banks, usually on black clay soils. A grass of rather low grazing value. It commonly occurs in the highland areas upto 3000 m altitude.

Eragrostis tenuifolia (A. Rich.) Steud.

Variable tufted annual or short lived perennial 15-70 cm high with flat leaf-blades upto 15-cm long and 4mm broad. Panicle spreading, 7-15 cm long, sometimes longer. Spikelets long pediceled, gray, 8-12 mm long by 1-2mm broad, with acute spreading lemmas giving the spikelets a saw toothed appearance. The persistent paleas are not memberanous as in most species but firm and green, lying along the wavy rachilla.

E. tenuifolia commonly occurs in grasslands, bushes, tickets and woodlands. It also occurs as a weed of arableland in abandoned cultivation and in overgrazed pastures. It is not readily grazed by stock. It is common in highland areas upto 3000 m.

V. ORYZEAE

Leersia hexandra Sw.

Scrambling stoloniferous perennial with running shoot rooting at the nodes and slender upright culms upto 100-120 cm high. Leaf-blades stiff, linear

15-20 cm long and slightly over 1 cm broad, tapering, gradually to sharp tip with tiny backward pointing spines on the back of the mid-rib which readily lacerate the skin. Inflorescence a narrow panicle 5-15 cm long with erect or slighly spreading, undivided branches, upto 12 cm long, with short spiny bristles along the margins. It is common in swampy river banks and also occurs in forests and ditches. It is not palatable. It is common in lowland areas upto 1500 m altitude.

VI. PANICEAE

Beckeropsis uniceta (Nees) K. Schum.

Tall but rather str ggling, much branched perennial upto 150-400 cm high with the spikes clustered in the upper axils and forming a large leafy panicle. Leaf- firm, linear lanceloate, shortly petiolate, 15-60 cm long and 3 cm broad. Panicle spatheolate. Racemes 1.5-6 cm long, spikelets 3mm long. It is common in thin woodland or in scattered tree savanna grassland. It is good grazing grass if it is properly managed. It commonly occurs in lowland areas upto 1500 m altitude.

Brachiaria brizantha. (A. Rich) Stapf.

Erect or suberect tufted stoloniferous perennial 80-120 cm in height, often forming small tussocks. Leaf-blades stiff, tapering to each end. Mostly 20-40 cm long and 1-2 cm broad. Inflorescence often with one to three branches (seldom with six or more branches). Spike mostly 6-15 cm, with slender scattered hairs along the margins of the rachis. Spikelets 4.5-5.5 mm long usually hairless and particularly stalkless. They are arranged at right-angles to the rachis in a single row. It is common in grasslands, bush and forest edges widely distributed in more or less moist areas from sealevel upto 2300m altitude. The chief habitat of the grass is scattered tree grassland. Produces palatable and nutritious feed.

Brachiaria Semindulata (Hochst. ex. A. Rich) Stapf

Annual 15-30 cm long. Racemes 3-8 cm long, dense, rarely over 15 cm long. Spikelets assymetric obtuse round on the back and 2 mm long. Common in grasslands, bush, rocky-ground, open thickets or woodland on red and clay soils. It also occurs as a weed of arable land. A small grass of low grazing value. It occurs in medium altitude and highland areas.

Digitaria abyssinica (Hochst ex. A. Rich) Stapf

Rhizomatous perennial upto 60 cm. high. Leaves broad 6-10 mm wide. Panicle of 2-9 racemes, often whorled and suberect, 2.5-8 cm long, with broadly elliptic, completely glabrous, obtuse spikelets. It is widely distributed in the moister regionsof East Africa from sealevel to 2700 m altitude and common in grassland, woodland, bush, on stream banks and is also a common and troublesome weed of arable land. It is highly palatable but is of low productivity and vigour.

Digitaria ternata (A. Rich) Stapf

Annual upto 60 cm high. Leaf- sheaths glabrous. Peduncle hairy just below the racemes. Racemes 2-7, sessile, subdigitately arranged, 5-15 cm long, with pale grayish-green, obtuse spikelets 2 mm long, with distinct longitudinal ridges. It is common in waiste places, thickets, road-sides usually in some shades. It also occurs as a weed of arable land. It is of low grazing value. It commonly occurs in the highland areas.

Digitaria velutina (Forsk.) P. Beauv.

Closely tufted annual upto 80 cm high, often with creeping stem bases, rooting from the nodes. Inflorescence with a common axis about as long as the lower branches . Leaf-blades 5-12 mm wide, flat and with soft hairs. Inflorescence of more than 8-17 cm long, racemes often with a few long hairs. Spikelets narrowly lanceolate, acute, 2mm long, with the lower glume scale like or absent.

It is a common weed of arable land and also occurs at forest edges in bush and frequently invades pastures, particularly when over-grazed or wrongly managed. It is of little pasture value. Commonly occurs in the lowland areas upto 1500 m.

Melinis macrochaeta Stapf and Hubb.

Straggling or erect annual upto 120 cm high often with stilt root at the lower nodes. Leaf-blades less sticky and odorous than Melinis minutiflora, 25 cm long, 1.5 cm broad, widest below the middle, tappering to each end. Inflorescence very conspicous at first with bright orange yellow anthers, to 25 cm long, with numerous, slender branches, the lowest to 8 cm long. Spikelets 1.5 to 2 mm long and 0.5 mm broad, not grooved. Slender, straight awns 1.5 to 2 cm long.

Paspalum commersonii Lam.

Synonym. P. orbiculare Forst.

A short-lived tufted perennial 60-90 cm high. Leaves glabrous and light-green in color. Leaf-blades 8 cm or less, slightly constricted at the base. Inflorescence usually of two racemes, rarely three racemes with awnless spikelets 2-2.5 mm long. It is distributed from sealevel upto 2500m altitude chiefly in moist grasslands, swamps and stream banks. It also frequently occurs in abandoned cultivation often on badly drained soils. It is a very palatable and digestible grass.

Pennistum adoense (Hochst.) Steud

Perennial upto 110 cm high, with slender, creeping rhizomes and glabrous, ascending, slender, simple or loosely branched culum. Leaf-blades flat, linear, accuminate. False spike yellowish-green, cylinderical, dense upto 6 cm long. Sessile spikelets, glabrous, 3-4 mm long. It commonly occurs in open grassland. It is of some importance for grazing and hay making in the high altitude areas.

Pennisetum glabrum Steud

Rhizomatous perennial 30-90 cm high forming loose tufts with glabrous culums. Leaves, narrow, flat or convulate. False spike dense with 3-6 cm long spikelets. False spike directed upwards. Grows in grasslands under moist conditions. It is a worse grass with tough leaves of low grazing value. It is common in medium and high altitude areas.

Pennisetum Polystachyon (L.) Shult

Sparsely or densely hairy or hairless tufted pernnial or rarely annual, 30-250 cm high. It is often much branched. Leafblades linear or lanceolate-linear, upto 60 cm long and 1.5 cm broad, widest about the middle. False spike under 10 mm wide, purplish, reddish or orange brown, cylinderical, very dense. Spikelets 3-5mm long. Solitary and stalkless surrounded by numerous bristles conspicously hairy in the lower half.

It occurs in open grasslands , in thi bush, on fallow disturbed soils, road sides etc. at low to medium altitudes of moderately dry areas. This grass is usually considered to be of medium grazing value.

Pennisetum ramosum (Hochist.) Schwieinf.

Hairless rather straggling annual or shortlived perennial upto 150 cm high, readily recognized by its short-staut false spike often only 1.2 cm long and seldom as much as 6 cm long. Leaf blades flat or folded, to 30 cm long by 1-2 cm broad, but usually tappering abruptly at the tip. Spikelets accuminate, 5-7 mm long, stalk-less surrounded by 10-30 mm long bristles . Mostly occurs in swamps and valley grassland usually on heavy black soils up to 1500 m. It has medium grazing value.

Pennisetum Schimperi A. Rich

Densely tufted perennial 60-120 cm. long with numerous hard wirey stems. Culms usually hairy below the inflorescence. Leaf-blades inrolled wirey.

False spike dense, 4.5-9 cm long. Spikelets surrounded by numerous bristles, 3.5-5 mm long. The largest bristle up to 12 cm.

This grass occurs in the highland grassland up to 2800 m. altitude. It is coarse unpalatable grass which is grazed to a very limited extent only when very young.

Rhynchelytrum repens (Willd.) C.E. Hubbard.

Straggling annual or short-lived perennial 30-120 cm high with parallel sided leaf blades or tappering from the base to the tip, 5-15 cm long and 3-7 mm broad. Panicles 5-20 cm long, silvery white, pinkish or more often bright red with villous, spikelets 2.5-6 mm long. Lower glume not separated from the upper. Awns so small as to be scarcely visible among the hairs.

It commonly occurs as weed of arable land, in abandoned cultivations, in grasslands along road sides. The grass is eaten by stock when young. It is common in the lowland areas upto 1500 altitude.

Setaria phragmitoides Staps.

An erect perennial upto 210 cm high (occasionally taller) with cylindrical short based and bearded culm nodes. Leaf-blades flat, glabrous and wide. False spike 15-35 cm long, with 3-4 mm long spikelets. It commonly occurs in grasslands, in bush and seasonally swampy areas. It is fiberous and tough grass of low grazing value. It commonly occurs in the medium altitude areas.

Snowdenia polystachya (Fresen) Pilger.

Tufted annual or short-lived perennial grass with more or less erect culms 30-90 cm high. The size of the plant is variable and depends mainly on soil fertility and moisture. Under cultivation it can easily reach a height of 70-100 cm. It has lanceolate leaf-blades. Inflorescence racemes, upto 4 cm long with spikelets 2.5-4 mm long.

This grass naturally occurs along road-sides wasteland and forest edges, shady places, in grasslands and as a weed of arable land, upto 2000 m altitude and above. It is a productive grass of high nutritive value.

VII POEAE

Festuca abyssinica. A. Rich

Tufted perennial upto 60 cm high. Inflorescence densely spike like with awnless or short awned spikelets of 7-12 mm long. It is common in grasslands among rocks and forest edges at 2500-3000 m altitude. Stemmy grass of low palatability and grazing value.

VIII SPOROLEAE

Sporobolus natalensis (Steud.) Dur. and Schiz.

Tufted perennial upto 100 cm high. Leaf-blades linear, upto 40 cm long and 5 mm wide. Panicles loosely contracted with branches upto 5 cm long. Closely covered with gray-green spikelets. Common in grasslands at 1500-2500 m. It is of low grazing value.

Sporobolus pyramidalis P. Beauv.

A very compactly tufted perennial with cylinderical or coarse compressed culms usually 60 to 100 cm high, but shorter in some conditions and sometimes upto 150 cm. Leaf blades mostly 15-40 cm long and 4-7 mm broad (occassionally slightly over 1 cm)more or less parallel-sided below and tappering very gradually to a sharp tip. Inflorescence gray-green, 3-5 cm long on the slender plants, 3-12 cm on the coarser forms, with erect or spreading branches covered with small spikelets, 2-5 mm long. The glumes are unequal and much shorter than the spikelets. It is common in grasslands, in bushes, at forest edges and fallows. It is mostly found in the medium altitude zones. It is of low grazing value.

LEGUMES

Trifolium Simense Fresen.

Dichotomously branched perennial or perhaps, rarely annual herb, 15-60 cm high with erect stems or sometimes procubent at the base but not rooting at the node, usually glabrous, sometimes pilose above. Leaflets oblanceolate or linear-lanceolate, sharply toothed, rigid 1-6 cm long, upto 3 mm wide, glabrous or sparsely pilose. Infloresence hemipherical or ovoid, upto 5 cm long pilose especially at the top. Bracts white, upto 1 mm long. Calyx within pilose at the margins only Corolla reddish purple, rarely white, standard 6-8 mm long, stamens 3-5 mm long. Ovary usually glaborous. Common in water-logged grasslands at 2000-3000 m altitude. Readily grazed by cattle.

Indigofera Atriceps Hook. F.

Coarse branching usually erect herb upto 200 cm long every where strigose, some or many of the biramous hairs being brown or black, except on the leaflets, glandular multicellular hairs always present on the pods and usually on the stems, inflorescence and leaf-rachis. Leaflets more elliptic upto 25 mm long and 8 mm wide. Racemes many flowered, dense. Calyx deeply divided; lobes narrowely triangular with subulate staceous tips. Corolla dark strigose outside. Stamens 4-6 mm long. Ovary much shorter than the style, which is bent through 90° beyond the middle. Pod straight, with both dark or pale biramous hairs and more or less grandular hairs.

Alysicarpus rugosus (Willd.) D.C.

Erect or ascending annual or perennial 30-100 cm high and occassionally taller herb with pubscent, pilose or practically glabrous stems. Leaflets oblong, ovate-lanceolate, linear-lanceolate or linear 1.5-11 cm long, 0.2-3.3 cm wide, petiole 0.2-1.7 cm long. Racemes dense 2.5 to 10 cm long; peduncle 1.3 cm long; pedicels 2-5 mm long; primary bracts elliptic, 5-10 mm

long, 3 mm wide, accuminate, glabrous or pubscent. Calyx glabrous to densely pubscent. Standard whitish-pinkish, reddish, purple or bluesh; obovate, 6-7 mm long, 3 mm wide; keel often greenish. Pods 5-10 mm long scarcely exerted from the clayx. Seeds olive, squarish, compressed, longer dimensions 1.5- cm thick.

Smithia elliotii Bak. F.

Prostrate herb 40 - 180 cm long with bristly stems. Leaves 10-28 cm long; foliolate; leaflets linear-oblong; 0.3-1.5 cm long; 1.2-5 mm wide, rounded or subacute but soiculate at the apex. Petiole 2-5 mm long; rachis 1.5 to 5.5 cm long; stipules 1.5-3.3 cm. long, 1.5-4 mm wide; glabrous. Inflorescsnce dense,subumbellate 0.8 to 1.5 cm long up to 2.5 cm wide; pedicel 2.5 mm long; bracts ovate-lanceolate, 4.5 mm long, 1-2 mm wide glabrous, clayx densly or very sparsely covered with yellow bristles . Corolla, rose mauve (purple) or blue; standard broadly abovate upto 1 cm long, 4-8 mm wide; glabrous. Pods 4-7 jointed. Seeds dark brown, rounded, compressed about 1.5 mm across, 0.5 mm thick.

SEDGES

Scleria Schemperiana. Boeck

Tufted annual upto 75 cm long with leaves upto 8 cm wide. Panicles few, the lateral ones solitary, pendulous on slender hairy peduncles. Female glumes 5.7 mm long, dark-brownish in color. Netlets smooth and glabrous. It commonly occurs in swamps and seasonally flooded grassland.

Kyllinga Ourata Nees

Tufted pernnial or annual upto 1 m high with wide scarious margined basal leaf-sheaths and numerous glabrous sparingly hairy leaves. Inflorescence of numerous light brown, narrowly ovate or lonceolate spikelets 3.5-6 mm long, rarely longer, with shallowy convex green keeled glumes. It commonly

occurs in swampy grassland and savanna, at stream banks and in swamps.

Fimbristylis dichotoma (L.) Vahl

Tufted perennial or annual 15-75 cm high with grayish often pubscent leaves. Umbels compound with numerous spikelets on a compressed but not winged peduncle. Spikelets upto 10 mm long, brown. Netlets longest longitudinally straight. Common at river banks, forests and swamps at altitudes of about 1800 m.

Cyperus Longus

Tufted rhizomatous perennial upto 60 cm high with scabrid margined leaves. Inflorescence spreading with distantly suberect bright chestnet linear spikelets 10-25 mm long upto 2 mm wide. Glumes 2-2.5 mm long, obtuse, with broad-white margins. Common on seasonally waterlogged grasslands upto 1400 m altitude.

Table A. Monthly Average Rainfall of six Stations in Nekemte Awraja

Stations	Average Rainfall in mm.												
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Nekemte (22yrs.Av.1952-75)[1]	6.8	70.6	55.8	74.9	119.9	350.5	354.9	456.5	253.7	159.2	52.6	9.6	1965
Didessa (2yrs.Av.1972-73)	5.4	3.0	3.6	69.4	224.7	227.9	350.4	253.9	163.4	137.5	52.1	6.7	1498
Anger Didessa (3yrs.Av.1972-75)	4.7	27.3	2.0	34.6	135.7	212.0	236.9	465.2	170.6	80.6	11.0	5.4	1386
Sibu Sire (3yrs.Av.1972-75)	17.0	18.9	52.3	75.8	157.8	242.3	258.8	268.6	172.9	73.9	42.5	2.9	1382.9
Bako Research Stations (20yrs.Av.1961-80)	12.6	20.4	46.2	60.2	167.4	203.0	284.9	229.3	143.0	66.5	27.1	14.9	1275.5
Jere (3yrs.Av.1976-78)	11.6	19.1	72.4	48.3	20.4	188.1	262.5	160.4	145.1	65.7	10.7	6.2	1010.7

[1] Data for the years 1964 and 1962 are not included.

Table B. Monthly Average Minimum Temperature of four Stations in Nekemte Awraja

Stations	Average Minimum Temperature in °C.												
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Nekemte (13yrs.Av.1960-75)[1]	11.1	11.9	12.8	13.2	12.7	11.8	11.6	11.9	11.9	12.1	12.0	1.3	12.0
Didessa (2yrs. Av. 1972-73)	6.3	17.6	11.8	12.1	10.8	11.5	11.5	11.1	11.3	6.5	5.0	7.0	9.4
Anger Didessa (3yrs. Av. 1972-75)	8.5	11.8	13.9	15.2	15.6	16.0	15.5	14.9	14.6	13.0	9.5	7.8	13.0
Bako Research Station (2oyrs.Av.1961-80)	10.2	11.9	13.6	15.5	14.5	14.2	14.0	13.9	13.3	12.1	10.4	9.0	12.7

[1]Data for the years 1962 and 1963 are not included.

Table C. Monthly Average Maximum Temperature of Four Stations in Nekemte Awraja

Stations	Average Maximum Tempteture in °C.												
	Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Nekemte (13yrs.Av.1960-75)[1]	24.6	25.9	26.5	26.3	23.9	21.1	19.0	19.7	20.9	22.5	23.1	23.9	23.0
Didessa (2yrs.Av.1972-73)	32.9	33.4	34.5	34.0	31.2	28.7	24.1	27.1	28.7	30.3	29.5	30.9	30.4
Anger Didessa (3yrs.Av.1972-75)	33.5	34.5	36.5	36.1	32.7	29.8	28.3	28.5	28.1	29.9	31.2	31.7	31.8
Bako Research Station (20yrs.Av.1961-80)	29.4	30.6	31.5	30.9	28.6	25.9	23.7	24.1	25.3	27.7	28.2	28.9	28.2

[1] Data for 1962 and 1963 are not included

Table D. Monthly Average Temperature of Four Stations in Nekemte Awraja

Stations	Temperature in °C												
	Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
Nekemte (13yrs.Av.1960-75)[1]	17.8	18.9	19.6	19.7	18.3	16.5	15.7	15.8	15.1	16.1	17.6	17.6	17.4
Didessa (2yrs.Av.1972-73)	19.6	20.3	20.7	23.1	20.9	20.1	19.4	19.1	19.9	19.5	17.4	19.5	20.0
Anger Didessa (3yrs.Av.1972-75)	21.0	22.9	25.9	25.7	24.1	22.9	21.9	21.4	21.3	21.6	20.6	19.8	22.4
Bako Research Station (20yrs.Av.1961-80)	18.8	21.2	22.4	22.8	21.7	20.1	18.9	19.1	19.3	19.7	19.3	19.0	20.2

[1] Data for 1962 and 1963 are not included.

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Map Showing Areas of Investigation in NEKEMTE Awraja

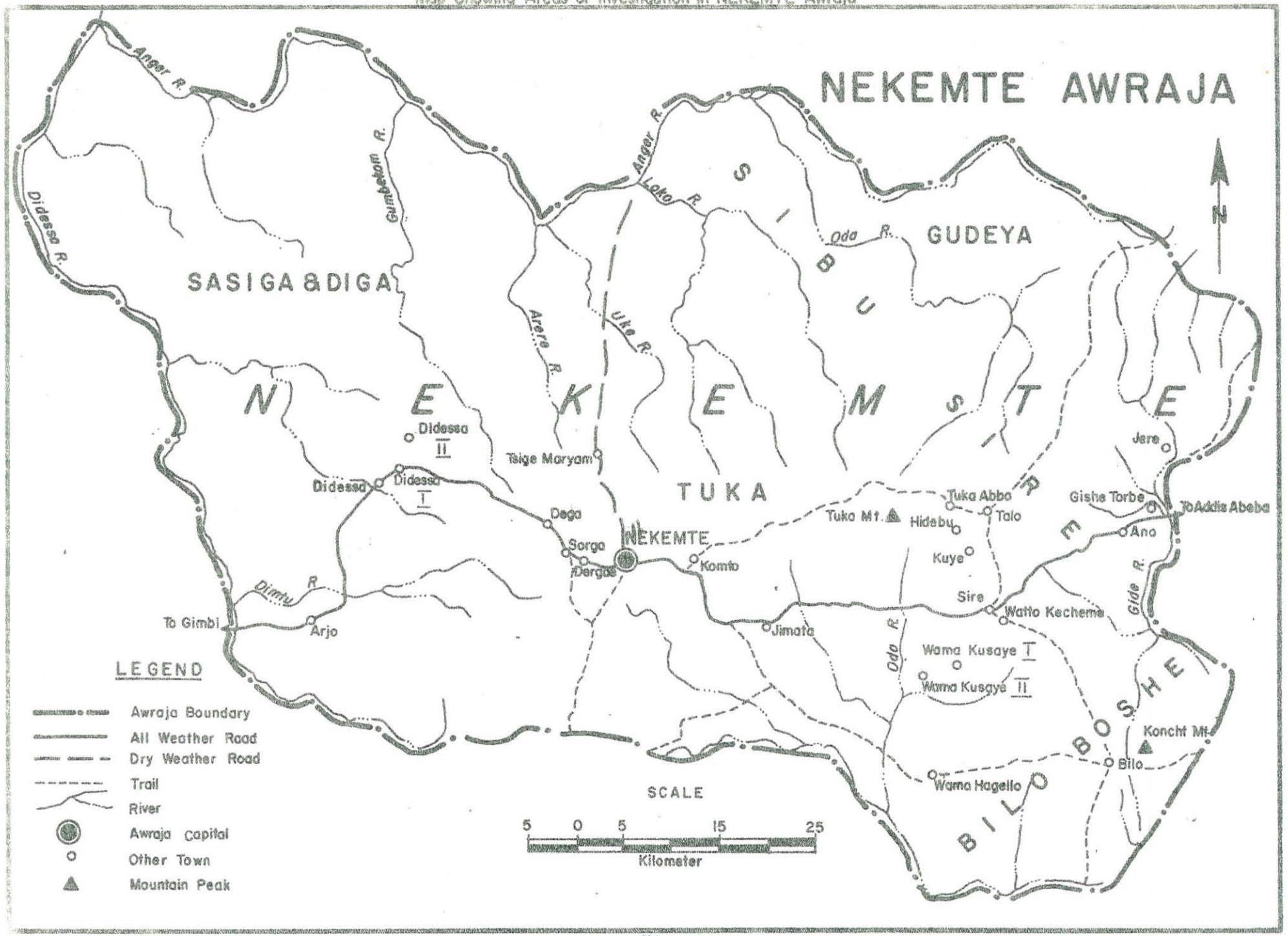

Fig I

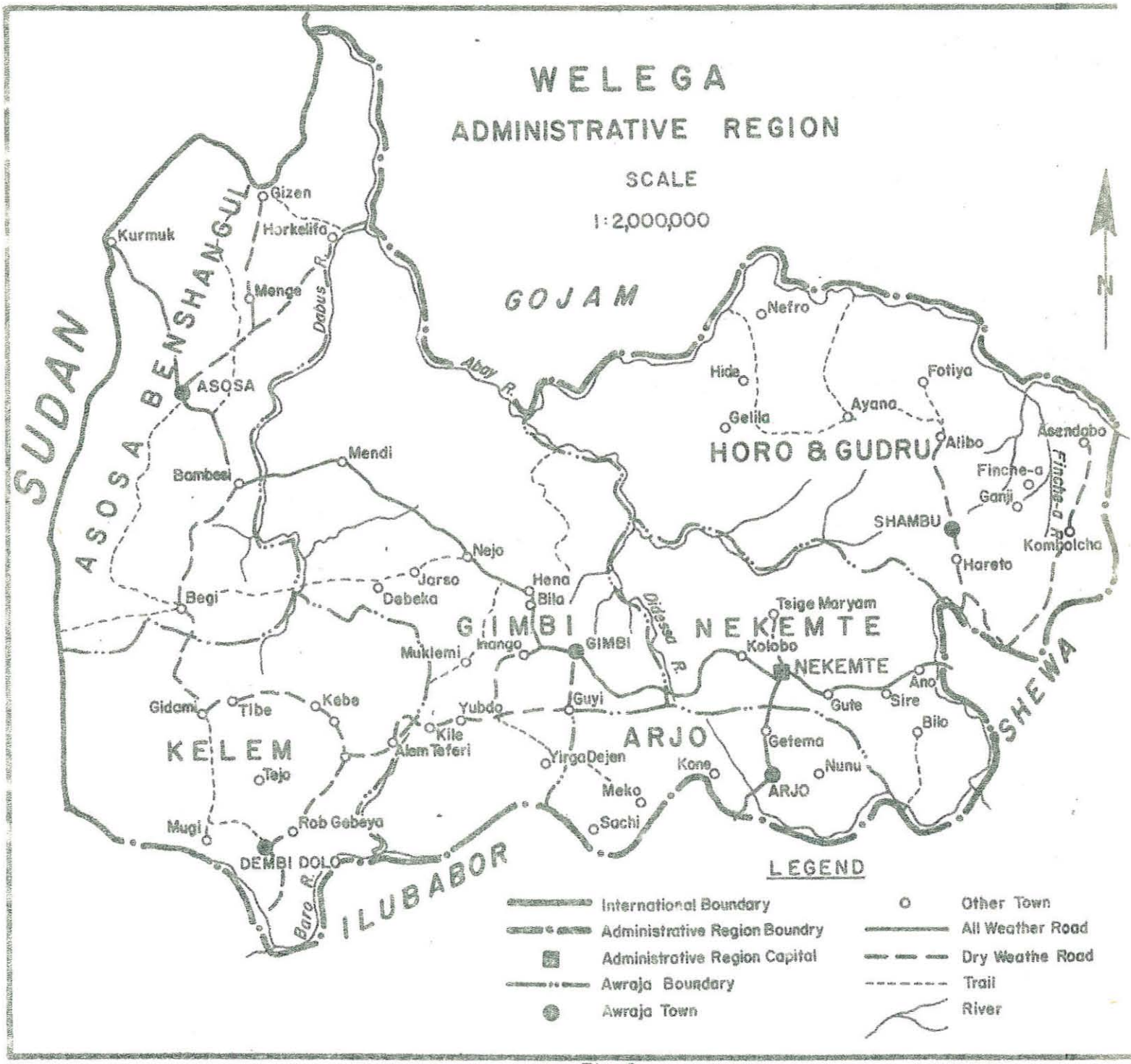
WELEGA
ADMINISTRATIVE REGION
SCALE
1:2,000,000
N
SUDAN
ASOSA BENSHANGUL
GOJAM
SHEWA
ILUBABOR
KELEM
GIMBI
NEKEMTE
HORO & GUDRU
ARJO
ASOSA
Gizen
Kurmuk
Horkelifa
Menge
Dabus R.
Abay R.
Mendi
Bambesi
Begi
Jarso
Debeka
Nejo
Hena Bila
GIMBI
Inango
Mukiemi
Didesa R.
Tsige Maryam
Kolobo
NEKEMTE
Ano
Sire
Gute
Bilo
Nefro
Hide
Gelila
Ayana
Fotiya
Atibo
Asendabo
Finche-a
Ganji
Finche-a R.
SHAMBU
Hareto
Kombolcha
Gidami
Tibe
Kebe
Yubdo
Guyi
Kile
Alem Teferi
Tejo
Yirga Dejen
Kone
Getema
Nunu
Meko
Sachi
Mugi
Rob Gebeya
DEMBI DOLO
Bare R.
LEGEND
International Boundary
Administrative Region Boundry
Administrative Region Capital
Awraja Boundary
Awraja Town
Other Town
All Weather Road
Dry Weathe Road
Trail
River

Fig 2


ETHIOPIA
SCALE
1 : 8,000,000
RED SEA
ERITREA
Asmero
SUDAN
GONDER
Gonder
Mekele
TIGRAY
WELO
Dese
DJIBOUTI
GOJAM
Debre Markos
SHEWA
ADDIS ABEBA
Harer
WELEGA
Nekemte
Metu
ILUBABOR
Jima
Assela
ARSI
HARERGE
KEFA
Awasa
Gobe
Arba Minch
BALE
GAMO GOFA
SIDAMO
SOMALIYA
KENYA
UGANDA

Fig 3

D E C L A R A T I O N

I, the undersigned, declare that this thesis is my work and that all sources of material used for the thesis have been duly acknowledged.

Name: Alemu Taddese

Signature: _____

Place and date of submission: College of Agriculture, Addis Ababa University, June, 1982.