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A STUDY OF BOVINE CLINICAL DERMATOPHILOSIS IN SOUTHERN PART OF TIGRAY REGION, EHTIOPIA

by
ENQUEBAHER KASSAYE

December, 1999

ADDIS ABABA UNIVERSITY AND FREIE UNIVERSITÄT BERLIN

A STUDY OF BOVINE CLINICAL DERMATOPHILOSIS IN SOUTHERN PART OF TIGRAY REGION, EHTIOPIA

A thesis submitted in partial fulfilment for the degree of Master of Science in Tropical Veterinary Epidemiology at the Freie Universität Berlin and Addis Ababa University

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DEDICATION

This paper is dedicated to my beloved wife Haregu and my beloved sons Shewite, Abrahame and Ephrem

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LIST OF ABBREVATIONS

GDP	Gross Domostic Product
MOA	Minstry Of Agriculture
MR-VP	Methyl Red Voges Proskaver
CBPP	Contagious Bovine Pleuropneumonia
AI	Artificial Insemination
ELISA	Enzyme-Linked Immunosorbent Assay
REST	Relief Society of Tigray
TBANRD	Tigray Bureau of Agriculture and Natural Resources Development
ICIPE	International Center for Insect Physiology and Ecology
OR	Odds ratio
CI	Confidence Interval
A. variegatum	*Amblyomma variegatum*
USD	United States Dollar
masl	meters above sea level
n	Sample size
MH	Mantel - Haenszel
SPSS	Software program for social sciences
L / A	Long acting

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SUMMARY

A cross sectional study on bovine clinical dermatophilosis was carried out in three agroclimatic zones (low, medium and high altitudes) during dry and wet seasons in the southern part of region Tigray, Northern Ethiopia from May to August 1999.

The objectives of the study were to estimate the prevalence and distribution of the disease, determine the risk factors and as preliminary and conservative study, to estimate the financial and production impact of the disease.

During the study 5,208 local breed and 378 crossbreed animals in 1113 household were inspected for clinical dermatophilosis. 108 farmers were interviewed on dermatophilosis using structured questionnaire. The preliminary financial estimate was assessed in 104 households having 107 cases of dermatophilosis affected in 1999.

Specimen (scabs, ticks, e.g. *A. variegatum,* and biting flies) were collected from clinically suspected animals and later confirmed in the laboratory. Giemsa stain and bacteriological isolation were used for confirmation of dermatophilosis.

According to the questionnaire survey farmers in lowland and medium altitude (100%) considered bovine dermatophilosis as economic important disease.

Prevalence of dermatophilosis 4.03% (95% CI 3.30-14.86) and 5.45% (95% CI 4.61-6.40) were recorded for the dry and wet period of the year, respectively. The difference was statistically significant ($\chi^2 = 5.51$, $p< 0.05$) with odds ratio (OR) of 1.38 (95% CI OR 1.0066-1.7980), that indicates the risk of dermatophilosis in wet season is 1.38 times higher than the dry season. The OR was adjusted for altitude and tick infestation. Statistically Significant association ($\chi^2 = 14.25$, $p< 0.05$) was also observed between severity of skin lesion and season being more severe in the wet season. At household level the prevalence of 16.90% and 28.86% were noted for the dry and wet seasons, respectively. The difference was also statistically significant ($\chi^2 = 22.72$, $p < 0.05$).

Prevalence of dermatophilosis was higher in the low and medium altitudes than the high altitude. In the dry period the prevalence of 6.9%, 5.18% and 0% were recorded for the low, medium and high altitudes, respectively. The difference was statistically significant ($\chi^2 = 58.58$, $p<0.05$). During the wet season prevalence rates of 9.10%, 7.14% and 0.12% were found for the low, medium and high altitudes, respectively, with statistically

significant (χ^2 = 75.18, p < 0.05) differences. Season adjusted multivariate analysis showed that there is a high statistically significant (p< 0.05) difference in medium vs high altitude with OR value 112.8 (95% CI (OR) 15.90-795.3466) that indicates the risk of acquiring dermatophilosis is 112.8 times higher in the medium altitude than the high altitude. OR value for the low vs highland was also so high implying practically the disease is absence in the highland.

During the two seasons prevalence of dermatophilosis was found higher in animals infested with *A. variegatum* than the uninfested one. In the dry period prevalence of 5.78% and 0.57% was obtained for animals infested with *A. variegatum* and without *A. variegatum*, respectively. The same is true for wet season where the point prevalence was 7.83% and 0.36% for animals infested with *A. variegatum* and not infested with the tick, respectively. In both seasons the difference was statistically significant (Dry χ^2 = 39, p < 0.05, Wet χ^2 = 59.94, p < 0.05) with OR value of 6.83 (95% CI (OR) 3.0194-15.4826) that implies animals infested with *A. variegatum* are 6.83 times at higher risk to dermatophilosis than the uninfested one. The OR was adujsted for season and altitude. Statistically significant association (χ^2 = 75.71, p <0.05) was also found between *A variegatum* tick count and severity of skin lesion. However, only 9.71% of skin lesion were related to the predilection-feeding site of the adult *A. variegatum*.

Statistically significant difference was not recorded (p< 0.05) in the prevalence of dermatophilosis between age, skin color and sex.

The prevalence of 4.03% in local breed and 15.10% in the cross breed was obtained in the dry period and the difference was statistically significant (χ^2 = 45.56, p< 0.05). In the wet season the prevalence of 5.45% and 8.60% was found for the local and cross breed animals, respectively, and the difference was not statistically significant (χ^2 = 3.22, p >0.05). However, logistic regression analysis of the over all prevalence of the two breeds show statistically significant difference with OR value of 2.68 (95% CI 1.894-3.7043). This indicates the risk of dermatophilosis was 2.868 times higher in the cross breed animals than the local.

The prevalence of the disease was found higher in areas with vegetation covers dominated by woodland and mixed (woodland and grassland) than in grassland. The difference was statistically significant (Dry χ^2 = 58.58, p< 0.05, wet χ^2 = 75.18, p< 0.05).

In the wet and dry seasons 11.97% and 25.71% of dermatophilosis positive cases were mixed with demodex, respectively.

The total financial loss due to dermatophilosis in the study area for one year was conservatively estimated at Birr 6,604,398 (USD 0.82) or Birr 226 (USD 28) per case.

From the above findings season, altitude, the tick *A. variegatum*, vegetation cover and breed were considered as the main risk factors for bovine dermatophilosis in the study area.

Based on the above finding tick control supported by study of seasonal tick population dynamics, treatment of early cases and culling of severe and chronic cases, improvement of the management practices particularly for exotic breeds were recommended. Further detailed study on the epidemiology and economical impact of the disease supported by socioeconomic study are considered important measures for further control of the disease. A chemotherapy study to look for effective treatment against the disease is also recommended.

1. INTRODUCTION AND OBJECTIVES

In Ethiopia the livelihood of 80% of the population depends on agriculture. The agriculture sector contributes 40% to the national GDP and 85% to the export earnings (MOA, 1996).

Livestock agriculture plays a critical role for the majority of the Ethiopian population. Livestock remains the major source of draught power for ploughing and also serves as an important source of food (milk & meat). Twelve to sixteen percent (12-16%) of the national earnings come from skin and hides, which is the second to coffee. The role of livestock manure as source of fertilizer should not be underestimated. Livestock also offers economic stability by reducing the risks associated with crop losses.

The livestock population of Ethiopia is very high. It ranks first in Africa and tenth in the world. However, its contribution to the national economy is very low. It only contributes 16% to the national GDP (MOA, 1996). The low productivity of livestock is attributed to many factors. Traditional husbandry and management system, poor nutrition and prevalence of endemic and epidemic animal diseases are the major factors that hinder the full productivity of the high livestock population of the country.

Bovine dermatophilosis is one among the major animal diseases, which has economic importance in Ethiopia as well as in other parts of Africa. It causes severe economic losses through reduced weight gain, damage to hides and outright death. It has frustrated many attempts at using exotic breeds of cattle to improve meat and milk production in humid and sub humid tropics (Coleman, 1967).

In Africa the disease has been reported in nearly all the countries of the continent and its islands. The exceptions are Egypt, Lesotho and Sào Tomà where it has not been reported, and Swaziland where it is suspected but not confirmed (Oppong, 1996). The incidence in the southern district of Sudan, Darfur province, was found to be 0.84% in January 1973. A high incidence was also noted during the rainy season, with an incidence of 15-20 % in Kordofan province. In Kenya, Tanzania and Uganda the incidence of dermatophilosis in cattle was, estimated by examination of raw and dry hides, as 16%, 9% and 0.02%, respectively (Soltys, 1964). In Nigeria, it is estimated that annually 10-12% of the total cattle population of the 11 Million (Food and Agricultural Organization, 1973) are clinically affected during the wet season and 4- 6% % during the dry season. The case fatality rate for dermatophilosis among cattle in Africa has been estimated at 10% during the rainy season (Hyslop, 1979).

Dermatophilosis became very important disease also in Ethiopia with introduction of exotic cattle for purpose of high milk production. Teshome and Ephraim (1989) reported that from two disease outbreaks of dermatophilosis, in 1986 and 1988, the incidence rate of 47% and 35% had been observed, respectively, in cross breed animals in Melkawerare research center (riftvalley of Ethiopia). Kiros (1985) found the prevalence of bovine dermatophilosis around Debre- Zeit in cross breed animals to be 13.29%. Mulugeta (1994) also reported the prevalence of the disease at 4.6% and 15% in Assela (central Ethiopia) in local and exotic breeds of cattle, respectively. Geremew (1998) reported a prevalence rate of 15.04% in local and 20% in cross breed animals from 540 cases examined for bovine dermatophilosis in Robe Veterinary Clinic (south Ethiopia). Another survey, Degu (1998) in eastern Shewa (central Ethiopia) revealed an infection rate of 5.1% from 6,530 animals examined for clinical dermatophilosis.

All these data indicate the increasing importance of bovine dermatophilosis in Ethiopia. Field reports and personal observations, nowadays, indicated that bovine dermatophilosis is not only an important disease in cross breed cattle, but also in local Zebu breeds of the country. Previously Desta (1985) reported prevalence of 0.69% for bovine dermatophilosis in and around Baher-Dar (northwest Ethiopia) in local breed. Tesfaye (1994) reported a prevalence of 5% in local cattle in and around Makalle (northern Ethiopia). Still the situation is worsening from time to time. In 1997, there had been also an outbreak of dermatophilosis in local breed cattle, in the southern part of Tigray region. In this outbreak the disease had been combined with demodicosis to produce the so-called "Senkobo Disease" a more severe and fatal combination. Farmers also routinely report the disease, as it is widely spread in local breed of cattle and brings about significant economic damage (personal observation).

Although dermatophilosis has become a progressively important disease in the country, its epidemiology and economic impact is not adequately studied. Hence this study on the epidemiology of dermatophilosis has been designed to be undertaken in selected site of Tigray region, northern Ethiopia. In discussion with the official veterinary personnel of the region, the southern part of Tigray was selected as study area, where bovine dermatophilosis was commonly reported.

OBJECTIVE OF THE STUDY

The objectives of the study were:

- to determine the prevalence and distribution of bovine dermatophilosis in local and cross breed animals in three agroclimatic zones during the dry and wet seasons of the year.
- to identify major risk factors related to bovine dermatophilosis.
- to conduct preliminary and conservative estimate of the financial impact of the disease in the area under investigation.

2. LITERATURE REVIEW

2.1 Definition

Bovine dermatophilosis (cutaneous streptothricosis) is an acute or chronic bacterial infection of the epidermis with *Dermatophilus congolensis*, characterized by an exudative dermatitis with scab formation (Oduye, 1975; Kaminjolo and Karua, 1981; Scanlan *et al.*, 1984). The earliest accounts of the disease are found in reports from tropical and sub tropical countries especially in areas of low altitude which are subjected to high ambient temperature and monsoon rain pattern (Hyslop, 1979).

The disease in cattle was first described in 1915 by Van Saceghem in Zaire (Van Saceghem, 1915).

2.2 Host species

Dermatophilosis affects a wide range of host species in all age groups. It occurs most often in cattle and sheep, but naturally occurring cases have also been seen in horses, goats, pigs, man, a variety of wild life species such as zebra (Stewart, 1972) and deer (Dean, *et al.*, 1961). The recording of human infections both naturally and experimentally, places the disease in the growing category of zoonoses. There was a recent outbreak of dermatophilosis in camel (Gitao *et al.*, 1998).

2.3 Geographical distribution and occurrence

Dermatophilosis is most prevalent in tropical or subtropical climates with high ambient temperature and a monsoonal rain pattern, as they occur in parts of Africa, Southern America, Australia, New Guinea, New Zealand and India. The disease also occurs sporadically in the United Kingdom, Europe, United States and Canada (Jubb *et al.*, 1993). Thus the disease is world wide distributed although the intensity is most severe in countries with less temperate climate.

2.4 The aetiological agent

2.4.1 Classification

Dermatophilus congolensis is the only species in the genus Dermatophilus that belongs to the family dermatophilaceae in the order Actinomycetales, class Schizomycetes.

It has been a matter of discussion whether *Dermatophilus congolensis* should be classified as a bacterium or as a fungus, however, Gordon and Edwards (1963) showed by electronmicroscopy that actinomycetales had no structural relationship with the eumycetales although, there were areas of close similarity with the eubacteriales. Its size and chemical composition distinguish the organism as a bacterium, but it forms a branched mycelium, which fragments into motile coccoid elements resembling the spores of a fungus. It is now generally accepted that *Dermatophilus congolensis* has to be classified as a bacterium and not as a fungus.

A soil-dwelling bacterium *Geodermatophilus obscurus*, resembles *Dermatophilus congolensis*. Both microorganisms form filamentous structure, which is divided both transversely and longitudinally, and form coccid cells that become motile. The two organisms can be differentiated by difference in the degree of filament formation, which is more pronounced for *Dermatophilus congolensis*, and by the absence of budding in *Dermatophilus congolensis*. The zoospores of *Dermatophilus congolensis* are isodiametric and equipped with between 5 and 50 (or even more) flagella per cell, while the zoospores of *G. obscurus* are ellipsoidal and possess a polar tuft of 1-4 flagella. *G. obscurus* has only been found in soil samples (Gordon, 1964).

2.4.2 Morphology and Stain Reaction

Dermatophilus congolesis is a pleomorphic gram positive and non acid fast bacterium that stains well with ordinary aniline dyes (Bull, 1929; Gordon, 1964; Gordon and Edward, 1963).

Dermatophilus congolensis grows as a filamentous, branching septate mycelium. Septation occur both transversely and longitudinally giving rises to small coccoid spores known as zoospores (Jubb *et al.*, 1993).

Various morphological forms of *Dermatophilus congolensis*, representing different stages in the life cycle have been recognized in lesions and culture (Abu-Samra, 1981). The bacterium grows as a branching filament mycelium. During the growth stage, the filament becomes transversely and longitudinally septet to form parallel rows of small, coccoid zoospores, which are dormant and can survive in the dried crusts of lesions for several months. Under favorable condition of moisture and temperature the zoospores are polar flagellated, which make them highly motile and thus able to infect new locations on the same or other susceptible animals (Horner, 1986). Zoospores are found mainly in dried exudate or scabs, while filaments occur mostly in active parts of the lesions (Bull, 1929; Le Reche, 1968).

2.4.3 Cultural characteristic

Dermatophilus congolensis is aerobic or facultatively anaerobic (Gordon, 1964). It grows readily at temperature ranging from 20^0C-37 ^{0}C (Bull, 1929). The organism is not fastidious and grows well in various broth media (Carter, 1979). It can be cultured on ordinary pepton nutrient media, but growth is greatly enhanced when it is enriched with defibrinated blood or serum (Bull, 1929; Gordon, 1964). On blood agar pinpoint colonies surrounded by a small zone of beta hemolysis are evident after twenty-four hours of incubation at 37^OC. After incubation for three to four days, colonies are considerably larger. The color of the colony also varies from grayish white to bright orange (Carter, 1979). The media or the atmosphere of incubation does not govern the colonial morphology and microscopic structure of the organism. However, Robert (1961) reported that restriction of oxygen or the presence of untreated blood serum in the medium is necessary for initial filament growth.

Dermatophilus congolensis shows a high degree of pleomorphism and can be either smooth (coccoid) or rough (filamentous), and the colonial morphology cannot be regarded as an isolate characteristic (Abu-Samra, 1978).

2.4.4 Biochemical characteristics

The biochemical characteristic of *Dermatophilus congolensis* are not well defined but, in general, most strains give the following reactions irrespective of the host species from which they are isolated. Acid production, without gas, is obtained with glucose, maltose, trehalose, dextrin, mannose and laevualose, but not with lactose, mannitol, dulcitol, and galactose. Casein, urea and gelatin are hydrolysed. Catalase is formed, but negative reaction are obtained with the nitrate reduction, methylene blue, MR-VP (Methyl Red Voges Proskaver) and indole tests (Buxton and Fraster, 1977).

2.4.5 Pathogencity for laboratory animals

Despite the occasional failure by some workers to produce lesions in laboratory animals, there are consistent reports of typical, exudative, scab lesions development in rabbits, guinea pigs and mice (Stewart, 1972).

2.5 Epidemiology

Dermatophilus congolesis affects various domestic, wild and laboratory animals, as well as humans (Roberts, 1966). This includes cattle, sheep goats and horses (Koney, 1996). Dermatophilosis is distributed worldwide but it seems to be more prevalent in high humid zones of tropics and sub tropics (Zaria, 1993). The agent, host and environment influence the frequency and distribution of bovine dermatophilosis.

2.5.1 Factors related to the agent

For the understanding of the epidemiology of dermatophilosis it is important to distinguished between strains of the organism. There is evidence of antigenic diversity and differences in *Dermatophilus congolensis*. Faibra (1993) has proofed that there is heterogeneity among 20 *Dermatophilus congolensis* isolates, originated from different parts of the world by using restriction fragment length polymorphism analysis. Genetic analysis using multilocus enzyme electrophoresis has confirmed also a significant genetic diversity within 41 Australian *Dermatophilus congolensis* isolates (Trott *et al.,* 1995). Ellis *et al.,* (1991) reported that there are differences in virulence and antigencity between isolates of *Dermatophilus congolensis*. Ellis *et al.,* (1993) have conducted a study to determine the variation in cultural, morphological and biochemical properties of *Dermatophilus congolensis* isolates from a number of species and whether or not the variation was related to their infectivity. The result of the study indicated that there is a considerable variation in *Dermatophilus congolensis* isolates. The variation was revealed in the properties of hemolytic activities and enzyme activities against casein, chondroitin 4-sulphate and lipids, which showed some link with infectivity. How and Lloyd (1990), in their study of dose–response for *Dermatophilus congolensis* infection demonstrated that there is a difference in virulence of different isolates of the organism.

2.5.1.1 Release and survival of zoospore

Zoospores are released from the lesion by transversal and longitudinal divisions of the hyphae. This is the infective stage in the life cycle of *Dermatophilus congolensis*. The rest of the cycle, from the germination and budding of the zoospore through the stage of hyphal growth to the formation of a new generation of zoospore, takes place on the infected skin. Their great advantage as an infective form lies in their size, shape and motility which permit their ready dispersal from the lesion (Roberts, 1957).

The zoospores resist drying and heating at $100^{O}C$. The zoospores possess flagellae and are motile. They do not survive for a long time under wet conditions, but deteriorate with time and are inhibited outside a narrow range of pH-value, osmotic pressure and salt concentrations. They are highly motile, independent of external nutrients and withstand external solutes well during the first hours after release. Zoospores are released from wetted scabs after about two hours, at room temperature, however, most of them released between the fifth and twenty-first hour after wetting. The emergence of the zoospore from within the wetted scab is probably accelerated by a negative chemotactic response of the zoospore to their own endogenous CO_2 (Roberts, 1963d). On the surface of dry scab no or very few viable zoospores are found and therefore it is believed that affected animals do not become a source of infection until the lesions are wetted. As stated above, wetting decreases the survival time of the zoospores and healed lesions where fresh zoospores are no longer produced become less infectious. In dry scabs the number of viable zoospores decreases rapidly during the two weeks following healing. However, a very small number of zoospores are still detectable after several months. The organism probably survives the dormant period within the herd on chronically infected animals, and these are the main sources of infection at the beginning of outbreaks. Small lesions have been observed to persist throughout the year on the ears and backs of adult cattle in herds where only calves were seriously affected. Chronically affected individuals are probably the organism's main means of survival within a flock or herd during a dormant period and the main source of infection at the beginning of the outbreaks (Roberts, 1967b).

Isolation of *Dermatophilus congolensis* from 25 soil samples was not successful and it was not possible to keep or grow the organism, added as a suspension of zoospores in wet soil. Inoculation of dry soil with dry scab material is the only way to keep soil infective. According to Teshale (1988) soil is most unlikely to provide for proliferation or survival of the organism or to act as important source of infection. Numerous investigators have suggested that the organism lives as a skin commensal and that infection does not occur until the skin is damaged. However, Macadam (1977) reported that the organism could not exist as skin commensal.

2.5.1.2 Transfer of zoospore

Various vectors like ticks and flies can transfer zoospores to a new animal thereby spreading the infection. Macadam (1962) succeeded to infect a rabbit with *Dermatophilus congolensis* by transfer of ticks from infected cattle. Both biting and non-biting flies have been shown to transfer infection between rabbits (Richards and Piers, 1966) and it has also been found that such a transfer requires wetting of the donor lesion. Transfer of infection by insects provides an explanation as to why most infections commence during the rainy season when insects become more numerous inspite of the finding that low temperature does not favor survival of the zoospore (Roberts, 1963a).

The association of dipping with outbreak of dermatophilosis in sheep has generally been attributed not only to the wetting of the skin and subsequent release of the zoospore, but also to the detrimental effect of the dip on the integrity of the sebaceous film of the skin. Dipping fluids which may be contaminated with *Dermatophilus.congloensis* might also be an important source of infection (Annon, 1977).

In the past numerous workers have noted the presence of mange mites in association with lesions of dermatophilosis infection. Mornet and Thiery (1955) incriminated Demodex species in nodular lesions in cattle. Roberts *et al.*, (1966) noted that penetration is a prerequisite of mange and under suitable climatic conditions a chronically infected animal carrying a few small scabs that could well produce numerous zoospores (Stewart, 1972).

Roberts (1967b) had reported that pastures containing spiny plants and sharp seeds, play an important role in the transfer of *Dermatophilus congolensis* as well as provided entry to the skin. Transmission may also be aided by water, spreading zoospore from existing lesion to other areas on the same animal (Teshale, 1988). Transmission by direct contact is controversially discussed. Plowright (1956) noted that there was no spread from infected cattle to cattle in contact even in wet weather. Soltys (1964) reconfirmed that there was no contact transmission. However, Le

Riche (1968) found that transmission of the disease would occur by sheep-to-sheep contact, especially if wet.

2.5.2 Factors related to the host

In animals, the epidermis is protected against infection of dermatophilosis by three barriers, namely

- the hair coat or fleece
- the sebum which impregnates the hair or wool and form a layer on the skin and
- the stratum corneum

The degree of development of each barrier, and hence the protection it provides, varies greatly between animals and different sites on the body (Robert, 1963c). There is a pronounced interdependency between the barriers. Development of the stratum corneum is inversely proportional to the density and protectiveness of the hair coat. On the other hand, the thickness and completeness of the sebaceous film on the skin are directly related to the density of the hair or wool fiber population because of the constant association of sebaceous glands with hair or wool follicles. Thus, in sheep, resistance of the non-wooled area to artificial infection depends mainly on the integrity of the stratum corneum, whereas the wooled skin has very little stratum corneum and is almost entirely dependent on the greasy fleece and the sebaceous film on the skin surface. The protectiveness of the sebaceous film depends entirely on its mechanical properties and is unrelated to the bacteriostatic power of the wax (Roberts, 1967a).

Roberts (1967b) postulates that there is a carrier state in dermatophilosis, and these cases are probably the organism main means of survival. Jubb *et al.* (1993) confirmed that the principal source of infection in dermatophilosis is the infected animal, including the healthy carrier and the apparently recovered animals. In endemic area, up to 50% of apparently healthy cattle may be carriers of the bacterium, which persists in the ostia of hair follicles. Stewart (1972) also explained that there is a carrier state and the carrier animals are not immune as they are diseased. Several factors govern the occurrence of the disease in a given host. These include breed, age, sex, nutritional status and other concurrent infections.

2.5.2.1 Breed difference in susceptibility

The N'adama and Muturu breeds from west Africa are believed to be resistant to dermatophilosis while Jersey are highly susceptible. In attempts to produce resistant crossbreeds, it has been

observed that N'Dama-Hereford crosses are highly resistant while N'Dama-Angus crosses are susceptible (Teshale, 1988). Amakri (1976) explained that the resistance of N'dama cattle is probably due to the high percentage of leucocytes and neutrophils in their healthy skin. Some workers have also described the difference in susceptibility of breed to dermatophilosis. Abu-Samra (1980) reported that the white fulani cattle, the zebu breed and the exotic breeds were found susceptible to infection with *Dermatophilus congolensis*. Morrow *et al*., (1989) also reported the susceptibility of pure breed Santa Gertrudis to dermatophilosis. The susceptibility of this breed to the disease in West Africa had been reported previously by Coleman (1967). A group of Charolais cattle imported into Costarica, where *A. variegatum* ticks have been recorded, was proved to be very susceptible to dermatophilosis with high mortality and morbidity rates.
Dermatophilosis has been a major limiting factor to the success of a number of projects to improve the productivity of indigenous cattle in Ghana. In September 1975, 120 Draughtmaster cattle (100 cows and 20 bulls) were imported from Australia. Nearly all these animals and their offsprings died of dermatophilosis (Simpson, 1976). Koney (1996) reported that the prevalence of dermatophilosis among exotic breeds of cattle in Nigeria is much higher than the local breed. It was estimated that the diseased animals lost 30 to 50 % of their normal market value.

2.5.2.2 Age difference in susceptibility

Cattle of all age groups are affected. However, some workers claim that adult animals are more susceptible than the younger ones (Teshal, 1988). Oppong (1996) noted that, during the dry season, the prevalence of dermatophilosis were 1.96% in the age group 0-12 months, 5.7% in the age group of 13-24 months and 5.88% in animals > 24 months and during the wet season the figure were 9.3 %, 10.4%, and 18.87% for the above mentioned age groups, respectively. This shows that adult cattle are more susceptible than the young onces. Samui and Hugh-Jones (1990a) in their study of bovine dermatophilosis in Zambia, found that adult cattle were more susceptible than the younger ones. However, Stewart (1972) was of the opinion that there is no age susceptibility and that adult and young animals are equally susceptible. Young calves may however suffer from a generalized form of dermatophilosis leading to rapid death.

2.5.2.3 Sex difference in susceptibility

According to Macadam (1976), both male and female animals have been found to be equally susceptible to dermatophilosis infection, but LIoyd (1976) states that male are more susceptible than female.

Contrary to the above mentioned researchers, Samui and Hugh-Jones (1990a) have reported that female cattle were found to be more susceptible to dermatophilosis than male, except in the younger animals where both sexes appear to be equally susceptible.

2.5.2.4 Nutritional factor

There are different views as to the effect of nutrition on the occurrence of dermatophilosis. Oduye (1975) does not support the idea that poor nutrition increases the susceptibility of animals to dermatophilosis. However, other researchers agreed as the organism is opportunist and only producing clinical symptoms when the susceptibility of the animal has increased by for example, nutritional deficiency (Egerton, 1964).

2.5.2.5 Concurrent infections

Abu-Samra (1980) reported that the susceptibility of animals to dermatophilosis has been found to increase by the presence of concurrent infections, such as strongylosis, babesiosis and histoplasmosis. Splenectomized goat and sheep that have orf infection were found more suscebtible to dermatophilosis. They also reported that in the outbreak of dermatophilosis in Sudan, the cattle were under the stress of continuous nomadic migration and suffered from generalized or localized debilitation due to internal and external parasitic diseases. In the course of an outbreak of mycotic dermatitis in sheep in Britain, all the animals affected were in late pregnancy and lambs that had simultaneous orf and strawberry foot rot. Dermatophilosis has been associated with rinderpest, Lumpy skin disease and trypanosomiasis (Schiltz, 1955). Nawathe (1992) has reported the immunosuppressive effect of dermatophilosis which blamed for an outbreak of CBPP in Nigeria. Many researchers have noted the presence of mange mites in association with dermatophilosis lesions. Both Demodex and Chorioptes species. have been found in association with the lesions of dermatophilosis (Teshale, 1988). Other lesions that have occasionally been associated with *Dermatophilus congolensis* infection include subepidermal granulomas (Momotani *et al.,* 1984) and oral lesions in cattle (Gupta, 1975) as well as chronic lymphadenitis (Singh and Murty, 1976). The ability of an exposed animal to respond to the organism is also important and would involve a combination of the cell- mediated and humoral immune response. Several factors that may affect the ability of the host's immune system to response to an infection may play a role. This includes animals with a heavy intestinal parasite load, lymphosarcoma, viral infection, and debilitated animals in which an increased incidence of dermatophilosis has been observed (Barre and Woodman, 1990)

2.5.3 Factors related to the environment

Predisposing factors play an important role in the occurrence of dermatophilosis (Roberts and Graham, 1966). Environmental factors that might damage the protective barrier of the skin and predispose the animal to dermatophilosis are:

1.Rainfall / moisture

2.Ticks and biting flies

3.Thorny bushes and spiny plants

4.Ox-pecker birds

2.5.3.1 Rainfall /Moisture

Rainfall and humidity are important epizootiological factors in the spread of the infection, and dermatphilosis has been described as a wet weather disease (Stewart, 1972).

Intense and prolonged wetting has two effects on the skin: It emulsifies and breaks up the sebaceous wax and macerates the stratum corneum (Roberts, 1963c). The zoospores, which are the infective stage of dermatophilosis, could then penetrate the epidermis (Roberts, 1965), with subsequent hyphal development and invasion of the hair follicles. In addition, increased moisture on the skin surface would result in increased release of zoospores, with a resulting increase in infectivity (Roberts, 1963a, b). Humidity alone is insufficient to precipitate lesion in an infected animal. An outbreak of dermatophilosis may occur in sheep and cattle following "Jetting" with a high pressure stream of water. Deep saturation of the skin affects both stratum corneum and the protective lipid layer. Moisture causes the individual corneocytes to swell and detaches from each other, and more intense wetting leaches out the protective sebaceous film from the intercellular space of the stratum corneum. The moisture also activates latent zoospores and supports in their transportation to distant sites on the body (Jubb *et al.*, 1993).

Many workers have found that the incidence of dermatophilosis increases during period of prolonged rains or rainy season. Stewart (1972) found a more than fourfold increases of the incidence from the beginning to the end of the rainy season. Oppong (1996) noted an incidence of 12.8% during the rainy season and 4.8% during the dry season, in Ghana. Stewart (1972) believes that there is a strong correlation between heavy rainfall and increase in the incidence of dermatophilosis.

Generally, it has been concluded that high temperature and high level of humidity does not affect the incidence of dermatophilosis. The only predisposing climatic factor is the wetting of the skin and the presence of carrier animals which act as source of infection for the outbreak.

2.5.3.2 Tick and other biting flies

Dermatophilosis in cattle occurs in all age groups (Egeraton, 1964) and is often associated with tick infestation, mainly of *A. variegatum* (Lloyd and Jenkinson, 1980). Koney *et al.* (1996) reported that there is a close association between infestation with *A. variegatum* and the occurrence of dermatophilosis on cattle on the coastal plains of Ghana. The lesions of dermatophilosis are found particularly in area of the body most heavily infested with ticks (Macadam, 1962). These suggestions are supported by reports from some parts of the world that lesions occur predominately at the predilection feeding site of adult *A. variegatum* on the hairless parts of the ventral surface (Sinclair, 1920; Plowright, 1956). However, Morrow *et al.*, (1989) indicate that although there was a steady increase in the prevalence of severe lesions as the level of infestation with adult *A. variegatum* increase, the distribution of skin lesion could not be related to predilection feeding site of adult *A. variegatum* ticks. Other reports suggest also that the predilection site for early lesions is the dorsal surface of the animal (Zlotnik, 1955). Data presented by Morrow *et al.*, (1989) indicated that lesions on affected animals in Antigua were not confined to the predilection feeding site of adult *A. vareigatum* and that in many cases it would appear to have started on the dorsal surface.

The conflicting reports on the site of the infection would appear to reflect a geographical or breed variation in the clinical picture of the disease. The role of *A. variegatum* ticks in the occurrence of severe dermatophilosis has yet to be explained. Possible mechanism mentioned included transmission and the creation of skin wounds and hypersensitivity reaction by the tick, which is infected with the organism (Davis and Philipott, 1980). Koney *et al.*, (1996) also investigated that the bases of the association between infestation with this tick and the occurrence of dermatophilosis would appear to involve tick-induced immunosuppression.

Oppong (1996) reported that filaments and hyphae of *Dermatophilus congolensis* were demonstrated in *A. variegatum*, collected from cattle affected with dermatophilosis. *Dermatophilus congolensis* was found in 7 out of 50 ticks collected from infected cattle on direct smear and in 15 out of 50 on culture (Teshale, 1988).

Flies and biting insects such as *Stomoxys calcitrans*, *Glossina morsitans*, *Musca domostica* and mosquitoes have also been reported to be involved in the transmission of the disease by breaking the skin barrier during feeding and releasing variable amount of serum and blood which provide moisture, nutrition and a suitable microclimate for the multiplication of *Dermatophilus conglensis* (Abu-Samra, 1977). Macadam (1962) showed that exposure of infected animals to insect bites caused spreading of the lesion. He also noted those biting flies such as *Glossina* spp., *Stomoxys calcitrans* and tabanids were responsible for initiation and spreading of dermatophilosis. Non –biting flies also seem to be attracted to area of the skin with dermatophilosis lesion and when disturbed move to some other places thereby spreading the lesion mechanically over the body. Non- biting flies can also aid in spreading the infection as attracted to wounds or defects in the sebaceous layer.

Lesions in cattle have also been associated with feeding sites of *Glossina* spp. and with area infected by the suckling louse *Haematopinus eurysternus* (Macadam, 1962), *Haematopota* spp. *Stomoxys* spp. (Jubb *et al.,* 1993), *Tabanus* spp. (Stewart, 1972) In England and Australia infection of dermatophilosis on the dorsal part and the face were associated with seasonal increase in the population of mosquito. The same is true in Kenya where infection of young lambs with *Dermatophilus congolensis* had been seen during severe mosquito infestation period (Roberts, 1967b). In draught oxen lesions are often found on the neck, which bear the yoke (Samui and Hugh-Jones, 1988).

2.5.3.3 Spiny plants and thorny bushes

Spiny plants have been suspected to be involved in the transmission of dermatophilosis. Zlotnik (1955) thought thorny bushes and tree branches were important in the transmission of the disease. Spiny plants have been suspected when the lesions are found mainly on the lips, muzzle and legs. Macadam (1962) also noted limb lesions on animals grazing on thorny bushes. When thorny bushes and tree branches are responsible for the trauma which aids the introduction of *Dermatophilus congolensis* into the epidermis, the lesions are found on the limbs, brisket, ventral aspects of the animal and perhaps also on the flanks (Oduye, 1975).

Sharp seeds may also be associated with the spread of the disease. It is not known if the plants transfer the organisms or only provide entry through the skin. Eradication on these bushes led to great reduction of the frequency of dermatophilosis in a given area.

2.5.3.4 Ox -Pecker birds

Ox- pecker birds feed on debris and ticks on the animal. It is difficult to determine the precise role of these birds in the spreading of dermatophilosis. The birds are helpful as they take away ticks and flies but also harmful as they damage the epidermis (Oduye, 1976).

2.6 The economic importance of the disease

The economic importance of bovine dermatophilosis has long been recognized in Africa, especially in western and central regions (Samui and Hugh-Jones, 1990b). It was placed second only to Contagious Bovine Pleuropneumonia (CBPP) on the list of important bacterial diseases (Doutre and Orue, 1968). This disease has negative impact on cattle reproduction, milk and meat production and hide values, and on draught animals and thus on crops (Samui and Hugh-Jones, 1990). Hyslop (1979) estimated the loss due to dermatophilosis in the northern state of Nigeria through hide damage, debility and death to be USD 30 million annually.

Dermatophilosis affects animal reproduction in various ways. Sekoni (1983) and others have reported cases of sterility in bulls from generalized scrotal infections and abnormal spermatogenesis. Cows may suffer from atrophy of ovaries as a result of the general debilitating effects of the disease (Ogwn *et al.*, 1981).

Lloyd (1976) and others have reported as much as a 20% drop in milk yields over a short period of time. They found that lesions on the udder often affected the teats, which can be encased in thick scabs making or suckling impossible. A stunted growth of suckling animals can be lethal for young calves. Clinically affected animals loose weights and, if they are not treated successfully, most become emaciated and will eventually die. Less obviously but possibly more economically important, the disease delays upgrading of herds by necessitating premature culling of more productive individuals. In Africa oxen represent a vital source of draught power. Prevalence rates of up to 10% have been reported among such cattle with potentially disastrous effects (LIoyd, 1976), especially as the disease often coincides with the onset of rainy seasons, when draught animals are needed for ploughing and field preparation. Most importantly, the disease has severely hampered the establishment of highly productive cattle breeds and the upgrading of indigenous cattle breed by cross -breeding. This has affected the utilization of both *Bos taurus* and *Bos indicus* imported stocks (Samui and Hugh-Jones, 1990b). Other exotic breeds, which have been imported into the country and affected by the disease, include Gir, Nelore and Friesian.

Efforts to " improve the quality " of indigenous cattle through artificial insemination using imported semen from exotic breed of cattle, met with poor success because of the incidence of dermatophilosis among the crossbreed calves. The high incidence of the disease contributed significantly to the collapse of the AI (Artificial Insemination) project in Ghana (Koney, 1996).

Hides from animals with dermatophilosis are severely downgraded and are not accepted for export. Lightly affected hides might in some cases be sold locally after the scabs have been scraped off. The lesions cause a much reduced thickness of the hide, sometimes holing it and leaving a pitted appearance on the grain surface after tanning. Invasion of *Dermatophilus congolensis* causes exaggeration of the dermal papillae, which can be seen as rounded, blemished in the tanned hide. The strength of the leather as a whole decreases and grain cracks appear when the leather is subjected to strain. The hides are therefore rejected (Teshale, 1988).

2.7 Pathogenesis

Following infection, the zoospores reach susceptible site of the skin by their own motility and a positive chemotactic response to carbondioxide which diffuses through the skin (Robert, 1963d). In contrast to the dermatophytes, which are parasites of the stratum corneum, the branching filaments of *Dermatophilus congolensis* invade the living cell layers of the epidermis and the sheaths of the hair or wool follicle, where extensive proliferation of the organism occurs. It does not invade the dermis or the hair or woolfibers (Robert, 1965).

Once epidermal defenses are breached and the zoospores germinate, branching filaments extend through the epidermis but do not usually penetrate the basement membrane zone. Keratinolysis may support the colonization. Extensive proliferation occurs in the outer sheath of the hair follicle, which probably represents the initial site of infection in the naturally occurring disease. The bacterial invasion stimulates an acute inflammatory reaction, characterized by superficial dermal edema and the accumulation of a large number of neutrophils. Neutrophilic exocytosis also leads to microabscess formation in the surface epidermal and the external root sheath. The inflammatory response, particularly the neutrophil component, inhibits deeper penetration by *Dermatophilus congolensis*. By 24 hours post infection, epidermal regeneration from adjacent external root sheath epithelia is established, and by 36 hours the epidermis is completely restored. Since the bacterial presence has stimulated premature keratinization in the original epidermis, the bacteria now invade the newly formed epithelium from a reservoir in the follicle sheath, and another burst of dermal inflammation is stimulated. Such cyclic events build up a scale-crust, composed of alternating layers of parakeratotic and orthokeratotic hyperkeratosis with bands of degenerating neutrophils. Bacterial filaments within the crust are largely composed of multiple rows of coccoid bodies, which eventually develop into motile zoospores (Jubb *et al.*,1993).

Dermatophilous congolensis does not produce toxins. The inflammatory response is attributed to the product of cellular damage diffusing from the infected epidermis (Roberts, 1957).

The restriction of *Dermatophilus congolensis* to the epidemis indicates the presenc of an inhibitory factor in the dermis. The invariable presence of a cellular exudate beneath the infected epidermis suggests that the inhibition may be due to the neutrophiles in the exudate.

Pathologically, dermatophilosis typically appears as hyperplastic superficial perivascular dermatitis with a palisading crust and prominent reticular degeneration of the superficial epidermis. Other reaction patterns less commonly observed include suppurative epidermatitis and suppurative folliculitis. Rarely, deep granulomatous or pyogranulomatous dermatitis and panniculitis may be seen, especially in cats and ruminants (Jubb *et al.*, 1993).

Microscopically the typical acute lesions are characterized by congestion and edema of the dermis (Roberts, 1965), degeneration, necrosis and hyperkeratosis of the cells in the epidermis accumulation of exudate on the surface of the skin and infiltration of neutrophili in the dermis and epidermis.

2.8 Immunology

2.8.1 Antigens

Gordon (1964) was able to demonstrate the presence of precipitins in the sera of hyperimmune rabbits, which had been infected artificially with strains of *Dermatophilus congolensis* and this was confirmed by Roberts (1965). Roberts working with zoospore suspension and aqueous solution of culture organism from sheep, horse and bovine recognized the following antigenic structures

- Somatic agglutinogens
- Somatic haemolysins
- Somatic precipitinogens: these were identical in all strains.
- Flagellar agglutinogens: show variation but some sharing between isolates.

All strains cross-reacted fully in delayed hypersensitivity reaction to soluble extracts of aceton-dried organism.

2.8.2 The Immunological response

A single acute infection induces a state of delayed hypersensitivity detectable by the reaction to either intradermal antigen or a second infection, but stimulates virtually no production of circulating antibody. Two infections at an interval of 14 days, induce somatic and flagellar agglutinins, precipitins and immediate cutaneous anaphylactic hypersensitivity (Roberts, 1966).

In sheep and rabbits measurement of the response is complicated by the presence of natural somatic agglutinins at high titers and natural flagellar agglutinin at lower titers. The natural and induced antibodies can be distinguished at 70 ^{0}C in the rabbit, but there is no difference in heat stability in the sheep (Roberts, 1966).

2.8.3 Influence of delayed hypersensitivity on course of infection

Hypersensitivity was reported to play a role in speedy recovery of animals after reinfection (Bida and Kelly, 1976). The role of the delayed type hypersensitivity reaction in the production of these effects is described by Roberts (1966). He reported that the circulating antibodies have no influence on the course of infection once established and the delayed hypersensitivity reaction to infection is associated with an accelerated infiltration of the lesion by neutrophils, accompanied by decrease hyphal penetration of follicles sheaths and earlier healing.

The intensification of the inflammatory response to infection by the delayed type hypersensitivity reaction may aggravate the disease in cases where there is continuos re-infection rather than chronic infection.

Morrow *et al.*, (1993) have studied the cellular responses of dermatophilosis infection in acute and chronic cases. They reported that neutrophils dominated the early response and were present also in large number in chronic lesions. Plasma cells were present in acute and chronic lesions. However, they disappeared from the skin at acute lesion sites after the lesions had resolved, whereas in chronic lesions they persisted. In the chronic lesions the mononuclear cell population was composed of T - helper and T - cytotoxic / suppressor lymphocytes in equal proportions, whereas in acute lesions at 14 days after infection, where lesions resolution was underway there were greater number of T - helper cells than T - cytotoxinc / suppressor cells.

2.8.4 Influence of circulating antibody on infection

Roberts (1966) discusses the effect of circulating antibodies on resistance. In rabbits, which have a high natural resistance associated with the efficient destruction of infecting zoospores by phagocytosis, the presence of antibody does not increase either the resistance of scarified skin, measured in terms of the infecting dose of zoospores or the destruction of zoospores by neutrophile leukocytes in vivo or in vitro.

In sheep and guinea pigs, whose phagocytes readily ingest the zoospores but are unable to destroy them, antibody increases the resistance of scarified skin and the destructive efficiency of the the neutrophiles to a point where in both respects they are equivalent to the rabbit. It seems clear, therefore, that the acquired resistance demonstrated in sheep and guinea pig is due to an enhancement by antibodies of the destructive phase of phagocytosis that follow engulfment.

Thompson (1954) reported that circulating antibodies that develop as response to the infection appears to have no influence on the course of the disease once it is established.

2.9 Clinical Signs

2.9.1 Incubation period

It is doubtful, under natural conditions, that an accurate incubation period can be estimated, especially in Africa (Stewart, 1972). However, Stewart summarized the available figures of the incubation period for dermatophilosis as follows:

Calves: Within 2 days of calving to 14 days.

Other bovine animals: Approximately 1 month

Lambs: With in 14 days.

Strawberry Foot Root (SFR): 2-4 weeks.

Man: 2-7 days.

2.9.2 The disease in bovine animals

Cattle of all age groups are affected, but there can be great variations, even within the same affected herd. The essential lesion consists of an exudative crust- like thickening of the epidermis. All lesions are devoid of hair and some may be so thick as to resemble horny out crops. Parakeratosis is not uncommon. The lesion commences as papules and pustules that soon coalesce into extensive scab formations. The areas of the dorsal surfaces of the back, hindquarter and neck with involvement of the chest and flanks are the common sites. Quite often the initial sites of the infection are on the scrotum, axilla and adjacent area of the dewlaps and groin (Stewart, 1972). Macadam (1962) agreed that the primary lesion could well develop at these sites, as they are also predilection sites for attachment of ticks, especially *A. variegatum*. The lower extremities of the legs can, on occasion, be seen to show early lesions. Equally frequently, lesions develop along the back, tail, head and hindquarter. These "paint brush" early lesions could be initiated by biting flies.

The lesion of dermatophilosis develops insidiously and early lesions may go unnoticed. Quite often these can be detected by palpation even though the skin appears to be normal. Other researchers such as Roberts *et al.*, (1962) also described the detection of early lesion by palpation.

The lesion commences as small papules involving few hair follicles and the epidermis around them. An exudate is produced and even at this pinpoint stage the organism can be demonstrated on smear (Stewart, 1961). This epidermal exudate coagulates causing the hairs to stick together. They thus stand erected, in contrast to the surrounding unaffected hair, and give rise to the so-called "paint brush effect". The invaded epidermis is shed by the exudate and pushed outward by the regenerating epidermis, below which coagulation of the hair and the cell debris forms a scab. The new epidermal layer in turn becomes infected and shed in a similar manner. Thus, there is formed a raised scab with a distinct lamellear structure (Roberts, 1967b). As the scab develops it appears grey, white or yellow-brown, raised above the level of the skin up to half an inch and is in general circular in outline and variable in size. When forcibly detached these scabs have a concave purulent base from which protrude the roots of hair. On occasion hair may be absent. The underline skin is raw and hemorragic. In the early stage scabs are firmly adherent to the underline epidermis, but as they become thicker and older they can be removed more easily, some eventually fall off spontaneously as the lesions heals (Stewart, 1972).

Mornet and Thiery (1955) described the typical bovine lesions into four forms.

Ichthyotic form: This is the scab like lesion commonly seen.

Nodular form: These lesions tend to be more nodular in formation and are invariably associated with concurrent *Demodex bovis* infection. Some nodules can be as large as 12 cm and up to 2 cm thick. The surfaces are irregular pitted with suppurative crates. Expressed pus is often rich in mange mites.

Tumorous form: This type of lesion is formed by production of a histiocytoma developing around a hair follicle bulb.

Leproid form: This is described as a dermal infiltration by inflammatory cells with a folliculitis. It is manifested by an epidermal thickening that exhibits subsequent parakeratosis. It is seen occasionally around the anus and vulva.

Mornet and Thiery also noted the presence of tongue lesions, hyperplastic lymph nodes and a toxic hepatitis and nephritis.

2.9.3 The disease in sheep

Most breeds of sheep seem to be susceptible to the disease but it is suggested that the close wool breed is more susceptible (Kane *et al.*, 1989). The nature of the lesion in the species is variable and depends largely on the geographical locality, climatic factor, the pathogenicity of the organism and the exact site of the animal attacked. In clinical terms three conditions are encountered, all being identified with *Dermatophilus congolensis* (Stewart, 1972).

"Mycotic dermatitis": Lesions on the wool-covered parts, mainly the back body side and neck region. This type of lesion is synonymous with the "Lumpy wool" (Bull, 1929).

"Dermatitis": Lesions on the hair- covered area of the head, especially the ear, commisures of the lips and hair covered the nasal bones. In rams the scrotum may be involved (Nisbet *et al.*, 1955).

"Strawberry Foot Root": Lesions associated with the hair of the legs from the coronet to the knee or hock joint (Harris, 1948).

2.9.4 Duration of the Lesion

In cattle in Africa, lesions may last from 15 days to many months, some lesions may possibly be carried over to the next rainy season (Macadam, 1962). Macadam also reported experimentally induced lesions last 18 days in ponies, 15 days in cattle, 42 days in goat and 1 months in sheep. These were under Nigerian conditions and he further showed that the addition of tick extract to his infecting culture prolonged the duration.

In humans the duration is up to two weeks unless antibiotic treatment terminates the infection (Stewart, 1972).

2.10 Diagnosis

A provisional diagnosis of dermatophilosis in animals can often be made on clinical basis alone (Roberts, 1967a). However, it can readily be confirmed by the examination of biopsy material from the lesion or of smear prepared from affected skin, the concave base of freshly removed scabs, or of suspensions of some most recently formed scabs in distilled water. Smears should be stained with Gram's stain or aniline dyes (Bull, 1929) or Giemsa (Buxton and Fraster, 1977) and examined for the presence of typically branched filaments which are transversely and longitudinally septet, to form characteristic parallel rows of coccoid elements (Bull, 1929). However, they appear best in histological sections stained with Hematoxylin and Eosin, in which clearly is demonstrated the alternating layers of keratin and exudate. The laminated appearance is also produced in ringworm infection that can be differentiated by the fact that *Trichophyton* species, the cause of bovine ringworm in East Africa, invades hair and hair follicle and usually form masses of spores towards the surface of the epidermis (Gebreab, 1983).

Dermatophilus congolensis is readily isolated from newly formed scabs, which are relatively free of secondary bacterial contamination, but for contaminated specimens the use of media containing polymyxin B is recommended (Abu-Samra and Walton, 1977). The identification of *Dermatophilus congolensis* is established by cultural, morphological and biochemical features (Tonder and Horner, 1986).

In older scab materials the hyphal structure are sometimes no longer recognizable, which have been completely converted to free zoospores. The use of the fluorescent antibody method, as described by Pier, Richard and Farrei (1964) may facilitate the diagnosis of these cases. This method is helpful in detecting residual fragments of the organism in crusts degraded by secondary bacteria. Diagnosis can also be made using counter-immunoelectrophoresis, a test that is considered to be specific, sensitive, easy to perform and suitable for screening of large number of sampled in field survey. It can also be useful in monitoring the immune response of animals in vaccination trials (Kwapinski, 1966).

The application of ELISA for the sero-epidemiological studies of dermatophilosis as well as its probable use for the sero-designation of the different phases of the clinical disease had been recommended by Makinde *et al.*, (1997). An ELISA was developed for measurement of *Dermatophilus congolensis* specific IgG antibodies in bovine sera.

Infection of laboratory animals with a suspension of the material may also assist the diagnosis. Sheep and guinea pigs are most suitable because *Dermatophilus congolensis* grows more abundantly in their epidermis than in that of the rabbit or mouse and because calves lick their lesion and the crusts may be removed before they can be recovered. The crusts may be removed and examined after about one week (Roberts, 1967a).

2.11 Differential diagnosis

In cattle, ringworm lesions (which are usually characterized by circular skin lesions on the face and neck) mange (which is usually pruritic), subacute to chronic photodermatitis (which only affects the non-pigmented area of the body), and the skin lesion associated with subacute to chronic sweating sickness may be confused with those of dermatophilosis (Tonder and Horner, 1986).

2.12 Treatment

There is no completely satisfactory treatment for cases which show very extensive involvement, or those being constantly reinfected or exposed to predisposing factors (Radostitis *et al.*, 1994).

2.12.1 External treatment

Because of the thick and firmly adherent scabs which cover the lesion, and because of the depth to which the bacterial filaments penetrate into the affected skin and follicle sheaths, topical treatment is neither practical nor effective (Roberts and Graham, 1966).

In Reports on the use of topical agents, removal of the scabs before treatment is often described. This implies that the infection is already overcome and the scabs partly detached.

External treatments including the use of arsenicals, cooper sulphate, quaternary ammonium compounds and formalin have no curative value because the majority of the hyphae are accessible in follicle sheaths (Buxton and Fraster, 1977).

2.12.2 Parenteral treatment

Since the agent invades a layer of tissue which, although avascular, is living and in biochemical equilibrium with the blood, it seemed likely that an antibiotic could be found that would diffuse from the circulation to the invading hyphae. The virtual absence of cellular infiltration of the infected tissue indicates that the destruction of *Dermatophilus congolensis* would not be assisted by phagocytosis. Therefore a chemotherapeutic agent, to be effective, would have to be present in the epidermis at a fully bactericidal concentration for at least a brief period, or at an inhibitory concentration for a period long enough to allow for the accumulation of a sufficient intervening thickness of the exudate and cornified tissue to prevent a transfer of infection from the old epidermis to the new (Roberts, 1967a).

Before a treatment with antibiotics is started it is important to distinguish between acute cases, having a high spontaneous recovery rate, chronic cases and cases of continuous reinfected.

A single treatment of penicillin and streptomycin given intramuscullarly at dose of 70,000 IU/ kg and 70mg/ kg respectively is usually effective (Roberts, 1963 a, b.). Good results have been obtained by treatment of affected cattle (Horner, 1986; Ilemobade *et al.*, 1979) and sheep (Gyang *et al.*, 1988) with a single dose of long-acting oxytetracycline at 20mg/ kg. However, in a study performed during the dry season in Nigeria by Ogwn *et al.*, (1981), long-acting tetracycline was not found to be effective, as the recovery rate after one or two infection was not higher than the rate of spontaneous recovery in the untreated control group. They reported also that the preparation was expensive.

Ilemobade *et al.*, (1979) have compared a single intramuscularly dose (20mg / kg) of longacting oxytetracycline with combination of penicillin (70,000 IU/kg) plus streptomycin (70mg /kg) of bovine dermatophilosis under conditions simulating traditional husbandry. Their results revealed that longacting oxytetracycline was found superior with 93% healing within four weeks than penicillin-streptomycin combination that cured only 36% of the treated animals within one month time.

The effectiveness of oral treatment with $ZnSO_4$ alone or in combination with the antibiotics (oxytetracycline or penicillin-streptomycin) was also investigated. However, treatment with $ZnSO_4$ orally, daily for three days, alone or in combination with a single dose of either of the antibiotics had no effect on the cure rate (Teshale, 1988).

Oduye (1975) has reported that intravenous sodium iodide (NaI) and / or oral administration of potassium iodide (KI) have been found to be beneficial in cattle in Nigeria.

If animals are continuously reinfected, treatment is unlikely to influence the course of the disease. Animals with advanced chronic lesions should be culled. Acute infections sometimes heal spontaneously. About 10% of the cattle that are not severely affected may recover without treatment (Samui and Hugh-Johes, 1988). Blancon (1976) has also reported that spontaneous recovery of up to 20% occurs during dry period especially if the animals are lightly infected.

2.13 Control

2.13. 1 General aspects

The type of control to be adopted in a particular instance will depend on its cost in relation to the loss it is designed to prevent, and on the factors governing the spread of infection, which vary considerably with circumstances (Roberts, 1967b).

Preventive measures should aim to interrupt the chain of epidemiological events required for the occurrence of outbreak of dermatophilosis (Roberts, 1963c).

The control of the disease differs in species affected.

In cattle, it has been shown that by controlling the tick population and keeping cattle free, a satisfactory, very low incidence of the disease results (Macadam, 1962). This is the practical measure which is feasible in many African territories (Stewart, 1972).

Plowright (1956) reported good control of bovine infection through control of the tick responsible for transmission. It would be easier to deal with a vector of this kind which is restricted to the animal it infests, than with vectors such as flies, mosquitoes and spiny plants which are widely spread in the environment and almost unlimited in supply.

Tick control and early proper treatment of infected cattle are the most important management factors influencing the prevalence of dermatophilosis in cattle (Samui and Hugh-Johes, 1988).

In sheep, a general method for the prevention of lumpy-wool in Australia is proposed by Roberts and Graham (1966).The method is based on the hypothesis that an outbreak of lumpy-wool require simultaneously (1) some infected animals as source of zoospores (2) wetting to permit the release of zoospores (3) increase availability of mechanical vector (probably) and (4) a deficient protective barrier on the wooled skin. The factors (1), (2) and (3) often coincide naturally and inevitable, especially in the late spring or early summer whereas (4) is largely dependant on the annual husbandry practices which may be modified to break the chain of coincidence, for example by alteration of the dates of shearing or lambing, or by improving dipping techniques to avoid scalding of the wooled skin (Roberts, 1967b).

2.13.2 Vaccination

Although improved husbandry and in particular, the use of acaricides to control ticks have been shown to be effective in reducing the incidence of infection (Plowright, 1956) such methods are not practicable in regions where animals are dispersed over a wide area. Some success has been obtained in controlling dermatophilosis by means of vaccination but a more effective vaccine-induced immunity are required (LIoyd, 1984).

Many workers advocated successful immunization of cattle against *Dermatophilus congolensis* infection by using whole cell antigen. Vaccination of rabbit with lives whole cell preparation of *Dermatophilus congolensis* either intradermally or subcutaneously with Freund's complete adjuvant has been shown to afford protection against subsequent challenge. How and LIoyd (1990) have reevaluated the above work and found significant but not complete protection against *Dermatophilus congolensis* challenge. Further vaccine development against dermatophilosis must recognize strain variations in *Dermatophilus congolensis* with respect to antigenicity and virulence, although vaccines previously developed have not given a high level of protection against homologous challenge (Sutherland *et al.*, 1991).

Teshal (1988) described the vaccination trial performed in Tchad, in 1971-72 by many workers. Two types of vaccines were used, one lyophilized and the other non-lyophilized. The result of the trial indicated that none of the vaccinated animals were affected while among the control many were affected. However, other workers such as Roberts (1967b) reported that neither infection nor vaccination protects animals against infection. Although it is not protective, Roberts recommended the vaccination of cattle because of the apparent importance of tick bites in bovine infection in which the neutrophiles probably have access to the infecting zoospores.

2.14 Eradication

The agent is so ubiquitous among herbivorous animals and is often so difficult to detect. Therefore, eradication would be a most formidable task if it was feasible and would be grossly uneconomical (Roberts and Graham, 1966). If the infection were eradicated from an individual herd or flock there would probably be a high danger of reentry from neighboring farms by insect danger of carriages, especially in view of the finding that flies can remain infective for 24 hours (Richard and Pier, 1966).

3. MATERIALS AND METHODS

3.1 The project area

The study was conducted in southern Tigray, Northern Ethiopia, located between latitudes 12^0 16' and 12^0 55' N and longitudes 39^0 22' and 39^0 53' E. The topography of the study area is characterised by three physiographic features, that is the lower plains, the mountainous and the small plateaus. Three main agroclimatic zones (the highland, medium altitude and low altitude) were identified in the study area (Relief Society of Tigray, 1998).

The highland

This includes the mountainous part of the "Offla wereda" with the altitude of 2400-2460 masl and mean annual rainfall of 964 mm. The mean annual temperature of the area varies from maximum of 22.3^0C to minimum of 10.5^0C with daily mean temperature of 16.4^0C.

The medium altitude

The altitude of this zone ranges from 1700-1970 masl. The mean annual rainfall goes to 156mm. The mean annual temperature varies from maximum of 26.78^0C to minimum of 12.42^0C. The "Enderta wereda" covers within this agroclimatic zone.

The low altitude

This includes an area with altitudes of 1580-1775 masl. The mean annual rainfall ranges from 573.7 mm to 485.4 mm with an average of 529.55 mm. The maximum and minimum mean annual temperature recorded are 27.2^0C and 14.8^0C, respectively, and the daily mean temperature is 21^0C. In this area, the lowland plains of "Chercher", "Mokoni" and "Alamata" are included.

The study area is characterised by bimodal rainfall pattern with a very short rainy season "Belgi" from February to March and a long rainy season "Keremti" from late June to September with peak in August. The rainfall pattern varies between the upper and lower escarpment of the project area. In the lower zone rainfall pattern is erratic and unreliable while in the highland it is more regular and relatively greater in intensity.

The monthly mean rainfall and temperature for 1992-1996 of the study area is presented in figure 1 and 2.

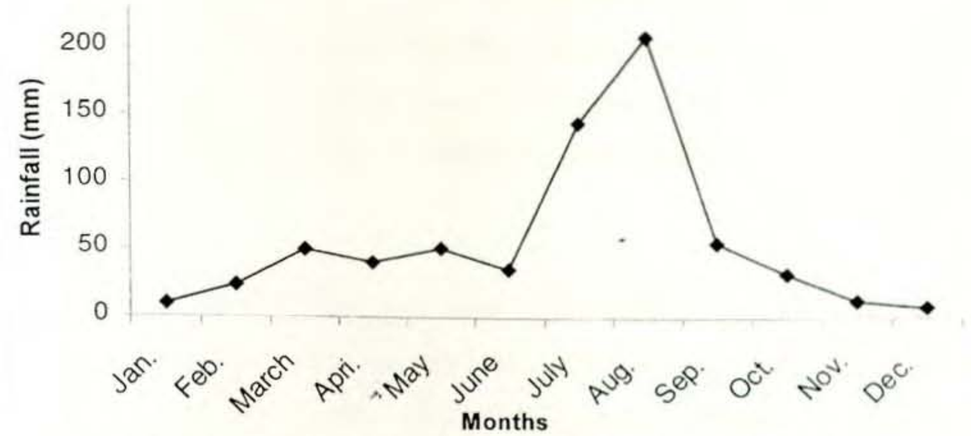


Figure 1: Monthly mean rainfall (mm) of southern Tigray

Source: Relief Society of Tigray (REST),1997.

Figure 2: Monthly mean temperature of southern Tigray

Source: Relief Society of Tigray (REST), 1997.

The dominant vegetation cover of the study area varies from woodland (high and low shrubs with scattered tree) in the low and medium to grassland in the highland.

The crop-livestock (mixed) farming system is the dominant farming system of the area with very small agropasturalist in the low altitudes. Very small semi-intensive dairy farms with crossbreed animals are also present in and around the capital city of the region, Mekelle, located in the "Enderta wereda".

According to Tigray Bureau of Agriculture and Natural Resource Development, (1998) the livestock population of the study area was estimated as 725,129 cattle, 201,954 sheep, 160,527 goat, 106,776 equine and 8,759 camels. The cattle population accounts for 23.84% of the Tigray region. The Harmo and Arado types of zebu breed are the dominant cattle type in the low and high altitude of the study area, respectively. The livestock feed of the study area has three sources: grazing / browsing of natural vegetation, crop residue and after math grazing of naturally cropped lands.

Preceded by and compounded with poor nutrition and backward animal husbandry practices animal disease remains to be one of the main constraints to livestock development across all the agroecological zones of the study area. REST (1997) reports showed that, internal parasitism in the highland, tick and tick-borne disease in the lowland are the main animal diseases of the study area.

Dermatophilosis is one among the important tick-borne disease of the lowland. The official annual veterinary report, from the zonal Agricultural Office, indicated that in the year 1995-1996, there had been 10 registered outbreaks of bovine dermatophilosis in the "Raya Azebo wereda", which affected 74 heads of cattle. The official regional veterinary report also showed that there had been 77 registered cases of bovine dermatophilosis with 20 dead in 1998/99 showing a case fatality rate of 25.97%.

In relation with the wide spread of infectious and contagious animal diseases in the study area the current delivery in the animal health service is inadequate, although there is a gradual improvement.

3.2 Study population

Cattle - local zebu breed animals under extensive management system.

- crossbreed animals (friesian x zebu) under semi-intensive management system.

3.3 Study designs

The epidemiological cross-sectional study was used as a study design. The cross- sectional study was carried out in two seasons (dry and wet) in three agroclimatic zones of the study area. The dry period study was conducted from late May to early June 1999 while the wet period in August 1999.

3.4 Sampling methodology

3.4.1 Local breed animals

First the stratified cluster and then the systematic random sampling methods were followed for the study.

The 8 "weredas", adminstrative units, in the study area were taken as secondary clusters.

The secondary clusters had been stratified according to their agroclimatic zone.

- High altitude: "Offla", "Endamokonnie" and "Alagie"
- Medium altitude: "Enderta", "Samre-Sahartie" and "Hintalo-Wajerate"
- Low altitude: "Raya-Azebo" and "Alamata"

From each agroclimatic zone one secondary cluster was selected using random sampling. The selected weredas were "Offla", "Enderta" and "Raya-Azebo" for the high, medium and low altitudes, respectively.

From each secondary cluster in each agroclimatic zone animals were sampled at household level using systematic random sampling. The household herd is an epidemiological unit of interest and considered as primary cluster. All animals in the herd were sampled.

A total of 75,588 household are present in the selected three secondary clusters (table 1).

Table 1 Summarised information of the sampled agroclimatic zones.

Altitude	Selected Secondary Clusters	Cattle Population per Secondary Cluster	Number of Households Per Secondary Cluster	Average Number of Cattle per Household
Highland	Offla	88,267	26,776	3.2
Medium	Enderta	79,493	22,632	3.5
Lowland	Raya-Azebo	140,374	23,180	6
Total		308,134	72,588	

Source: TBANRD (1998).

3.4.2 Crossbreed animals

All animals of the dairy farms in Mekelle were sampled.

3.5 Sample size determination

3.5.1 Local breed animals

For sample size determination the EPISCOPE computer programme, Win Episcope 1.0 (sample size to estimate percentage 1), recommended by Frankena (1990) was applied.

Sample size determination was based on the following basic information and estimates.

- The estimated prevalence of bovine dermatophilosis: 10% (TBANRD, 1997).
- Cattle population in the selected secondary clusters: Offla=88,267; Enderta=79,493, Raya-Azeb=140,374 (TBANRD, 1998).
- Accepted error: 4%
- Level of confidence: 95%

Using the aforementioned data the calculated sample size for each secondary cluster was 217. Since the cluster sampling method was used for the study, to compensate for the non-independence of clustermates, large number of individuals are required. Hence, the sample size calculated by Episcope programme was inflated by four. Therefore, the adjusted sample size for each secondary cluster was 868 and for the three secondary clusters 2604 animals / season. During the dry and wet seasons a total of 5208 animals were investigated.

3.5.2 Cross breed animals

All the crossbreed animals in and around Mekelle were sampled during the dry (n = 192) and wet (n = 186) seasons.

3.6 Study methods

3.6.1 Clinical examination

Visual and physical (palpation) inspection of every sampled animal for clinical bovine dermatophilosis was performed. Besides demographic and other data such as sex, age, breed, skin color, altitude and vegetation cover of the study area were registered. For each animal the presence or absence of *A. variegatum* ticks was also noted. The cases of dermatophilosis were classified as light (+), moderate (++) and severe (+++) depend on the severity and extensiveness of the skin lesions. The skin lesions were also examined for presence of other skin disease.

3.6.2 Specimen collection

From clinically suspected animals, the concave base of freshly removed scabs and other skin specimen, if the dermatophilosis lesion were combined with other skin diseases, were collected in sterile dry containers.

The adult *A. variegatum* ticks were collected, if any, from the predilection sites of clinically suspected animals while they were cast down in dorsal recumbency. For comparison purpose the same ticks were collected, in the same manner, from uninfected animal of the same age, sex, skin color and tick burden like that of clinically suspected animals. The ticks were preserved in 10% formalin.

Biting flies found attached in the animal body were caught and preserved in 10% formalin for identification.

3.6.3 Laboratory examination

The collected scabs were examined in the laboratory for *Dermatophilus congolensis* according to Buxton and Fraster (1977). In this method a suspension of the scab was made with distilled water. Smears were prepared from the suspension, air dried and heat fixed. Thereafter the smears were stained with Giemsa for 30 minutes and later examined under oil immersion within objective lens for the presence of typical branched filaments, transversally and longitudinally septeted with parallel rows of coccoid element which is the characteristic feature of *Dermatopilus congolensis.*

Out of 247 Giemsa positive specimens 61 (25%) were subjected to bacteriological isolation procedure, according to the method described by Abu-Samra (1977). In this method scabs were grounded to fine powder using sterile mortal and pistle and transfered to a sterile universal bottle, where two parts of distilled water are added to one part of the scab material, shaked well and allowed to settle for 15 minutes. The suspension is then exposed to 20% CO_2 using a candle jar for another 15 minutes. Thereafter the supernatant is removed with sterile pasteure pipette and seeded on 10% sheep blood agar containing 1000 IU polymixine B in 1 ml of agar. The media were then incubated in a 20% CO_2 atmosphere at 37^0C. After 48 hours the media were examined for typical pinpointed, grey-white colonies of *Dermatophilus congolensis* with β hemolysis. From the colonies smears were prepared and stained with Giemsa and examined for *Dermatophilus congolensis* with the aforementioned procedure. Furthermore, biochemical tests for catalase urease, TSI (Triple Sugar Iron) and fermentation tests for maltose, galactose, lactose, saccharose, manitol and sorbitol using bromthymol blue as indicator were used for further identification.

Ticks, which were collected from the dermatophilosis infected and uninfected animals, were identified according to Hoogstral (1956), as they are *A. variegatum* and later counted.

The biting flies collected were also sent to International Centre for Insect Physiology and Ecology (ICIPE), Ethiopia branch, for identification.

3.7 Questionnaire survey

A questionnaire survey was conducted, at household level, in parallel with the inspection of individual animals for clinical dermatophilosis. Before administration, the questionnaires were tested, at field level and adjusted as necessary.

During the dry and wet seasons, a total of 108 animal owners, 36 from each agroclimatic zone, were interviewed using the structure questionnaire. One hundred percent (100%) response rate was obtained. The main objective of the survey was to know the attitude of the farmers towards bovine dermatophilosis. The content of the questionnaire comprise of relevant questions concerning bovine dermatophilosis ranging from the importance of the disease to the action taken by the respondent against the disease. (See the Annex).

3.8 Study on financial impact of bovine dermatophilosis

A preliminary and conservative estimate of the financial and production impact of bovine dermatophilosis for the year 1999 was done by interviewing 104 households having infected herd, which were identified during the prevalence study. The names of the respondents were noted to avoid double interviews on the same subject.

The study was carried out from late May to August 1999 using structured questionnaires. The field study method described by Samui and Hugh-Jones (1990b), for assessment of the financial and production impact of bovine dermatophilosis, was followed.

The financial estimate was assessed, based on 107 cases of dermatophilosis in 104 households in 1999. Costs incurred included treatment, opportunity cost, management of cases (sale, slaughter and mortality) and reduction in production (milk and draught power) of infected animals. The farmer's classification of cases of dermatophilosis depends on the severity and extensiveness of the skin lesion. Animals with early and small skin lesions were considered as lightly infected and chronic cases with larger part of skin affected were taken as moderately to severely infected.

Calculation of the financial loss was done considering the current livestock production parameters generated from group interview of farmers and the price system of the region for 1999, obtained from the annual livestock market study of the Tigray Bureau of Agriculture and Natural Resources Development (TBANRD, 1999).
The prevailing exchange rate 1 USD: 8 Birr (Ethiopian currency) was used for the calculation and was assumed to be constant throughout the year.

3.9 Data analysis

Microsoft Excel served as database. The EpiInfo version 6 and statgraphics plus computer programme were used for analysis of the data. Calculation of the prevalence rates, confidence intervals (CI) of the rates, chi-square test, odds ratio (OR), confidence interval of the OR and Mantel-Haenszel adjusted OR were performed using the computer program and hand calculators. Calculation of the chi-square test and odds ration served to investigate differences, associations and degree of association of bovine dermatophilosis between different risk factors. Multivariate analysis was also conducted using logistic regression by SPSS for window 8 programme, to assess the level of interaction between risk factors. Hence the comparison was correlated for all other variables in the model to eliminate confounding. Factors of epidemiological relevance such as season, agroclimatic zone (low, medium and high altitudes), vegetation cover, presence or absence of *A. variegatum* tick, tick count, severity of skin lesion, breed, skin color, age and sex were selected. They were considered as risk factors for comparison of outcome variables. Animals having the same risk factors were assumed to have some degree of dependency in contrast to those without the factor of interest.

4. RESULTS

4.1 Questionnaire results

In the survey a total of 108 farmers, 36 farmers from each agroclimatic zone, were interviewed. The main objective was to know the attitude of farmers toward bovine dermatophilosis.

Lowland

Economic importance and ranking of bovine dermatophilosis:

In the lowland 36 (100%) farmers responded that bovine dermatophilosis is economical important disease of their locality and it is known by the local names of "Kematte" by 55.56%, "Katto" by 33.33%, and "Shuhure" by 11.11% (picture 1). All farmers (100%) ranked the disease in first position of the cattle skin diseases prevailing in the area. In relation to other diseases 20 (55.56%) ranked bovine dermatophilosis as the fourth important and 16 (44.44%) as the fifth important animal disease.

Picture 1. A cow infected with severe form of dermatophilosis in southern part of Tigray (Raya-Azebo wereda)

The Seasonality of the disease:

Fifteen (41.67%) claimed that bovine dermatophilosis commonly emerged in the beginning of the wet season and 21 (58.33%) stated that, the disease is commonly prevailing in the wet period of the year.

Thirty (83.33%) of the 36 responded that bovine dermatophilosis is not contagious disease and 6 (16.67%) suggested as it is.

Major predisposing factor for bovine dermatophilosis:

Twenty eight (77.78%) were of the opinion that ticks are the major predisposing factor, whereas 2 (5.55%) agreed on wet weather and 6 (16.67%) suggested that poor management is the main predisposing factor for the disease (figure 3).

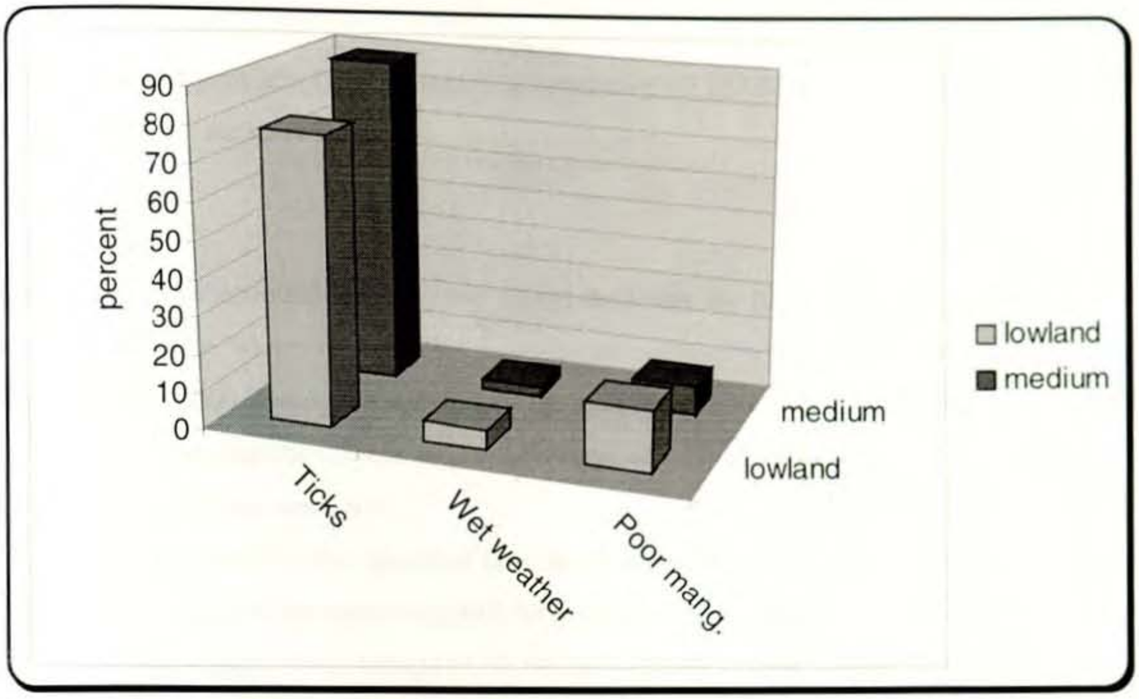


Figure 3. Farmers response to predisposing factors of bovine dermatophilosis in southern Tigray.

Thirty-four (94.44%) farmers reported that tick control practices would reduce the incidence of dermatophilosis and 2 (5.56%) they do not agree. However all 36 (100%) farmers apply a tick control practices of which 7 (19.44%) using acaricide, 20 (55.56%) manual and 9 (25%) both acaricide and manual.

Action taken against dermatophilosis:

If their animal is infected with dermatophilosis the actions taken by the farmers vary. Three (8.33%) responded that they will sell, 2 (5.56%) they will slaughter, 10 (27.78%) they will treat and 21 (58.33%) they will take no action (figure 5).

Regarding the fate of the infected animal:

As far as their knowledge is concerned, 4 (11.11%) agreed that there is spontaneous recovery, 15 (41.67%) responded as cure and later relapse and 17 (47.22%) are on the opinion that, the disease will progress from a mild to a severe stage and eventually the animal will die.

Effect of modern treatment against dermatophilosis:

Three (8.33%) believed it is effective, 11 (30.56%) it is moderate, 15 (41.67%) responded that it is not effective and 7 (19.44%) stated that they do not have a clear knowledge. Concerning the cost of the treatment 15 (41.67%) said it is expensive, 12 (33.33%) it is moderate and 9 (25%) they do not have the knowledge.

Herbal medicine:

Five (13.89 %) responded that they use herbal medicine for the disease and 2 (40%) found it effective and 3 (60%) not.

Feed shortage and dermatophilosis: Out of the total interviewed 22 (61.11%) reported that there is association between the disease and feed shortage and 14 (38.89%) not.

Biting flies and dermatophilosis:

The biting flies, which were identified later as *Hypoboscа* spp. 21 (58.33 %) farmers believed that they play a role in the transmission of dermatophilosis, 12 (33.33%) not, Where as 3 (8.34%) do not know the role of these biting flies in the epidemiology of the disease (figure 4).

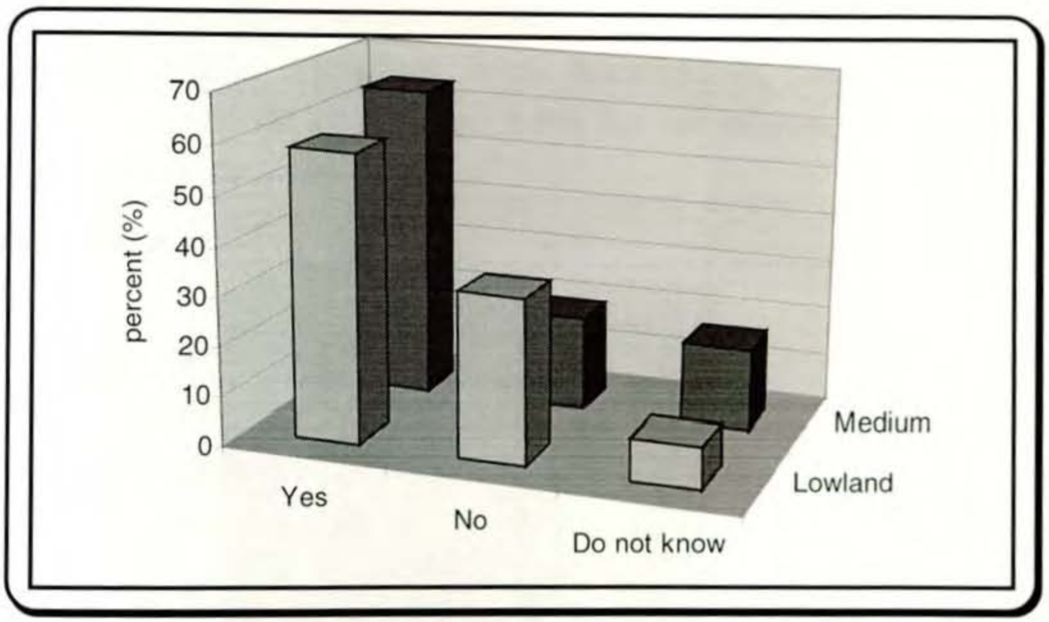


Figure 4. Farmers response, whether biting flies play a role or not in transmission of *D. congolensis*

Medium altitude

Economic importance and ranking of bovine dermatophilosis:

In the medium altitude all the 36 (100%) interviewed farmers considered bovine dermatophilosis as economical important disease. It is known by the local name "Shuure" by 31 (86.11%) and

"Tettfe" by 5 (13.89%). In relation to other cattle skin diseases around 100% of the interviewed farmers ranked dermatophilosis as the economically most important disease whereas in comparison with other diseases around 15 (41.67%) considered it as fourth important and 21 (58.33%) as fifth important animal disease.

Seasonality of the disease

Eight (22.22%) farmers believed that the disease is commonly seen in the beginning of the wet season, 26 (72.22%) during wet season and 2 (5.56%) were ignorant of the disease.

Twenty-four (66.67%) out of the 34 interviewed farmers reported that dermatophilosis is not contagious disease whereas 12 (33.33%) agreed that it is contagious.

Predisposing factor:

Out of the total interviewed, 32 (88.89%) strongly suggested that, ticks are the major predisposing factor for bovine dermatophilosis, 1 (2.78%) suggested wet weather and 3 (8.33%) suggested poor management (figure 3). Thirty-five (97.22) of the farmers reported that tick control program will reduced the incidence of the disease and 1 (2.78%) did not agree. All interviewed farmers reported that, they practiced a tick control methods ranging from using acaricide (33.33%) and manual deticking (27.78%) to both practices (38.89%).

Action taken against dermatophilosis infection:

When their animal is infected with bovine dermatophilosis, 13.89% interviewed farmers responded that, they will sell the animal, 8.33% they will slaughter, 25% they will treat and 52.78% they will take no action (figure 5).

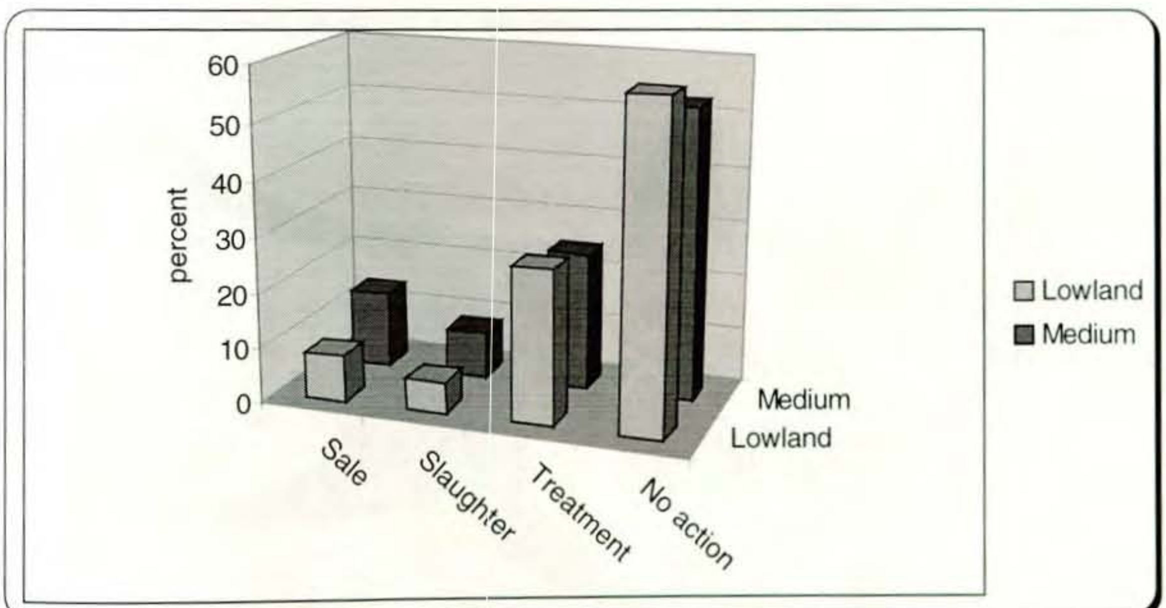


Figure 5. Action taken by farmers against bovine dermatophilosis in southern Tigray

Fate of infected animal:

Seven (19.44%) interviewed farmers suggested that there is spontaneous recovery, 18 (50%) reported although there is cure, relapse is inevitable and 11 (30.56%) responded that the disease will progress from mild to sever and then the animal will die.

Modern treatment:

Eight (22.22%) responded that treatment against the disease is effective, 9 (25%) moderate, 12 (33.33%) not effective and 7 (19.44%) that they are ignorant. Concerning the cost, 18 (50%) reported that it is expensive, 11 (30.56%) agreed that the cost is reasonable and 7 (19.44) responded that they do not have the knowledge because they do not use the practice. Out of the total 36 farmers interviewed 8 (22.22%) were familiar with herbal medicine against the disease and 2 (25%) reported that it is effective whereas 6 (75%) found it is ineffective.

Feed shortage and dermatophilosis: Out of the total 36 farmers 18 (50%) reported that there is association between dermatophilosis and feed shortage and the rest did not agree.

Biting flies and dermatophilosis:

Twenty three (63.89%) believed that the identified biting flies, *Hypobosca* spp., known by the local name "kocha" may play a role in the transmission of the disease whereas 7 (19.44%) not and 6 (16.67%) responded that they are ignorant of the matter (figure 4).

In the highland, all the 36 (100%) interviewed farmers reported that bovine dermatophilosis is not an economically important disease and since it is not prevalent, their knowledge on the disease was limited.

Picture 2. Dermatophilosis skin lesions in the ventral body part of a bull, in the southern Tigray

4.2 Prevalence of bovine dermatophilosis

4.2.1 Seasonal prevalence

The study was carried out in the dry and wet periods of the year, in order to assess the effect of season on dermatophilosis prevalence. In the dry and wet seasons a total of 5208 local breed animals, 2604 animals in each season, were inspected for clinical bovine dermatophilosis. The point prevalence for the dry and wet seasons was 4.03% (95% CI 3.3-4.86) and 5.45% (95% CI 4.61- 6.4) respectively (figure 6).

There is statistically significant difference between the prevalence of the two seasons (χ^2 =5.51, $p < 0.05$). Multivariate analysis using logistic regression, adjusted for altitude and tick infestation (*A. variegatum*) also indicated that there is a statistically significant difference ($p < 0.05$) between the two seasons with an OR value of 1.38 (95% CI (OR) 1.066- 1.7980) (table 9). Odds ratio results indicate that the risk of dermatophilosis during the wet season is 1.38 times higher than the dry season irrespective of the altitude and the *A. variegatum* tick infestation.

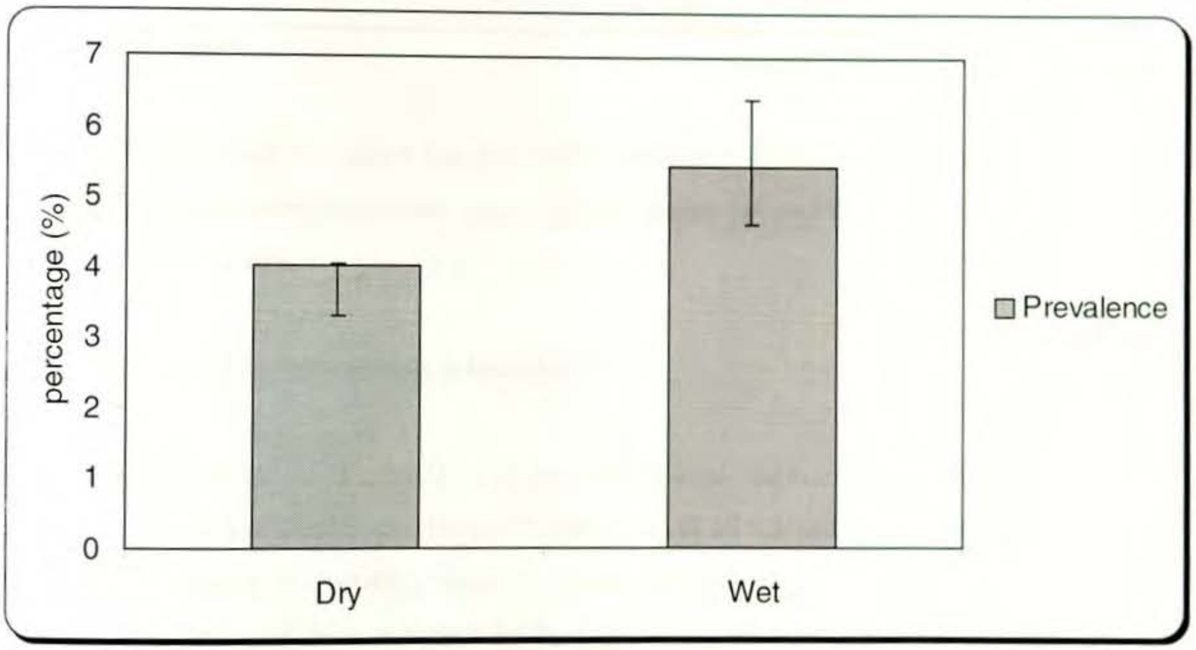


Figure 6. Prevalence of dermatophilosis during dry and wet seasons in southern Tigray,1999.

Season and severity of skin lesions

The severity of dermatophilosis skin lesions were studied in relation with the season.
The skin lesion of dermatophilosis encountered during the study were grouped into three categories (light +, moderate ++ and severe +++) depending on the extensiveness and severity of the lesions. In the dry period, of the total 105 cases 67.61%, 30.48% and 1.91% were light, moderate and severe lesions, respectively. In the wet period, out of the 142 cases 49.30% were light, 35.91% moderate and 14.79% were severe lesions (table 2).

Table 2. Season and severity of dermatophilosis lesion in southern part of Tigray in1999

Severity	Season and the proportion			
	Dry	(%)	Wet	(%)
Light (+)	71	67.61	70	49.30
Moderate (++)	32	30.48	51	35.91
Sever (+++)	2	1.91	21	14.79
	105	100	142	100

$\chi^2 = 14.82$, $p < 0.05$

Univariate analysis of the above finding (table 2) indicates that there is a strong association between severity of dermatophilosis lesion and the season ($\chi^2 = 14.82$, $P < 0.05$) being more severe in the wet season.

4.2.2 Prevalence of dermatophilosis at household level

In the dry and wet period, a total of 1113 households were inspected in the three agroclimatic zones for clinical dermatophilosis. The point prevalence of 16.9% and 28.86% were noted for the dry and wet seasons, respectively (table 3). There is statistically significant difference in the prevalence of dermatophilosis at household level in the two seasons ($\chi^2 = 22.72$ $p < 0.05$), being higher in the wet season. Altitude adjusted Mantel Haeszel ($_{MH}$) Odds ratio analysis of the disease in the two seasons, indicated that the prevalence of the disease is 1.62 times higher in the wet season than in the dry season ($OR_{MH} = 1.68$).

Table 3. Prevalence of bovine dermatophilosis at household level in the dry and wet seasons

Season	Total households inspected	No of positive households	Point prevalence (%)	95% CI of positives
Dry	621	105	16.9	14.04- 20.09
Wet	492	142	28.86	24.89-33.03

4.3 Prevalence of dermatophilosis in the three altitudes

During the dry and wet season, the prevalence of bovine dermatophilosis was studied related to low, medium and high altitudes to assess the effect of altitude on the disease prevalence. In the dry period, prevalence of 6.9%, 5.18% and 0% were recorded for the low, medium and high altitude, respectively, with the respective 95% CI (figure 7). There is a statistically significant difference in the prevalence of the disease within the three altitudes ($\chi^2 = 58.58$, $p < 0.05$). A statistically significant difference was also observed between

lowland vs highland ($\chi^2 = 60$, $p > 0.05$)

medium vs highland ($\chi^2 = 44$, $p > 0.05$)

medium vs lowland the difference, however, was not statistically significant ($\chi^2 = 1.98$, $p > 0.05$)

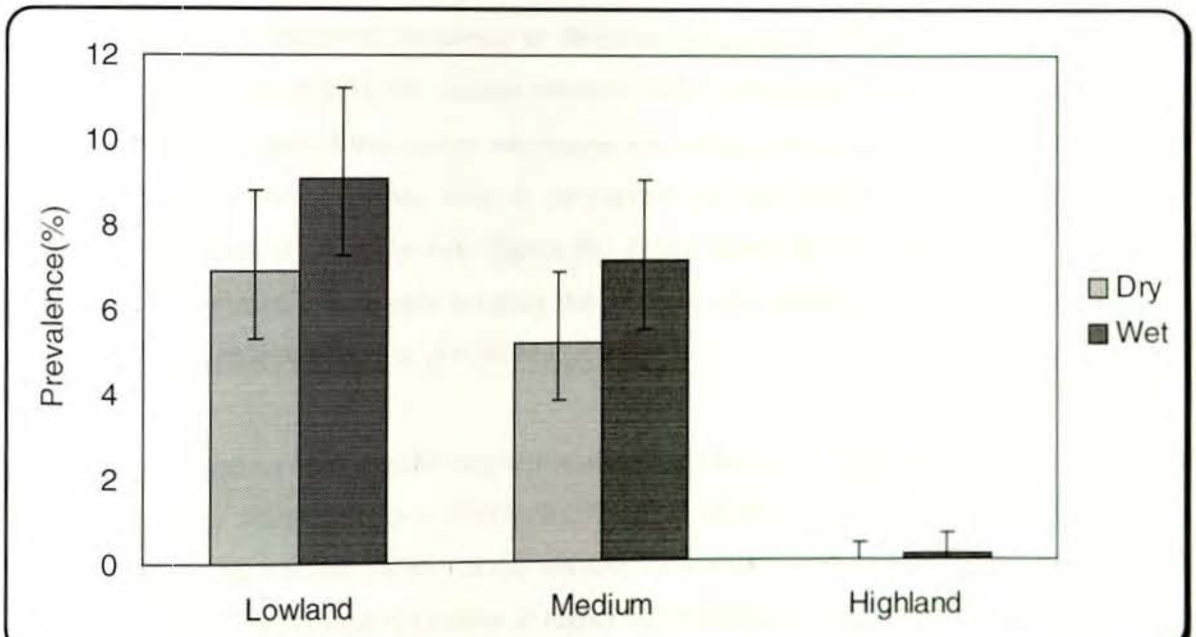


Figure 7. Prevalence of dermatophilosis in the three altitudes in dry and wet seasons

In the wet season, the prevalence of the disease was 9.1%, 7.14% and 0.12% for the low, medium and high altitudes, respectively (figure 7). A statistically significant difference was also recorded within the three strata ($\chi^2 = 75.18$, $p < 0.05$).

The difference in the prevalence of the following strata was also found statistically significant.
low vs highland ($\chi^2 = 75.18$, $p < 0.05$)
medium vs highland ($\chi^2 = 59.29\%$, $p < 0.05$)

Season adjusted multivariate analysis with logistic regression showed that there was a high statistically significance ($P < 0.05$) difference in medium altitude vs highland with OR value112.8 (95% CI (OR) 15.90-795.3466) (table 9). This indicated that the risk of acquiring dermatophilosis is 112.8 times higher in medium altitude than the high altitude. OR for the lowland vs highland was also so high, that implies practically the disease is absent in the highland.

4.4 Prevalence of dermatophilosis and the tick *A. variegatum*

In both seasons the prevalence of dermatophilosis was found higher in animals infested with *A. variegatum* than the uninfested ones.
In the dry season, the point prevalence of dermatophilosis was 5.78% (95% CI 4.72-6.98) and 0.57% (95% CI = 0.19-1.33) for animals infested with *A. variegatum* and without *A. variegatum*, respectively. The same is true for the wet season where the point prevalence was 7.83% (95% CI 6.62-9.17) for animals infested with *A. variegatum* tick and 0.36% (95% CI 0.07-1.05) for animals not infested with the tick (figure 8). It was noted that in both seasons, there was statistically significant difference between the presence and absence of *A. variegatum* tick (dry period $\chi^2 = 39.28$, $p < 0.05$, wet $\chi^2 = 59.94$, $p < 0.05$).

Mutivariate analysis with logistic regression also indicates that the difference in the prevalence was statistically significant ($p < 0.05$) with OR 6.8375 (95% CI (OR) 3.0194-15.4826) (table 9). This analysis was adjusted for season and altitude. The result of OR implies that animals infested with *A. variegatum* ticks are 6.83 times at higher risk to dermatophilosis than the uninfested ones irrespective of the season and altitude.

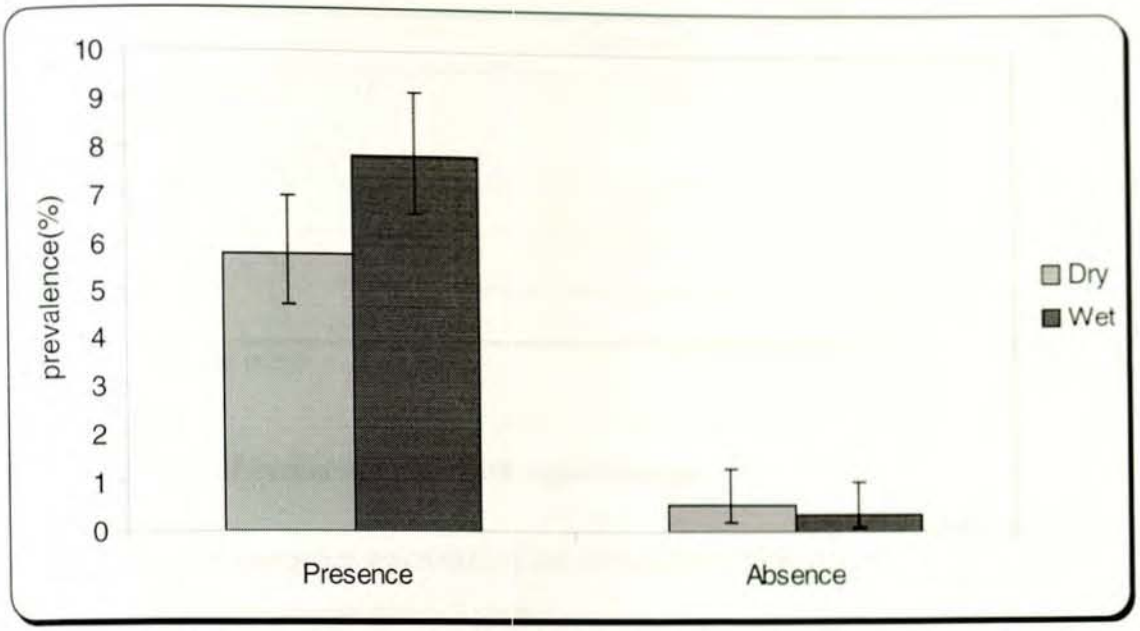


Figure 8. Prevalence of dermatophilosis in relation to presence and absence of *A. variegatum* ticks in the dry and wet seasons

Out of the 5208 animals inspected in the two seasons, 1716 (98%) animals in the lowland, 1706 (98.27%) animals in the medium altitude and 75 (4.32%) animals in the highland were found infested with *A. variegaum*.

Out of the total 247 dermatophilosis cases 24 (9.71%) had skin lesions in the predilection feeding sites of adult *A. variegatum* tick, that is on the ventral hairless parts of the animal body.

4.4.1 *A. variegatum* tick count and severity of dermatophilosis lesion

During the two seasons study, from 495 animals the adult *A. variegatum* ticks were collected, counted and analyzed in relation with the skin lesion using chi-square (χ^2), in order to know whether there is association between the number of ticks and severity of dermatophilosis skin lesions.

The result indicated that there is a statistically significant association between the level of adult *A. variegtum* tick count and severity of the skin lesion (table 4).

Table 4. Adult *A. variegatum* tick count and severity of dermatophilosis skin lesions

Severity of skin lesion	Tick count		
	0	1-20	> 20
-	38	93	117
+	5	22	114
++ and +++	3	10	93

$\chi^2 = 75.71$, $P < 0.05$

4.5 Prevalence of dermatophilosis with regards to age

During the study age group was stratified into three groups. Calves: < 1 year, replacement stock: 1 –3 year and productive animal: > 3 years.

In the dry period, the prevalence of 4.62%, 2.22% and 4.4% were recorded for the age group of < 1 year, 1-3 year, and > 3 year respectively (table 5). The difference in the prevalence of the disease with in the age group were not statistically significant ($\chi^2 = 5.26$, $p > 0.05$). Statistically significant difference were not also observed between the following age groups using univariate analysis

-< 1 year vs 1-3 year ($\chi^2 = 3.77$, $p > 0.05$)

-< 1 year vs > 3 year ($\chi^2 = 0.01$, $p > 0.05$)

However, a statistically significant difference in the disease prevalence was recorded in 1 – 3 year vs > 3 year ($\chi^2 = 4.26$, $p < 0.05$), but analysis of the data using logistic regression (multivariate analysis) showed that the difference is not significant ($p > 0.05$).

In the wet season the point prevalence of 4.02%, 4.18%, and 6.26% were obtained for the age group of < 1 year, 1-3 year and > 3 year, respectively (table 5). The difference of the prevalence within the age groups was not statistically significant ($\chi^2 = 5.38$, $p > 0.05$) with the univariate analysis. The result of multivariate analysis using logistic regression showed also that there is not statistically significant difference ($\chi^2 = 2.44$, $p > 0.05$) within the three age strata.

Table 5. Prevalence of dermatophilosis with regard to age during dry and wet seasons

	Dry season				Wet season			
	Total animals		P (%)	95% CI	Total animals		P (%)	95% CI
Age group	Inspected	positive			Inspected	positives		
< 1 year	541	25	4.62	3.01-6.75	298	12	4.02	2.09-6.93
1-3 year	496	11	2.22	1.11-3.93	693	29	4.18	2.82-5.95
> 3 year	1567	69	4.4	3.41-5.54	1613	101	6.26	5.13-7.56

Dry: $\chi^2 = 5.26$, $p > 0.05$ Wet: $\chi^2 = 5.38$, $p > 0.05$

4.6 Prevalence of dermatophilosis according to sex

During the dry period a point prevalence of 5.04% (95% CI 3.78 - 6.58) and 3.39% (95% CI 2.56- 4.4) for the male and female were recorded, respectively. However, the difference was not statistically significant ($\chi^2 = 2.99$, $p > 0.05$).

In the wet period the point prevalence for the male and female was found as 6.08% (95% CI 4.76 – 7.63) and 4. 08% (95% CI 3.92 – 6.21), respectively, and like that of the dry period the difference was not statistically significant ($\chi^2 = 1.3$, $p > 0.05$). Analysis of CI of the prevalence also showed overlapping in both seasons (figure 9).

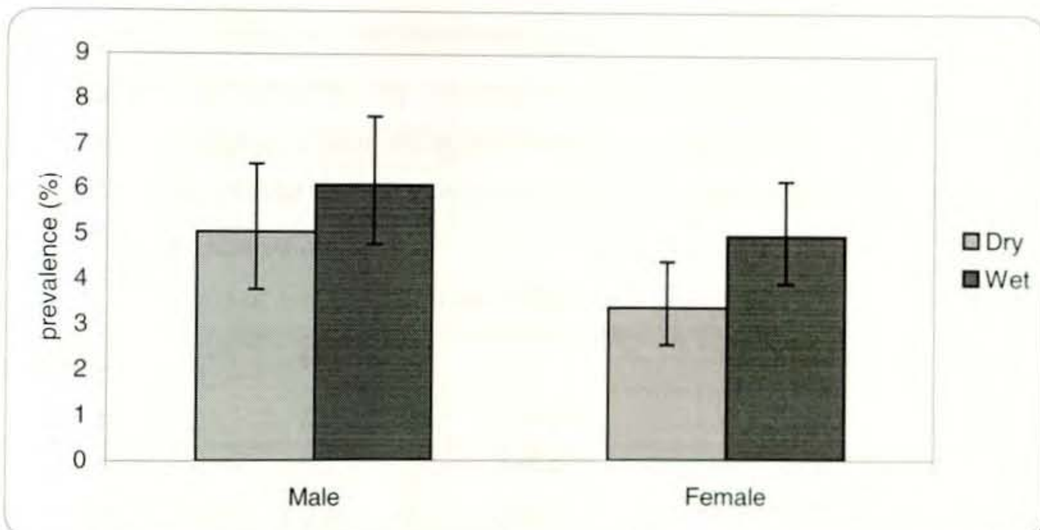


Figure 9. Prevalence of dermatophilosis according to sex during dry and wet seasons

4.7 Prevalence of dermatophilosis according to skin color

From all animals inspected during the dry season the prevalence of 3.99%, 3.42%, 5.5% and 2.28% were recorded for animals with a white, black, light brown and brown skin color, respectively. However, the difference was not statistically significant ($\chi^2 = 5.93$, $p > 0.05$) as shown on table 6.

Table 6. prevalence of dermatophilosis according to skin color in dry and wet periods

Skin color	Dry season				Wet season			
	Total animals		P		Total animals		P	
	Inspected	Positive	(%)	95% CI	Inspected	Positive	(%)	95% CI
White	726	29	3.99	2.69-5.68	537	36	6.70	4.73-9.16
Black	906	32	3.42	2.33-4.82	913	50	5.83	4.36-7.62
Light brown	709	38	5.5	3.94-7.44	868	49	5.65	4.20-7.39
Brown	263	6	2.28	0.84-4.89	144	7	4.86	1.98-9.76

In the wet period, the prevalence of 6.70%, 5.83%, 5.65% and 4.86% were obtained for the animals with skin color of white, black, light brown and brown, respectively (table 6). However, the observed prevalence was not statistically significant ($\chi^2 = 1.01$, $p > 0.05$) as that of the dry period. Further analysis was also carried out within each skin color as shown in table 7. However, statistically significant difference was not recorded ($p > 0.05$). Multivariate analysis of the skin color also proved that there was no a statistically significant difference ($\chi^2 = 3.39$, $p > 0.05$) between the skin colors.

Table 7. Comparison of skin colors for dermatophilosis prevalence

Skin color	Dry season			Wet season		
	χ^2	Df	p-value	χ^2	Df	p-value
White vs black	0.13	1	0.7202*	0.62	1	0.4328*
White vs light brown	1.5	1	0.2712*	0.42	1	0.5185*
White vs brown	1.2	1	0.274*	0.32	1	0.5699*
Black vs light brown	2.78	1	0.0955*	0.00	1	0.9652*
Black vs brown	0.66	1	0.4183*	0.01	1	0.9284*
Light brown vs brown	3.52	1	0.0605*	0.03	1	0.8693*

* = not significant

4.8 Prevalence of dermatophilosis in local and cross breed animals

During the dry period inspection, a total of 2604 local zebu and 192 cross breed dairy cattle (Friesian x zebu) were examined for clinical dermatophilsis. The prevalence of 4.03% (95% CI 3.3 – 4.86) in the local breed and 15.1% (95% CI 10.35 – 20.97) in the cross breed animals were obtained (figure 10).

Analysis of the dry period results with univariate analysis indicated that there is a statistically significant difference between the two breeds ($\chi^2 = 48.04$, $p < 0.05$). However, in the wet season where the prevalence was 5.45% (95% CI 4.61 – 6.41) and 8.60% (95% CI 4.99 –13.59) for the local breed and cross breed animals, respectively, a statistically significant difference was not observed ($\chi^2 = 3.22$, $p > 0.05$). The confidence interval of the prevalence exhibited also overlapping as showed in figure 10.

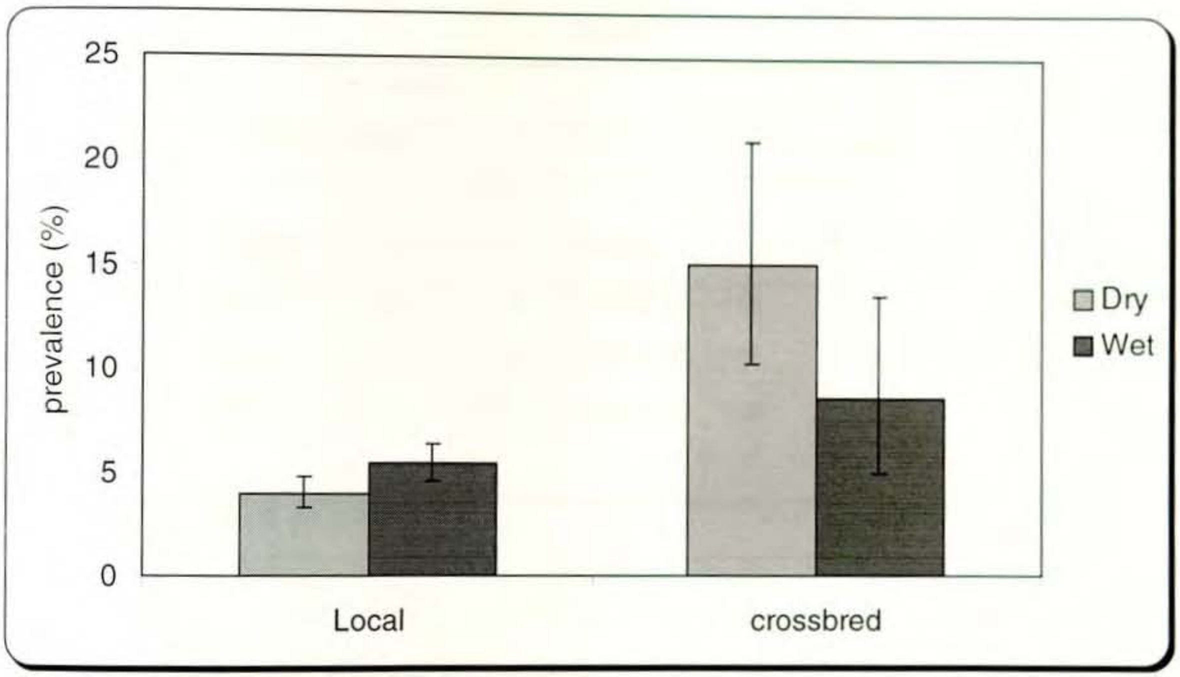


Figure 10. Prevalence of dermatophilosis in local and cross breed animals in dry and wet seasons

Analysis of the two seasons prevalence with logistics regression revealed that there is a statistical significant difference between the two breeds ($p < 0.05$) and OR 2.68 with 95% confidence interval of 1.8794 – 3.7043 (table 9). Odds ration results indicate that the risk of dermatophilosis infection is 2.68 times higher in the cross breed animals than the local zebu breed.

4.9 Vegetation cover and dermatophilosis prevalence

Three dominant vegetation covers were identified in the study area: woodland, mixed (woodland and grassland) and grassland. The vegetation covers were analyzed related to the dermatophilosis prevalence. Prevalence rates of 6.9% (95% CI 5.32 –8.81) and 5.18% (95% CI 3.81- 6.88) were recorded during the dry period for woodland and mixed type vegetation cover, respectively and none in the grassland. There is a statistically significant difference ($\chi^2 = 58.58$, $p < 0.05$) in the prevalence of the disease within the dominant vegetation covers. In the wet season the prevalence 9.1%(95% CI 7.27-11.21), 7.14% (95% CI 5.52-9.09) and 0.12% (95% CI 0.00-0.64) were obtained for the woodland, mixed and grassland vegetation cover, respectively. The difference was also statistically significant ($\chi^2 = 72.18$, $p < 0.05$) as presented in table 8.

Table 8. Prevalence of dermatophilosis according to vegetation cover in the southern part of Tigray

Vegetation cover	Dry season				Wet season			
	Total animals				Total animals			
	inspected	positive	P (%)	95% CI	inspected	positive	P (%)	95% CI
Woodland	868	60	6.9	5.32-8.81	868	79	9.1	7.27-11.21
Mixed	868	45	5.18	3.81-6.88	868	62	7.14	5.52-9.06
Grassland	868	0	0	0.00-0.42	868	1	0.12	0.00-0.64

Dry: $\chi^2 = 58.58$, $p< 0.05$ Wet: $\chi^2 = 75.18$, $p< 0.05$

4. 10 Dermatophilosis and other skin diseases

The skin lesions of dermatophilosis encountered during the study were observed whether they are combined with other skin diseases or not. The results indicated that in the dry period out of 105 cases 27 (25.71%) and during the wet period out of 142 cases 17 (11.97%) were found combined with demodex mange.

4.11 Biting flies identified

The biting flies found attached with the animal body of the study herd were collected and later identified. ICIPE identified the flies to be *Hypobosca* spp. These biting flies were observed throughout the two study seasons, in the three altitudes.

Table 9 The degree of association between risk factors of dermatophilosis as indicated by Odds ratio (OR) with 95% CI

Variables	In (OR)	Df	OR	95% for OR	P-value
Season (wet vs dry)	0.3250	1	1.3841	1.066 – 1.7980	0.0149
Tick presence vs Tick absence (*A. variegatum*)	1.9224	1	6.8375	3.0194 – 15.4826	0.0000
Altitude (high vs medium)	4.7728	1	112.4778	15.9066 – 795.3466	0.0000
Vegetation cover (grassland vs woodland)	4.7728	1	112.4778	15.9066 – 795.3466	0.0000
Breed (cross vs local)	0.9702	1	2.6386	1.8794 – 3.7043	0.0000

In (OR) = Natural logarism of odds ratio Df = Degree of Freedom

4.12 Financial impact study

According to the interviewed 104 households, in the year 1999, 107 cases of dermatophilosis occurred in their herds. Action taken against dermatophilosis by the respondent varied, ranging from selling, slaughtering and treating to taking no action. Out of the total 107 cases encountered, 12 (11.21%) animals were sold, 7 (6.54%) slaughtered, 12 (11.21%) died, 32 (29.91%) treated and to the remaining 44 (41.13%) animals no action was taken (table 10).

The effect of bovine dermatophilosis: morbidity and mortality

When a farmer is aware that his animal is infected with dermatophilosis, considering that the disease is dangerous, recovery after treatment or spontaneous recovery is less probable, he is expected to sell the animal at a reduced price. A 40% reduction of its normal market price was reported from the respondents, taking in account that the buyer was also aware of the nature of the disease. The average normal price of a healthy animal varies depending on sex, age and season of the year. However, the average annual livestock price of the study area obtained from TBANRD (1999) and the average price at which lightly affected animals were sold are presented in table 11.

Table 10. Action taken against bovine dermatophilosis by animal owners of the infected herd

	Action taken										Mortality
	Sell		Slaughter		Treatment		No action				
	L	M&S	L	M&S	L	M&S	L	M&S	L	M&S	M&S
Cow	5	-	4	-	4	-	21	2	-	-	3
Ox	4	-	-	-	9	-	-	-	18	3	2
Young Bull	1	-	-	1	5	-	-	-	-	-	1
Heifer	1	-	2	-	3	-	-	-	-	-	4
calves	1	-	-	-	1	-	-	-	-	-	2
Total	12	-	6	1	32	-	21	2	18	3	12

L= Lightly infected, M&S= Moderately to severely infected

Table 11. Average price for healthy and dermatophilosis affected animals

	Average price (Birr)		Loss / animal (Birr)
	Healthy animal	Affected animal (L)	
Cow	616	370	246
Ox	700	420	280
Young bull	432	259	173
Heifer	444	266	178
Calves	199	119	80

L = Lightly affected animal

Considering the stage of infection and the average reduction in market price of affected animals (tables 10 and 11), an overall loss of Birr 2781 was estimated for the 12 animals sold of dermatophilosis infections.

Although slaughtering of animals infected with dermatophilosis is not common because they are very emaciated and the skin lesion is discouraging for consumption, some farmers expected to slaughter the infected animals when other alternatives are blocked. According to farmers of the infected herds, infected animals loose 40% of the normal market carcass value when lightly infected and 70% when moderately or severely infected. In both cases complete rejection of the hides were reported. The average prices for carcasses and hides of healthy and affected animals are presented in table 12.

Table 12. Average price for carcasses and hides of healthy and affected animals

	Normal carcass (Birr)	Affected carcass (Birr)		Loss/ animal (Birr)		Hide value (Birr)		
		L	M&S	L	M&S	Normal	Affected	Loss/hide
Cow	664	398	199	266	465	12	0	12
Young bull	478	287	143	191	335	15	0	15
Heifer	495	297	149	198	346	9	0	9

L= Lightly infected, M&S =Moderately to severely infected

During this study 7 animals (4 cows, 1 young bull and 2 heifers) were slaughtered due to dermatophilosis, at different stages of infection. Taking into account the stage of infection and reduction in the normal market price of the carcass and hide due to dermatophilosis, an average loss of Birr 1876 was extrapolated (table 13).

Table 13 Loss of carcasses and hides value due to dermatophilosis

	No. of animals slaughter		Loss / carcass (Birr)		No. of affected hide	Loss / hide (Birr)	Total loss (Birr)
	L	M&S	L	M&S		L,M&S	
Cow	4	-	266	465	4	12	1112
Young bull	-	1	191	335	1	15	350
Heifer	2	-	198	346	2	9	414
						TOTAL	1876

L= Lightly infected, M&S= Moderately to Severely infected

According to the interviewed farmers, 32 (29.91%) of the affected animals were treated in the near by veterinary clinic. Two forms of treatment were in use in these clinics. Oxytetracycline (long and short acting) or combination of penicillin-streptomycin both followed by topical application of disinfectants. L/A oxytetracycline at dose of 20mg/kg one injection or short acting oxytetracycline at dose of 10mg/kg for 3 days or combination of penicillin (22 IU/kg) and streptomycin (22 mg/ kg) for 7 days were given.The cost of the drug for each treatment were Birr 26 for oxytetracycline and Birr 37 for penicillin-streptomycin. One Birr was also charged for each topical treatment. Out of the 32 animals, 19 were treated with oxytetracycline and 13 with penicillin-streptomycin, in both cases followed by external treatment. Therefore, the total cost incurred for treatment of the 32 cases was estimated as Birr 1007. A farmer spent an average of 4 hours (double trip) to travel to the veterinary clinic and waits an average of ½ hours during the treatment, hence he spends a total of 4½ hours for each treatment. For the 32 cases an average of 144 hours were spent. In order to calculate the opportunity cost, a farmer is paid an average of 10 Birr for 8 hours labour work in the project area. Therefore during treatment the farmer lost an average of Birr 180 as opportunity cost. Hence a total of Birr 1187 was lost during the treatment of 32 cases both for the costs of the drug and opportunity costs.

Out of the 107 cases 12 (11.21%) animals were reported to have died because of dermatophilosis. Taking into account the average normal market price of healthy animals a total loss of birr 5,854 was estimated due to dermatophilosis mortality (table 14).

Table 14. Mortality and financial loss due to dermatophilosis

Animal type	Number of death	Average price/animal (Birr)	Total loss (Birr)
Cow	3	616	1848
Ox	2	700	1400
Young bull	1	432	432
Heifer	4	444	1776
Calves	2	199	398
Total	12		5854

Draught Oxen:

Out of the 107 cases 21 animals (19.63%) were draught oxen of which 18 were lightly and 3 moderately to severely infected. For those cases no action was taken.

The major purpose of oxen in the project area is ploughing of cultivated land. If oxen are infected with dermatophilosis, a typical farmer continues to plough with the animal because he do not possess substitution oxen. However, the efficiency of the infected animal is reduced. According to the group discussion with the farmers a typical healthy ox works an average of 150 days per year, taking into account the social and religious holidays. However, if it is lightly infected with dermatophilosis the working days are reduced to 130 days and moderate to severely infected oxen only works 110 days per year. Therefore, an average loss of 20 days for lightly infected and 40 days for moderately to severely infected animals per year were reported. In order to compensate this loss of working days, a farmer has two options. He either hires another oxen or he sells his labour to rich farmers around. An ox is hired at an average of Birr 10-20 / day or the farmer spends two days working for rich farmers. Their labour demand varies, depending on the season of the year, being high during the ploughing and cultivation periods.

Based on the above assumptions the owner of a lightly infected oxen losses an average of Birr 300 /year whereas with a moderately to severely infected oxen he lost Birr 600/ year.

Extrapolating these figures to the total of 21 infected oxen (18 lightly and 3 moderately to severely infected) total loss of Birr 7200 was estimated.

The effect on cow productivity:

Out of 107 cases, 23 (21.5%) were lactating cows on which no action was taken. According to the interviewed farmers dermatophilosis had a remarkable impact on milk production. In the study area the lactation period of local cow varies from 4 - 6 months with an average of 5 months or 150 days. Milk production per day also depending on seasonal feed availability. However, farmers agreed that the average milk production /day for a typical cow of local breed averages 2.25 litres. According to the animal owners, the milk loss due to dermatophilosis was estimated as 30% and 75% of the average milk production for the lightly and moderately to severely infected animals, respectively. Based on the lactation period and production / day, a lightly infected animal looses an average of 101.25 litres of milk per year whereas moderately to severely infected cows looses an average of 253 litres of milk per year. The average normal price of milk per litre in the project area was Birr 2. A lactating cow, lightly infected with dermatophilosis looses an average of Birr 202.5 /year whereas a moderately to severely infected cow losses an average of Birr 506 / year. The total 23 cows (21 lightly, 2 moderately to severely infected) , thus the total loss of Birr 5265 was estimated.

The overall total estimated financial losses for the sample of 107 cases of bovine dermatophilosis for 1999 was Birr 24,115 (USD 3,014) or Birr 226 / case (USD 28 / case) as presented in table 15.

Table 15. Summary of estimated financial losses due to dermatophilosis

	No .of cases	%	Total financial loss(Birr)	Loss/case(Birr)
Sale	12	11.21	2781	232
Slaughter	7	6.54	1876	268
Mortality	12	11.21	5854	488
Milking cow	23	21.5	5265	229
Ploughing oxen	21	19.63	7200	343
Treatment	32	29.91	1187	37
TOTAL	107		24,163	226

5. DISCUSSION

According to the questionnaire results bovine dermatophilosis is an important disease in the low and medium altitudes of the study area, where as in the highland it is not. In the two altitudes it is known by the local name "kematte", "Tettefe", "katto" and "shuurre" which signified as dangerous skin disease equivalent to leprosy in human being.

The ranking of the disease first of the cattle skin disease and fourth or fifth of all animal diseases around also implies that the disease is an emerging disease with increasing economic importance in the local breed animals.

Concerning the seasonality of the disease, the majority of the farmers claimed the disease as a wet period disease (lowland 58.33%, medium altitude 72.24%) or a disease seen in the end of the dry season or beginning of the wet seasons (lowland 41.67%, medium altitude 22.22%). Many researchers also supported the farmer's perception concerning the seasonality of the disease. Stewart (1972) reported that rainfall and humidity are important epizootiological factors in the spread of infection, and dermatophilosis has been described as wet weather disease.

The majority of the farmers, 77.78% in the lowland and 88.89% of the medium altitude are on the opinion of that ticks are the major predisposing factor for dermatophilosis and they believed that (lowland 94.44%, medium 97.22%) reduction in the tick population will reduce the incidence of the disease too. The available evidence from many workers also coincides with the farmer's opinion. Plowright (1956) reported that exposure of cattle to heavy rainfall in the absence of tick infestation, did not result in cutaneous dermatophilosis, while Macadam (1964) suggested that high humidity had little if any effect on course of clinical diseases when affected animals were kept free of ectoparasites. Morrow *et al.*, (1989) reported also that, there was a steady increase in the prevalence of severe clinical dermatophilosis as the level of tick infestation challenge increases.

All interviewed farmers in the low and medium altitudes use a tick control method ranging from the application of acaricide to manual deticking practices which signified that they are aware of the devastating effect of tick and tick born diseases. They are particularly conscious on the long mouth ticks, which they claimed, in addition to dermatophilosis, causes mastitis and later fibrosis of the udder.

From the interviewed farmers who have access to modern treatment, the majority that is 41.67% in the lowland and 33.33% in the medium altitude claimed that modern treatment is not effective against bovine dermatophilosis. The farmer's suggestion may show some implication in that the need for an effective therapy should calls attention. Dermatophilosis is treated in the veterinary clinics with L/A oxytetracycline (20mg/kg) once or shortacting oxytetracycline (10mg/kg) for 3 days or with combination of penicillin (22 IU/kg) and streptomycin (22mg/kg) for 7 days. The veterinary personnel in the project area suggested that the main reason for the failure of the treatment against the disease is that the majority farmers do not follow the treatment schedule properly. The farmer's dissatisfaction on the treatment should be also seen in terms of the predisposing factors. When the predisposing factors are with in and/or around the animal, the recovery of diseased animal is less probable. Radostitis *et al.*, (1994) described that complete satisfactory treatment could not be achieved for cases which are exposed to predisposing factors or to those constantly reinfected. Dermatophilosis cases with extensive and severe skin lesions were observed in the dry (1.9 %) and in wet (14.79%) seasons. These cases should be culled, because complete recovery with treatment is very difficult (personal observation). Severe and chronic cases of dermatophilosis should be culled, in that complete recovery with treatment is not achieved, and rather they act as source of infection for healthy animals (Radostitis *et al.*, 1994; Roberts, 1967b).

Alternative to the ineffective modern treatment, herbal medicines for example, the use of leaves known by the local name "chewee", grease, cattle urine, increase salt lick etc are reported to be practices by 13.89% of the lowlanders and 22.22 % of the medium altitude farmers. The result claimed, as it is not encouraging although there are some cures.

According to the questionnaire survey if an animal is infected with dermatophilosis, the response of the farmer varies. Although selling, slaughtering and treatment are not uncommon, the majority of the farmers, that is 58.33% of the lowlanders and 52.78% of the medium altitude do nothing. The reason is that

- complete recovery through treatment is not easily achieved (particularly severe cases) and relapse is very common.
- their access to modern treatment is limited
- there is also some hope for spontaneous recovery.

Majority of the farmers 61.11% in the lowland and 50% of the medium altitude gave their opinion that feed shortage exaggerates the incidence of bovine dermatophilosis, which coincides with Samuai and Hugh-Jones (1988) finding who explained that poor nutritional status is often associated with bovine dermatophilosis infection.

The hypothesis of Samui and Hugh- Jones (1990a) which states that in Zambia entomological factors, such as biting flies may play a more important role in the causation of bovine dermatophilosis has been supported by 58.33% (low altitude) and 63.89% (medium altitude) farmers. They agree that the biting flies, *Hypobosca* spp., may play a role in the transmission of bovine drmatophilosis in the study area.

The seasonal study of clinical bovine dermatophilosis in the southern part of Tigray, indicates the prevalence of the disease as 4.03% in the dry and 5.54% in the wet seasons in local zebu breed. Although no study has been conducted on seasonal prevalence of dermatophilosis in the country, some specific studies previously conducted on the subject showed that the prevalence of the disease in local breed as 5.1% in central (Degue, 1998) 5% in northern (Tesfay, 1994) and 0.05% in north west (Desta, 1985) Ethiopia. In comparison with the study of Desta (1985), this study showed that the trend of the disease is on the increase and became an economically important disease in the country. Questionnaire survey results also supported the idea in that farmers also consider bovine dermatophilosis as an economically important animal disease. In other countries in Africa the disease was also reported as important, occurring with different prevalence rates. Samui and Hugh-Jones (1990a) found the prevalence of dermatophilosis in local breed as 5% in Zambia and Bida (1976) reported the prevalence of 4- 6% during the dry season in Nigeria.

This study also showed that there is a statistically significant difference in the prevalence of the disease in the two seasons. The disease prevalence was higher in the wet season than the dry season and furthermore the severity of the skin lesion. It was observed that there is a strong association between dermatophilosis lesion and the season. In the wet season, animals of the study area are highly exposed to rainfall because they spend the nights in unroofed open yards that is fenced with thorny and spiny dry plants. Intense and prolonged wetting has two effects on the skin: it emulsified and breaks up the sebaceous wax and it macerates the stratum cornieum (Roberts, 1963d). The zoospores, which are the infective stages of dermatophilosis, could then penetrate the epidermis (Roberts, 1965). In addition increase moisture on the skin surface would result in increase release of zoospore, with a resulting increased in infectivity (Roberts, 1963b).

Many researchers also found that the incidence of dermatophilosis increases during the rainy season. Stewart (1972) described dermatophilosis as wet weather disease. Oppong (1969) noted an incidence of 12.8% during rainy season and 4.8% during the dry season. Stewart (1972) found a more than fourfold increase of the incidence from the beginning to the end of the rainy season. He reported that there is a strong correlation between heavy rainfall and increase in the incidence of dermatophilosis.

Nyska (1995) reported an outbreak of dermatophilosis in the mediterranean climatic zone, Israel, which he closely related to the rains of the winter months. Zaria (1993) reported that humidity has significant influence on the maturation and motility of the infective zoospore. Hence the finding of this study that the prevalence of dermatophilosis was higher in the wet season than the dry season agrees with the findings of the above researchers.

The prevalence of bovine dermatophilosis in relation to the three altitudes indicates that there is a higher prevalence of the disease in the low and medium altitudes than in the highland. The higher prevalence of dermatophilosis in the lowland and medium altitudes and almost not existing in the highland may be related to geographical distribution of the tick *A. variegatum*. During the dry period animals inspected in the highland were free of *A. variegatum* tick. In the wet season only 4.32% of the inspected animals were found infested with the tick. The owners of these animals claimed that the animals were spending the dry period in the lowland where the availability of feed and water is relatively better. Each species of tick is adapted to certain ranges of temperature and moisture, some occurring only in warm region with a fair degree of humidity, while others are winter ticks most active in wet climate. In the highland the altitude goes up to 2460 masl, the annual mean minimum and maximum temperatures recorded are 10.5^0C and 22.3^0C, respectively, and the annual mean rainfall is 965.4 mm. In this geographical zone tick and tickborne diseases are not a common problem. Questionnaire survey results also indicated that, tick and tick borne diseases including dermatophilosis are not animal health problem of the highland. In the lowland 98% and in the medium altitude 98.27% of the inspected animals were found infested with *A.variegatum* ticks. Hence, the presence of dermatophilosis in the lowland and medium altitudes may be related to the presence of *A. variegatum* tick. The occurrence of dermatophilosis on animals in the tropics is often associated with the presence of *A. variegatum* ticks (Plowright, 1956). This association is based on their similar geographical distribution (Butler, 1975; Burridge *et al.*, 1984; Garrist and Scotland, 1988) and similar seasonal occurrence of adult *A. variegatum* tick and dermatophilosis (Plowright, 1956). Hobday (1952) and Plowright (1956) reported that tick control measures also reduced the incidence of dermatophilosis. Hoogstraal (1956) reported that in a single rainy season area of Africa *A. variegatum* tick has a typical seasonal distribution with adult appearing towards the end of the dry season. Numbers increase and remain high through the rainy season and decrease rapidly in the dry season

The prevalence of dermatophilosis was also higher in animals infested with *A. variegatum* than in the uninfested ones. Morrow *et al.*, (1989) reported that the prevalence of dermatophilosis was higher on animals having *A. variegatum* tick compared to that of animals not infested with *A. variegatum* tick. Koney *et al.*, (1996) reported that there is a close association between infestation with *A. variegatum* and occurrence of dermatophilosis on cattle in the Coastal plains of Ghana. The result of this study is in agreement with the finding of the above mentioned workers.

A statistically significant association was also observed between the severity of dermatophilosis lesion and the number of adult *A. variegatum*. As the number of adult *A. variegatum* tick count increases the severity of the skin lesion increases too. In contrary to the above mentioned finding of this study, Morrow *et al.*, (1989) did not find any association between the level of tick infestation and the severity of lesions on affected animals.

In this study, of the 247 dermatophilosis cases only 9.71% of the skin lesions were found in the predilection feeding site of *A. variegatum*. There are controversial views about the relationship between skin lesion of dermatophilosis and predilection feeding site of *A. variegatum*. The lesions of dermatophilosis are found particularly in area of the body most heavily infested with ticks (Macadam, 1962). These suggestions are supported by reports from some parts of the world that lesions occur predominately at the predilection feeding site of adult *A. variegatum* on the hairless parts of the ventral surface (Sinclair, 1920; Plowright, 1956). However, Morrow *et al.* (1989) reported that, although there was steady increase in the prevalence of severe lesion as the level of infestation with adult *A. variegatum* increase, the distribution of skin lesions could not be related to predilection feeding site of adult *A. variegatum*. The finding of this study agreed with Morrow *et al*,. (1989) finding in that, 90.29% of the dermatophilosis skin lesions were not distributed in the predilection feeding site of the adult *A. variegatum*.

The role of *A. variegatum* tick in the occurrence of severe dermatophilosis has yet to be explained. Possible mechanisms include transmission of *Dermatophilus congolensis* and creation of skin wounds and hypersensitivity reaction by the tick, which is infested with the organism (David and Philipott, 1980). Koney *et al.*, (1996) investigated also that the bases of association between infestation with tick and the occurrence of dermatophilosis would appear to involve tick-induced immunosuppression.

During the dry period the prevalence of dermatophilosis in the local breed and cross-breed animals were 4.03% and 15%, respectively, and the difference was statistically significant. Previously conducted studies in Ethiopia also showed that crossbred animals are more susceptible to dermatophilosis than the local breed. Mulugeta (1994) reported the prevalence of the disease as 4.6% and 15% in the local and cross breed animals, respectively, in the central Ethiopia. Abu-Samra (1980) and Morrow *et al.*, (1991) reported the higher susceptibility of pure breed exotic animal to dermatophilosis than the local breed animals. Amakrin (1977) explained that the resitance of N´dama cattle to dermatophilosis is due to the high percentage of leukocyte and neutrophiles in their healthy skin. Hence, the higher prevalence of dermatophilosis in the crossbred than in the local breed in this study matches with the finding of the above mentioned workers. However, in the wet season, the prevalence of the dermatophilosis in the crossbred was 7.4% and in the local breed 5.45%, although the prevalence seems higher in the crossbreed cattle it is not statistically significant. The reason for the reduction of the dermatophilosis prevalence in the crossbreed dairy cattle in the wet season is that the general management of the dairy farms was improved significantly, that includes culling of moderately to severely infected animals, improving tick control, housing, and general hygienic condition of the farms. Tick control and early proper treatment of infected cattle are the most important management factors influencing the prevalence of dermatophilosis in cattle (Samui and Hugh-Jones, 1988).

The difference in the prevalence of dermatophilosis in the three age groups (<1 year, 1-3 year and > 3 year) was not statistically significant in the two seasons. This finding coincides with Steweart (1972) who was in the opinion that there is no age susceptibility, the adult and young animals are equally susceptible to dermatophilosis. However, in contrast Oppong (1996) reported that adult cattle are more susceptible to dermatophilosis than the younger ones.

During the dry and wet periods study no statistically significant difference was observed in the prevalence of dermatophilosis in male and females. This finding is in agreement with Abu-Samra (1980) and Macadam (1976) who reported that male and female are equally susceptible to dermatophilosis infection. In contrary to the aforementioned findings Samui and Hugh-Jones (1990a) have reported that female cattle were found to be more susceptible to dermatophilosis than males, except in the younger animals where both sexes appeared to be equally susceptible.

Attempts have been done to know whether there is association between skin color of animals and prevalence of dermatophilosis, however statistically significant difference was not obtained.

The prevalence of dermatophilosis was analyzed in relation to dominant vegetation cover of the study area. In both seasons, dry and wet, the prevalence of the disease was higher in the woodland and in mixed (woodland and grassland) vegetation cover than the grassland. The difference was statistically significant. In agreement with this finding Samui and Hugh-Jones (1990a) reported that the prevalence of bovine dermatophilosis was significantly higher in herds on woodland savanna or thorny bush grazing than herds in grassland in Zambia. The importance of the type of vegetation in the epidemiology of bovine dermatophilosis has been shown to be twofold. Firstly, mechanical damage to the skin by bushes, may provide portal of entry for *Dermatophilus congolensis* into the skin and secondly the distribution of the vectors and their abundance depends on the vegetation type and density (Samui and Hugh-Jones, 1990a). Zlotnik, (1955) also thought that thorny bushes and tree branches were important in the transmission of the disease.

During the dry season 27 (25.71%) and in the wet season 17 (11.97%) animals with dermatophilosis lesions were found complicated with Demodex mange to form the so called "Senkobo" disease a more severe and fatal combination. Numerous workers have also noted the presence of mange mites in association with lesions of dermatophilosis. Mornet and Thery (1955) and Roberts (1962) have reported that the lesion of dermatophilosis associated with Demodex and Chorioptes species of mange. Hence the finding of the study coincides with the above researchers report.

In this study the biting fly *Hyboposca* spp. was identified. These flies were found attached with the inspected animals during the two study season in the three altitudes. Many workers such as Abu- Samra, (1977) and Jubb *et al.*, (1993) stated that flies and biting insects such as *Stomoxys calcitrans*, *Glossina morsitans*, *Musca domostica* and mosquitoes have been involved in the transmission of the disease. They break the skin barriers during feeding and releasing variable amount of serum and blood which provide moisture, nutrition and a suitable microclimate for the multiplication of *Dermatophilus congolensis*. Although, as it had been reported by the above mentioned researchers, biting flies could be involved in the transmission of dermatophilosis, the exact role of *Hypobosca* in the epidemiology of dermatophilosis in the study area is not exactly defined. Hence further investigation on the role of the biting flies in the epidemiology of dermatophilosis is of paramount importance.

A typical farmer, if his animal is infected with dermatophilosis he may sell or slaughter when the infection is at an early stage or else he may treat or do nothing. All these actions may bring about financial loss.

According to this study, sale of infected animal incurred a loss of up to 40% of the average market value and slaughtering of an emaciated animal implies a financial loss of

40-70% of its average carcass value, depending on the stage of infection, and the complete rejection of its hide.

Treating an infected animal needs extra cost for drugs as well as opportunity cost for farmer's labour. According to farmer's opinion, in the majority cases treatment thought does not lead to recovery. The financial loss due to mortality is also significant. Out of the total of 107 cases 12 died of dermatophilosis resulting in a case fatality rate of 11.2%. Estimated financial losses due to moralities were Birr 5,854. Hyslop (1979) also reported that among cattle in Africa, the case fatality rate for dermatophilosis during the rainy season is about 10%.

From this study the financial loss extrapolated from the sale, slaughter, treatment and mortality estimated at Birr 186 / case.

The financial impact of dermatophilosis on the working oxen is remarkable. In Africa, oxen represent a vital source of draught power. Prevalence rates of dermatophilosis of up to 10% have been reported among such cattle with potentially disastrous effects (Lloyd, 1976), especially as the disease often coincides with the onset of the rainy season, when draught animals are needed for ploughing and field preparation. The financial impact of the disease on working oxen in this study was conservatively estimated at Birr 7200 (USD 900) and the impact on milk production was estimated as Birr 5265 (USD 658).

In total the financial loss was Birr 226 / case of bovine dermatophilosis for the year 1999. To a poor country, like Ethiopia where the GDP per capita is only Birr 1600 (USD 200), such kind of loose from a single disease is economically significant.

As has been reported in the prevalence study, bovine drematophilosis was estimated to occur in the study area with a prevalence rate of 4.03 during the dry and 5.45% during the wet season of the year.

If the dry period prevalence and the total cattle population of the study area 725,129 are taken 29,223 cases of bovine dermatophilosis are expected for this season. Taking the above financial loss per animal (Birr 226 / case), the total loss due to dermatophilosis in the study area for one year is conservatively estimated as Birr 6, 604, 398 (USD 0.83 million).

This preliminary and conservative estimate of the financial and production impact of dermatophilosis only considered the losses associated with sale, slaughter, mortality, treatment and reduction in draught power of oxen and milk production of a cow. The economical impact of any disease thought consists of several components, some of which are more obvious than others. It is the more obvious aspects, which are often considered when financial losses are estimated, and the impact estimated is then often far from the true economical loss (Samui and Hugh-Jones, 1990b). Therefore this study should not be considered as economical estimate study, rather it is a financial impact study of bovine dermatophilosis.

The true financial loss due to dermatophilosis in the study area may be far higher than indicated, if other losses such as the opportunity cost spent for caring and feeding of sick animals, calf mortality because of lack of milk from infected cows etc. are considered. Samul and Hugh-Jones (1990b) also explain that there are additional costs when the genitalia are badly affected and cows cannot be served and further more emaciated cow are likely to suffer anoestrus.

This study thus showed that the financial and production impact of bovine dermatophilosis is significant. Researchers in some parts of Africa estimated before the financial and economic loss of dermatophilosis. Hyslop (1979) estimated the annual loss due to dermatophilosis in the northern state of Nigeria through hide damage, debility and death to be USD 30 million. Samui and Hugh-Jones (1990b) also reported the annual financial and production impact of bovine dermatophilosis in Zambia as USD 3 million per year.

Although this financial analysis on the impact of bovine dermatophilosis has to be supported by a detailed socioeconomy study, this preliminary and conservative study clearly indicates that bovine dermatophilosis is an economical important animal disease of the study area.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Prevalence study

- Bovine dermatophilosis is an important animal disease of the low and medium altitudes of the southern part of Tigray region.
- The prevalence of dermatophilosis is related to the distribution of *A. variegatum* tick.
- Prevalence and severity of the dermatophilosis increases during the wet season
- The cross breed cattle are more susceptible to dermatophilosis than the local zebu breed.
- *variegatum* tick, wet weather and breed are considered as the major risk factors for dermatophilosis

Financial study

- Financial and production impact of bovine dermatophilosis seems to be very significant beyond one anticipated.

6.2 Recommendations

- Tick control practices are the major solution to control bovine dermatophilosis in the study area. Tick control measures should be supported by seasonal tick population dynamics study.
- Treatment of early cases should be encouraged. However, study on the chemotherapy against dermatophilosis should be carried out related to practical field condition. It seems an urgent need.

- Chronic and severe cases of dermatophilosis should be culled, as they are the main source of infection for a given herd.
- The introduction of cross breed animals for high production should be supported by the overall improved management system of the herd.
- Strengthening of the extension package for the treatment, control and prevention of animal diseases by veterinary personnel and others is of paramount important.
- Further improvement the veterinary infrastructure and facilities with private sector and governmental efforts are necessary.
- Detailed economical analysis on bovine dermatophilosis supported by socio-economic study should be carried out. This will help to know in more detailed the magnitude of the damage occurring due the disease. The amount of input needed for the control of the disease will be determined related to the economic losses incurred by the disease.
- Further study on the epidemiology of dermatophilosis at regional and national level, in order to ascertain the exact prevalence, transmission and the major risk factors related to the diseases, is necessary. This will be of paramount importance to propose effective control and prevention measures against bovine dermatophilosis.

7. REFERENCES

Abu-Samra, M.T. (1977): Ph.D thesis, University of Liverpool, Great Britain.

Abu-Samra, M.T. Walton, G. S. (1977): Modified techniques for the isolation of *Dermatophilus congolensis* spp. from infected material. Sabouraudia. **5**, 23 - 27.

Abu-Samra, M.T. (978a): Morphology, cultural and biochemical characteristics of *Dermatophilosis congolensis. Zentralblatt für Veterinärmedizine*. **25B**, 668 -688.

Abu-Samra, M.T. (1978b): Dermatophilosis infection. The clinical disease and diagnosis. *Zentralblatt für Veterinärmedizine*. **25B**, 641 - 651.

Abu-Samra, M.T. (1979): A study of the ultrastructure and the life cycle of *Dermatophilus congolensis. Zentralblatt für Veterinärmedizine*. **26B**, 110 -124.

Abu-Samra,M:T (1980): The epizootiology of *Dermatophilus congolensis* infection *Rev. Elev. Med. Vet. Pays. Trop*. **33**, 33 - 32.

Abu-Samra, M.T. (1981): Resistance of *Dermatophilus congolensis* and the effect of vitamin supplementation on the growth of the organism. *British Vet. J.* **137**, 196 - 202.

Allworth, M.B., West D.M., Bruere, A.N. (1985): Ovine dermatophilosis in young sheep associated with the grazing of brassica spp. crops. *Newzeland Vet*. J. **33**,210 - 212.

Amakri, S.F. (1976): Proc. "Dermatophilosis infection in animals and man, symposium Univ. Ibadan, Nigeria 1973", London, Acasemic press. 163 - 171.

Annon (1977): Lumpy wool may increase by dipping. *Journal of Agriculture Wester Australian*. **18**, 111 - 112.

Barre, N., Woodman, S. (1990): Dermatophilosis. Advanced in Veterinary Dermatology.Vol. **1.** pp.407.

Bekker, J. G. (1927): Undescribed skin diseases of sheep in southern Africa. *Journal of the South Africa vet. Medicine association.* **1**, 51 - 57.

Bida, S.A., Kelly, D.C. (1976): Immunology study of antigenic components of *Dermatophilus congolensis* . In: Lloyd, D.H. and Sellers, K.C.(eds) Dermatophilus infection in animals & man .Proceedings of the symposium held at the University of Ibadan, Nigeria, 1973, London academic press.

Blancou, J. M. (1976): The treatment of infections by *Dermatophilus congolensis* with particular reference to the disease in cattle. In: Lioyd, D. H., Seller, K. C. eds. Dermatophilus infection in animals and man. London: Academic press. pp. 246 - 259.

Bull, L. B. (1929): Dermatomycosis of sheep (Lumpy or matted wool) due to Actinomycese Dermatonomus (n.sp). *Australian journal of expermental biology and medical science*. **6**, 301-314.

Burridge, M. J., Barre, E., Camus, E., Uilenberg, G. (1984): Epidemiology studies on heartwater in the Carribbean with observation on tick-associated bovine dermatophilosis. In: proceeding of XIII world congress on disease of cattle, Vol. **1**, pp. 542-546. South Africa veterinary association, Durban, South Africa.

Butler, M. C. (1975): Dermatophilosis of cattle and sheep in St. Lucina. *State veterinary journal.* **30**, 279-283.

Buxton, A. Fraster, G. (1977): Immunology, Bacteriology, Mycology, Diseases of Fish and Lab. Methods Animal Microbiology, Oxford: Blackwell Scientific Publications Vol.1. pp. 295 - 297.

Carter,G. R. (1979): Diagnostic procedure in veterinary bacteriology and mycology. 3rd edition. pp.210 - 213.

Clements, L.O., Weavers, E.D. (1980): *Dermatophilus congolensis* infection in lambs. *Irish veterinary journal*. **34**, 65-67.

Coleman, C.H. (1967): Cutaneous Dermatophilosis in West Africa. *The veterinary record*. **81**, 367-373

David, D., Philpott M. (1980): Expermental chronic Dermatophilosis. Proceeding of the Royal Society of Edinburgh, 79B, PP 47-53.

Degu, B. (1998): Survey of Bovine Dermatophilosis in Eastern Shewa. DVM thesis, FVM, Debre-Zeit, Ethiopia.

Dean, D. J., Gordon, M. A., Severinghaus, C.w., Kroll, E: T., Reilly, J.R. (1961): Streptothricosis: A new zoonotic disease. *New York state journal of medicine*. **1**, 1283 - 1287.

Desta, A. (1985): Dermatophilosis and its prevalence in cattle in and around Baher-dar, DVM thesis, FVM, Debre-zeit, Ethiopia.

Doutre, M., Orue, J. (1968): Current problems of bacterial disease in west Africa. In: Agriculrural research priorities for economic development in Africa. The Abjan conferrence **3.** pp.146.

Egerton, J.R. (1964): Mycotic dermatitis of cattle. *Australian Vet. J.* **40**, 144-147.

Ellis, T.M., Sutherland, S. S., Davies, G. (1991): Strain variation in *Dermatophilus congolensis* demonstrated by cross-protection studies. *Veterinary Microbiology*. **28**, 337-383

Ellis, T.M., Carson, J.M., Gregory, A.R. (1993): Variation in cultural, morphology and biochemical properties and infectivity of Australian isolates of *Dermatophilus congolensis*. *Veterinary Microbiology*. **38,** 81-102.

Faibra, D. T. (1993): Heterogeneneity among *Dermatophilus congolensis* isolates demonstrated by restriction fragement length polymorphisms. *Rev. Elev. Med. Vet. Pays. Trop*. **46**, 253 – 256.

Food and Agricultural organization (1973): Production year book, Rome.

Frankena, K.J.P. (1990): Episcope: Computer programme in Vet. Epidemiology. *Veterinary Record*. **126**, 573-576.

Garris, G.I., Scotland, K. (1988): Tick on livestock in St. Lucina. *Veterinary parasitology*. **18**, 367-373.

Gebreab, F. (1983): Notes on tick species and tick borne disease of domestic animals in Ethiopia, FVM, AAU.

Geremew, T. (1998): Prevalence of bovine Dermatophilosis in and around Robe, DVM thesis, FVM, Debre - zeit, Ethiopia.

Gitao, C.G., Agab, H., Khalifalla, A.J. (1998): Outbreak of *Dermatophilus congolensis* infection in camel (*Camelus dromederius*) from the Butana region in Eastern Sudan. *Revue.- Scientifigue - et- Technique Office–International-des-Epizootics*. **7**, 743–748.

Gordon, M.A. and Edwards, M.R. (1963): Micromorphology of *Dermatophilus congolensis*. *Journal of Bacteriology*. **86**, 1101-1115.

Gordon, M.A. (1964): The genus Dermatophilus, *Journal of Bacteriology*. **88**, 509 - 522.

Gupta, P.P., Sinha, B.P. (1975): Oral Dermatophilosis Associated with Actinomycosis in Cattle. *Zentralblatt für Veterinarmedizine*. **25 B**, 211-215.

Gyang, E.O., Ilemobade, A.A. Shannon, D. (1988): Treatment of Ovine Dermatophilosis with long acting oxytetracycline. *The Veterinary Record*. **106**, 106.

Harris, S. T. (1948): Proliferative dermatitis of the legs (" Strewberry foot rot") in sheep. *Jou. Comp. Pathol*. **58**, 314 - 328.

Hart, C.B. (1967): Mycotic Dermatitis in sheep. Clinical Observation in Great Britain.*The Veterinary Record*. **79**, 36-37.

Hobday, I. A. (1952): Streptothricosis (Senkobo skin disease) In: annual report, department of veterinary service for the year 1952. N. Rhodesa, pp. 12.

Hoogstral, H. (1956): *A. variegatum*. In: Africa Ixodoidea. 1. Tick of the Sudan, pp. 259–276. United States Department of Navy. Bureau of Medicine and Surgery, Cairo.

Horner, R. F. (1986): *Dermatophilus congolensis* infection in cattle. *Journal of the South Africa Vet. Assocation.* **57**, 121-123.

How, S.J., LIoyd, D.H. (1990): Immunity to experimental dermatophilosis in rabbit and cattle following immunization with live whole cell vaccine. *Revue d'Elevage et de Médecine veterinaie des pays Tropicauxs.* **41**, 139-146.

Hyslop, N.S.J. (1979): Dermatophilosis (streptothricosis) in animals and man. *Comparative immunology, Microbiology and infections diseases.* **2,** 389-404.

Ilemobade, A.A., Gyanng E.O., Bida, S.A., Addo, P.B. (1979): Cure of *Dermatophilus congolensis* infection in cattle by long- acting oxytetracycline, *Research in veterinary science.* **27,** 302–305..

Isitor, G.N. Kazeem, H. M. Njkm, C.O. Abegboye, D. S., Dellmann, H.D. (1988): Frequency of involvement of Pox virus in lesions of bovine dermatophilosis. *Tropical Animal Health and Production.* **20**, 2-10.

Jubb, K.V.F., Kennedy, P.C., Palmer, N. (1993): Pathology of domostic animals, 4th Edition, Academic press, inc. pp. 649-651.

Kaminjola, J.S., Karua, S.L. (1981): Dermatophilosis in cattle in Malawi. *Kenya Veterinarian.* **5**, 1.

Kane, G. J., Downing, W., Wiesdos, A.j. (1989): Mycotic dermatitis in Great Britain. *Veterinary record.* **67**, 779.

Kiros, S. (1985): Epidemiology of Bovine Dermatophilosis around Debr-zeit, DVM thesis. FVM, Debre-Zeit, Ethiopia.

Koney, E.B.M. (1996): Dermatophilosis in Ghana: Effect on the livestock Industry. *Tropical Animal Health prod.* **28,** 35-85.

Koney, E.B., Morrow, A.N., Heron, I. D. (1996): The association between *Ambylomma variegatum* and dermatophilosis: Epidemiology and immunology. *Tropical Animal Health prod..* 18s-25s.

Kwapinski, J.B. (1966): Serological and chromatographic characterization of exo- antigens of dermatophilus. *Aust. J. Exp. Med. Sci.* **44**, 87 – 92.

Le Riche, P.D. (1968): The Transmission of Dermatophilosis (Mycotic dermatitis) in sheep. *Australia Veterinary Journal*. **44,** 64-67.

Lloyd, D.H. (1976): The economic effects of bovine streptothricosis. In: D.H. Lloyd and K.C.Sellers, (Eds.) *Dermatophilus congolesis* infection in animals and man (Academic Press, London), pp 274-291.

Lloyd, D.H., Jenkinson, D.M. (1980): The effect of climate on experimental infection of bovine skin with *Dermatophilus congolensis. British Veterinary journal*. **136,** 122- 130.

Lloyd, D.H. (1984): Immunology of dermatophilus, Recent development and prospects for control. *Preventive Veterinary Medicine*. **2,** 93-102.

Macadam, I. (1962): Bovine streptothricosis: Production lesion by the bites of the ticks, *Ambylomma Variegatum. The Veterinary Record*. **74,** 643-646.

Macadam, I. (1976): In: proc. " Dermatophilosis infection in animals and man. Symposium Univ. Ibadan, Nigeria 1973." London, Academic press, pp 33-42.

Macadam, I. (1977): Control of *Dermatophilus congolensis* infection. *The Veterinary Record*. **100**, 411.

Makinde, A.A., Ojo, M. O. (1997): Serodiagnosis of dermatophilosis. III: A comparsion of extracellular and cytoplasmic antigens of *Dermatophilus congolensis* in enzyme-linked immunosorbent assay (ELISA). *Nigerian Veterinary Journal*. **18**, 48 – 55.

Mammerickx, M. (1961): Observations sur la dermatose contagius des ruminants au Congo. *Annale des societes belges de me'decine Tropicae*. **41**, 131-144.

Memery, G.,Thiery, G. (1960): *Revue Elev. Med. Vet. Pays trop*. **26**, 123-142.

Ministry of Agriculture (1996): Ruminant Livestock Development Strategy (RLDS). AddisAbeba, Ethiopia Vol.1, pp 4.

Momotani, E., Iiui, S., Ishikawa, Y., Azume, R. (1984): Granolomatous subdermal lesion in sheep inoculated with *D.congolensis*. *Journal of Comparative Pathology*. **94.** 33-43.

Mornet, P., Thiery, G. (1955): Dermatophilosis in bovine animals. In: Stewart, G. H. (1972): Dermatophilosis: A skin disease of animals and Man. *Vet. Record*. **91,** 537 – 544.

Morrow, A. N., Heron, I. D., Walker, A.R., Robinson, J. L. (1989): *A. variegatum* ticks and the occurrence of bovine streptothricosis in Antigua. Center for Tropical Vet. Medicine, University of Edinburgh. *J. Vet. Med.***36**, 247-248.

Morrow, A., Poermadjaja, B., Ambrose, N., Walker, A. (1993): Cellular response in experimental chronic and acute dermatophilosis infection of sheep. *Revue-d'Elevage- et de-Medecine-Veterinaire-des-Pays-Tropicaux.* **46**, 277 – 287.

Mulugeta, B. (1994): A study of prevalence of dermatophilosis in Assela and its response to a single dose treatement: DVM thesis , FVM, Debre-zeit, Ethiopia.

Nawahe, D.R. (1992): Resurgence of Contagious Bovine Pleuropneumonia in Nigeria. Rev. Sci. tech. Offi. Inter. Epiz. **11**, pp. 799-804.

Nisbet, D.I., Bannatyne, C. C. (1955): A dermatitis of sheep associated with an organism of the genus *Actinomyces.The Veterinary Record.* **67**, pp. 713-715.

Nyska, A. Yeruham, I. (1995): Skin disase in a merino sheep herd related to an excessive rainy winter in a Mediterranean climatic zone. *J. Vet. Med.* **43**, 35 - 40.

Oduye, O.O. (1975): Bovine cutaneous streptothricosis in Nigeria. *World Animal Review.***16**, 13-17.

Oduye, O.O. (1976): Incidence, economic effect and control of bovine streptothricosis in northern Nigeria. *Bulletin de I' office international Des epizooties.* **83**,1123-1129.

Ognu, D., Osori, D.J.K., Kumidia, J. (1981): Bovine dermatophilosis and reproduction in Northern Nigeria: A case study. *Theriogenol.*. **15**, 469-475.

Ogwn, D., Alhaji, I., Osori, D. I.K. (1981): The effectiveness of long acting teramycine injectable solution in the treatment of streptothricosis in cattle. *Br. Vet. J.* **137**, 585-589.

Oppong, E.N.W. (1976): In: Proc. " Dermatophilosis in animals and man. Symposium University Ibadan, Nigeria" London, Academic press, pp.17-32.

Oppong, E.N.W. (1996): Research on Dermatophilosis in Africa. *Tropical animal Hlth Prod.* **28**, 9S.

Pier, Richard, Farrel (1964): Fluorescent antibody and cultural techniques in cutaneous streptothricosis. *Am. Jour. Vet. Res.* **25**, 1014.

Plowright, W., (1956): Cutaneous streptothricosis of cattle: 1 Introduction and Epizootiological feature in Nigeria. *The Veterinary Record.* **68**, 350-355.

Radostitis, O.M., Blood, D.C., Gray, C.C. (1994): A text book of the disease of cattle, sheep, pigs, goat and horses. Bailliere, Tindall, London, Philadephia, Sydney, Tokyo, Toronto, 8 th Edn. pp. 735-738.

Relief society of Tigray (1997): Raya Valley Development Project Feasibility study report on livestock develpoment, Mekelle, Tigray, Ethiopia, Vol. 5, pp. 1 - 2.

Relief society of Tigray (1998): Feasibility study report for Raya Valley Agricultural development Project, Tigray, Ethiopia Vol. 1, pp 1-127.

Richards, J. L., Pier, A.C: (1966): Transmission of *Dermatophilus congolensis* by *Stomoxys Calcitrans and Musca domostica. American journal of veterinary research.* **27**, 419-423.

Roberts, D. S. (1957): An ecological study of the mycotic dermatitis organism *Australian Vet. Journal*, **33** 233-236.

Roberts, D.S: (1961): The life cycle of dermatophilosis dermatonomus, the causative agent of ovine mycotic dermatitis. *Australian journal of experimental biology*. **39**, 463-476.

Roberts, D.S. (1962): Approch to the control of mycotic dermatitis. *Wool technology and sheep breeding.* **9,** 101-103.

Roberts, D.S. (1963a): Properties of *Dermatophilus congolensis* zoospore in relation to the transmission of mycotic dermatitis. *Australian Journal of Agr. Research.* **14**, 373-385.

Roberts, D.S. (1963b): The release and survival of *Dermatophilus dermatonous* zoospores. *Australian Journal of Agr.Research..* **14**, 386-399.

Roberts, D.S. (1963c): Barrier to *Dermatopilus congolensis* infection on the skin of the sheep. *Australian Journal of Agr.Research. Res.***14**, 492-508.

Roberts, D.S. (1963d): The influence of carbondioxide on the growth and sporulation of *Dermatopilus dermatonomus*. *Australian Journal of Agr.Research*. **14**, 412-423.

Roberts, D.S. (1965): The histopathology of epidermal infection with the actinomycetes, *Dermatophilus congolensis*. *Journal of Pathology and Bacteriology*. **90,** 213-216.

Roberts, D. S. (1966): The influence of delayed hypersensitivity on the course of infection with *Dermatophilus congolensis*. *The British Journal of Expermental Pathology*. **47**, 9-16.

Roberts, D.S. (1967a): Chemotherapy of epidermal infection with *Dermatophilus congolensis*. *Journal of Comparative pathology*. **77**, 129-136.

RobertS, D.S. (1967b): Dermatophilus infection. *Veterinary bulletin*, Weybridge. **37,** 513-521.

Roberts, D. S.,Graham, N. P.H. (1966): Control of Ovine Cutaneous Actinomycosis. *Aust. Agri . Res*. **42**, 74-78.

Rosser, J. (1995): Infection crusting dermatoses.Veterinary Clinics of Northern America Vol.1, 1, pp. 56.

Samui, K.L., Hugh-Jones, M.E. (1988): The Prevalence of Bovine Dermatophilosis in Zambia. *Acta Veterinaria Scadinavia*. **584**, 98-100.

Samui, K.L., Hugh-Jones M.E. (1990a): The epidemiology, of bovine dermatophilosis in Zambia. *Veterinary Record communication*. **14**, 267-278.

Samui, K.L., Hugh-Jones M.E. (1990b): Financial and production impact of bovine dermatophilosis in Zambia.*Veterinary Record communication*. **14**, 357-365.

Scanlan, C.M. Garrett, P.D., Geiger, D.B. (1984): Compendium on continuing education for the practicing veterinarian, (Iowa state university press) 6, pp.4 - 10.

Schultz, K.C.A. (1955): Mycotic dermatitis (senkobo skin disease) of cattle in the union of South Africa. *Bulletin of Epizootic Disease of Africa*. **3,** 244-261.

Sekoni, V.O. (1983): Terminal sterility in a Friesian bull naturally affected with scrotal Cutaneous Streptothricosis (Kirchi). *Theriogenology*. **20**, 27-36.

Soltys, M.A. (1964): Cutaneous streptothricosis in cattle in Sudan. *Sudaness journal of veterinary science and animal husbandary.* **5**, 20-27.

Simpson, H.A. (1976): Handing over notes, March12,1976.File no. Cvs/Rvo/R1/7. Veterinary Service Departement, Accra, Ghana, pp. 13.

Sinclair, J.M. (1920): Report of the chief veterinary surgeon for the year 1920, Salisbury, Rhodesia, pp 266-269.

Singh, V.P., Murty, D.K. (1976): An outbreak of *Dermatophilus congolensis* infection in goat. *Indian Vet. Journal*. **55**, 674-676.

Stewart, G.H. (1961): "Senkobo skin disease. Notes on the epidemiology of the disease" Report to director of Vet. Service Former federation of Rhodesia and Nyasaland.

Stewart, G.H. (1972): Dermatophilosis; A skin disease of animals and man. *Vet. Record.* **91**, 179-222.

Sutherland, S.S., Ellis, T.M., Edwards, J.R. (1991): Evaluation of vaccines against ovine dermatophilus. *Vet. Microbiol*. **27**, 91-99.

Tegene, A. (1988): Study of the Epidemiology of Bovine Dermatophilosis in Chilalo province (Ethiopia) and therapeutic effects of formaldehyde. DVM thesis, FVM, Debre-Zeit, Ethiopia.

Teshale, B. (1988): Bovine streptothricosis in SEAD -zone, Ethiopia SUAS / IRDC working paper (Sweden). No 70, pp 56-72.

Teshome, Y., Ephraim, G. (1989): Dermatophilosis outbreak in local and cross breed cattle at Melkawerer. *Ethiop. Journal of Agri. Science*. **11**, 89-92.

Tesfay, A. (1994): Study of dermatophilosis in and around Mekelle. DVM thesis, FVM, Debre-Zeit, Ethiopia.

Thompson, R.E. (1954): A species of Rhizobium isolated from strawberry foot rot in sheep. *Journal of Pathology and Bacteriology*. **68**, 445-452.

Tigray Bureau of Agriculture and Natural Resources Development (1997): Tigray Livestock Development action Programme Main Report Vol.1.Mekelle, Tigray. pp.4-15.

Tigray Bureau of Agriculture and Natural Resources Development (1998): Livestock census analysis result, Mekelle, Tigray, Ethiopia.

Tigray Bureau of Agriculture and Natural Resources Development (1999): Livestock and livestock products annual marketing study report, Mekelle, Tigray, Ethiopia.

Tonder E.M., Horner R.F. (1986): Dermatophilosis, section five: chapter 176,pp 1472-1481.

Trott, D.J., Masters, A.M., Carson, J.M., Ellis, T.M., Hampson, D.J. (1995): Genetic analysis of dermatophilus spp. Using multilocus enzyme elecrophoresis. *Int. J. Microbiol. Virol. Parasitol. Infect. Dis.* **28**, 24-34.

Van Tonder, E.M. (1980): Lumpy wool and fleece discoloration: Symposium on smallstock ectoparasite and dip tank management, liaison committee of the Agri. And Vet. Chemical Assocation of South Africa, pp 1-13.

Van Saceghem, R. (1915): Dermatose contagieuse (impetigo contagieux). *Bulletin de la societe de pathologie exotigue*. **8**, 354-359.

Zaria, L.T. (1993): *Dermatophilus congolensis* infection (dermatophilosis) in animal and man. An up dated Comp. Immun. Infection dis. pp 176-222.

Zlotnic, J. (1955): Cutaneous Streptothricosis in cattle. *The Vet. Record*. **67**, 631- 614.

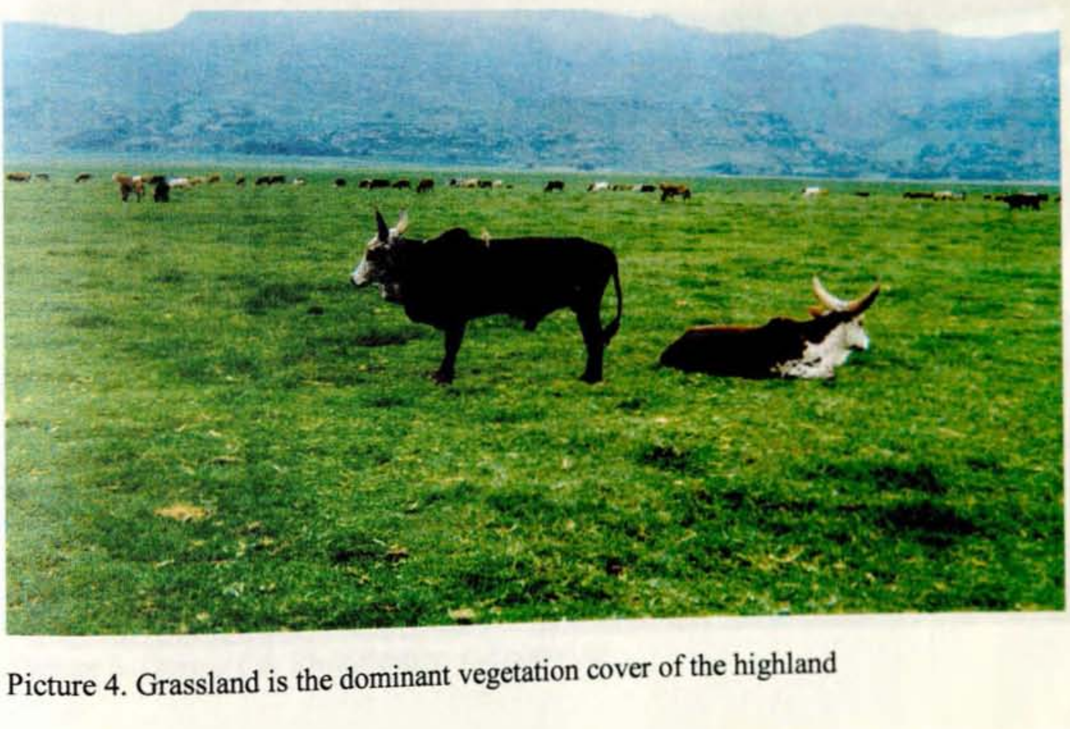
8. ANNEXES

Picture 3. Case of dermatophilosis in the Raya – Azebo wereda

Pictre 4. Typical skin lesions of dermatophilosis

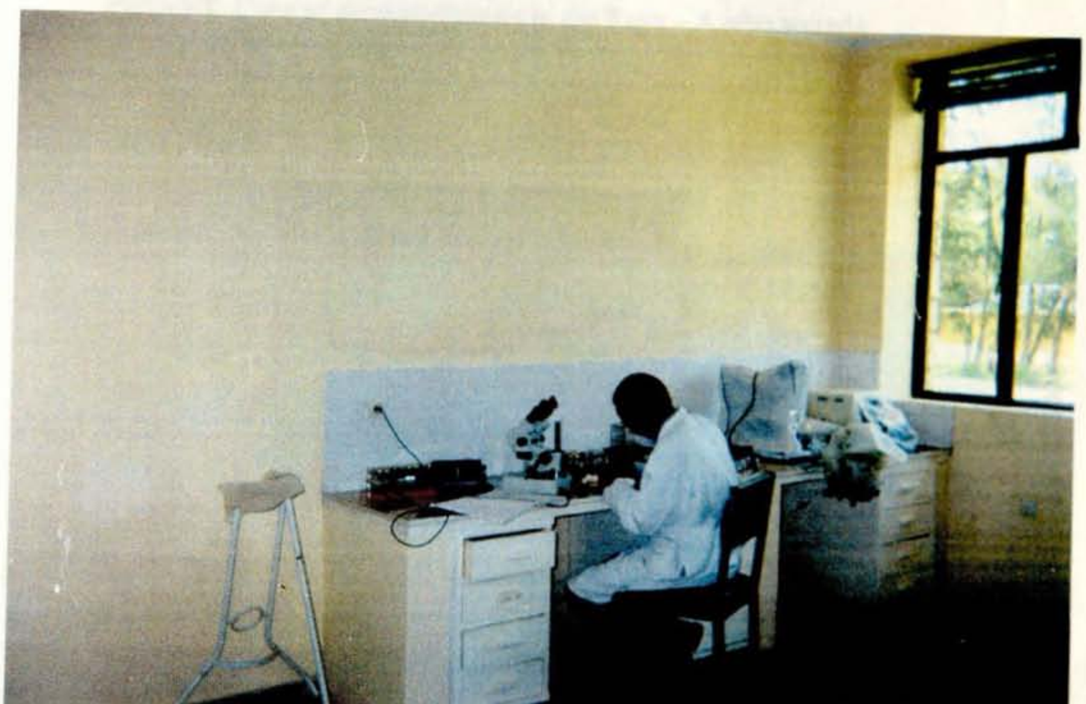
8 ANNEXES

Picture 3. The dominant vegetation cover of the low altitude, woodland with scattered bushes



Picture 4. Grassland is the dominant vegetation cover of the highland

Picture 5. During the laboratory work



Picture 6. During tick identification and counting

Picture 7. Case of dermatophilosis in the Raya – Azebo wereda

Pictre 8. Typical skin lesions of dermatophilosis

QUESTIONNAIRE No. 1

Farmers attitude towards bovine dermatophilosis

Date___________

Werda________Agroecological zone ______Respondent name____________Sex________

1. Livestock owned: cattle ❑ Sheep ❑ Goat ❑ Camel ❑ Donkey ❑

   Others_______________________________

2. Breed of the cattle____

3. Objective of cattle keeping: Dairy ❑ Draught ❑ Both ❑ Feedlot ❑

4. Production system:

   4.1 Settled ❑ Nomadic ❑ Seminomadic ❑ Trade ❑

   4.2 Livestock only ❑ Mixed farming system (crop-livestock) ❑

5. Are you familiar with the disease dermatophilosis? Yes ❑ No ❑

6. What is the local name? ______________________________

7. Do you believe that the disease is important? Yes ❑ No ❑

8. What is its rank in comparison with other diseases and skin diseases around?

In relation with other diseases______ In relation to other skin diseases___________

9. Seasonality of the disease: When does the disease most commonly revealed?

Dry ❑ Month______________ Wet ❑ Month_______________

10. Do you believe that dermatophilosis is a contagious disease?

   Yes ❑ No ❑ I do not know ❑

11. Which of the following, you believe is/ are predisposing factor/ s for dermatophilosis?

Ticks ❑ Poor nutrition ❑ Wet weather ❑ Biting flies ❑

Breed ❑ Thorny bushes ❑ Poor management ❑

12. Do you have tick control programme? Yes ❑ No ❑

   12.1 Type: Manual ❑ Chemical ❑ Both ❑

   12.2 Interval_____________________________

13. Does the tick control programme have an effect on dermatophilosis?

Yes ❑ No ❑

14. What is your recommendation, if your animal is infected with the disease?

   Cull/ sell ❑ Slaughter ❑ Modern treat. ❑ Herbal ❑ No respond ❑

15. What is in majority cases, the fate of an animal if once infected with dermatophilosis ?

Spontaneous recovery ❑ Cure and relapse ❑ Progress from moderate to severe and death ❑

16. Effect of modern treatment on dermatophilosis?

Effective ❑ Moderate ❑ Not effective ❑ I do not know ❑

17. Cost of the treatment

Expensive ❑ Moderate ❑ Cheap ❑ I do not know ❑

18. Do you know herbal medicine against dermatophilosis Yes ❑ No ❑

If yes the type ______________________________

18.1 Its effect Effective ❑ Moderate ❑ Not effective ❑

19. Feeding practice Communal feeding ❑ Enclosing grazing ❑ Indoor feeding ❑

20. Current feed condition: Excess ❑ Adequate ❑ Below average ❑ Critical shortage ❑

21. In which month of the year do you have shortage of feed? ______________

22. Do you expect that there is association between dermatophilosis and feed shortage?

Yes ❑ No ❑

23. Do you expect that there is association between dermatophilosis and other concurrent infections? Yes ❑ No ❑

24. If yes with which disease? Demodex ❑ Internal parasitism ❑ Trypanosomiasis ❑ Others ______________________________

25. Housing condition:

25.1 Roofed ❑ Not roofed ❑

25.2 Fenced Yes ❑ No ❑

25.3 Adult and calves spend together Yes ❑ No ❑

25.4 Contact to each other Yes ❑ No ❑

25.5 Floor condition Soil ❑ Concrete ❑

26. Is there any thing that brings traumatic wound to the animals? Yes ❑ No ❑

26.1 If yes the type Ox pecker birds ❑ Concrete floor ❑ Thorny and sharp objects ❑

27. Is there any biting flies in the area? Yes ❑ No ❑

27.1 If yes the local name ______________________________

27.2 Months seen in abundance __________ 27.3 Reason ______________

28. Do you believe that there is relationship between high number of the biting flies and incidence of dermatophilosis? Yes ❑ No ❑ I do not know ❑

29. Previous history of dermatophilosis outbreak in the village/ tabia/ farm?

Yes ❑ No ❑ I do not know ❑ Year/ month ______________

30. Dominant nature / type of the available vegetation cover?

Woodland ❑ Grassland ❑ Mixed ❑

Form No. 1

Inspection of individual animal for clinical dermatophilosis

Wereda__________________ Tabia/ Village_______________

AN ID	Season	Agro .eco.	House hold	Skin color	Breed	Purp ose	AGE						Result		Severity			Ticks		
							<1 year		1-3 year		>3 year									
							M	F	M	F	M	F	+	-	L (+)	M (++)	S (+++)	A.vare. spp	Rhi. spp	Bo. spp

REMARK: L-Light, M-Moderate, S-Severe, DO-Draft oxen, MC-Milking cow, RS-Replacement stock, A.vare.spp.-Ambylomma variegatum species, Rhi.spp-Rhipicephalus species, Bo. Spp.-Boophilus species, D-dry, W-Wet, HA-High altitude, MA-Medium altitude, LA-Low altitude

For dermatophilosis positive animals

Form 2

Code No.	When started	Stage of infection		Site of infection					Relationship b/n tick vs Siteof infection		Other infections		Specimens collected			
		Acute	Chronic	D	L	V	G	O	Yes	No	No	Yes Ten. Diagnosis.	S	T	SB	Other

REMARK: When started: <1month (1), 2-11months=(2), >1year=(3), Specimen collected: S= Scabs, T=Ticks, SB= Skin biopsy, O= Others

Site of infection: D= Neck (1), Wither (2), Hump(3), Back (4), Rump(5),Tail head(6) L= Head(7), Shoulder(8), Flank(9), Thight(10)

V= Dewlap(11), Brisket(12), Lower forelegs(13), Belly (14), Udder(15), Ventral genitalia(17) G= Generalized(18) O= Mouth, others etc(19)

Financial impact study/ price list for normal and affected animals (All prices are in Birr) Form 3

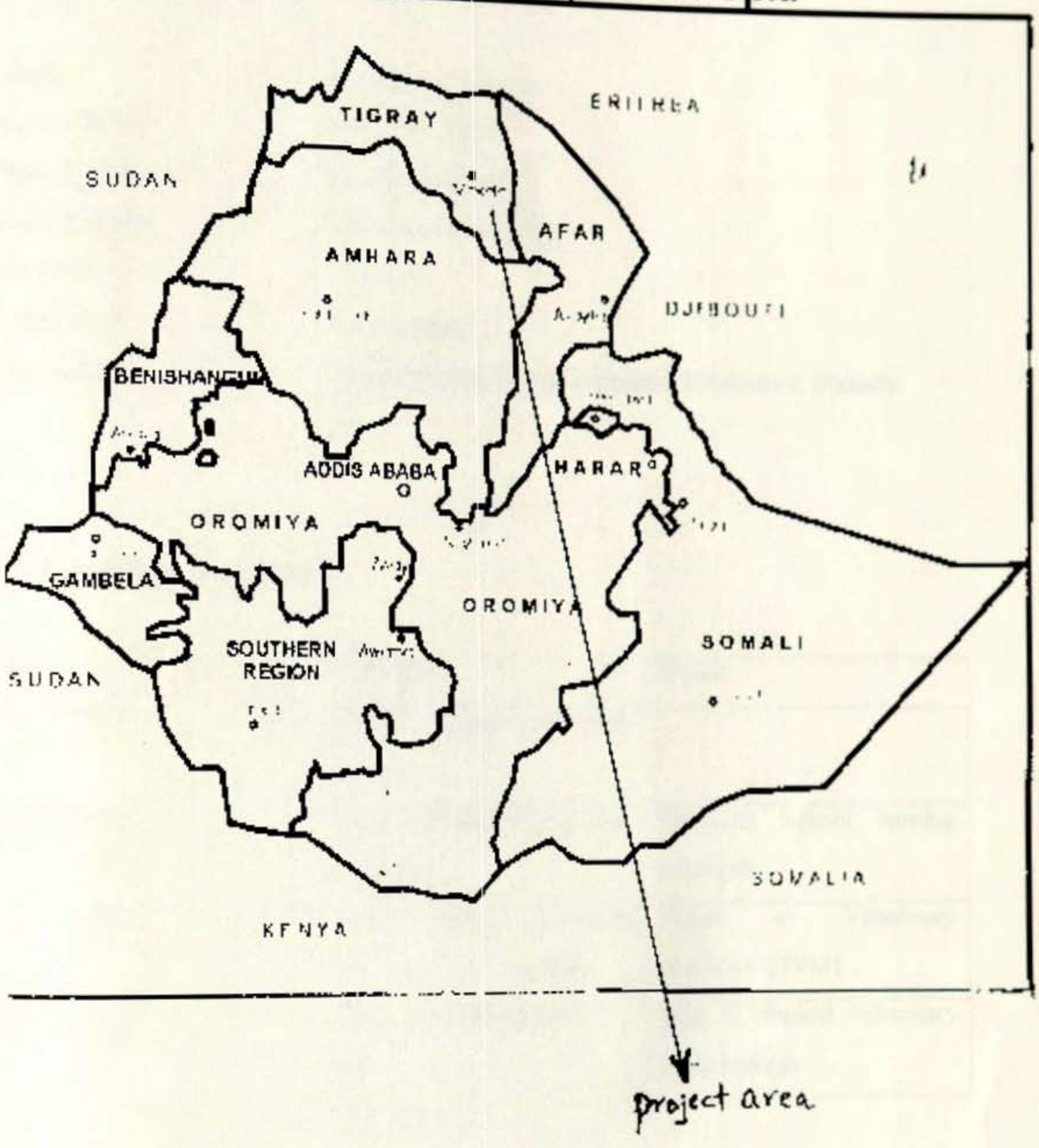
Serial No.	Animal type	Sell		Slaughter				Milk L/ day		Working hours Days/year	
				Carcasses		Hides					
		Nor.	Aff.	Nor.	Aff.	Nor.	Aff.	Nor.	Aff.	Nor.	Aff.

REMARK: Nor. = Normal, Aff.= Affected

Financial impact study / Mortality, sell and slaughter Form 4

Households	No. of sell	No. of slaughter	No. of death	AGE AND SEX						
				< 1 year		1 – 3 years		> 3 year		Remark
				M	F	M	F	M	F	

Administrative Map of Ethiopia



9. CURRICULUM VITAE

Personal data

Name:	Enquebaher Kassaye
Date of Birth:	March 20, 1964
Place of Birth	Tigray, Ethiopia
Marital Status:	Married with 3 children
Nationality:	Ethiopian
Profession:	Veterinarian
Occupation:	senior research officer in regional Laboratory, Makelle.

1. Educational Background

Year	Institution	Award
1970 - 1974	Gereb Tsedo elementry school	-
1975 - 1980	Atse Yohannes Comp. Sec. School	Ethiopian School leaving certificate
1981 - 1986	Addis Abeba University Faculty of vet. Medicine	Doctor of Veterinary Medicine (DVM)
1998 - 2000	Free university, Berlin	Msc in tropical veterinary epidemiology

2. Work Experience

Year	Institution	Responsibility
1987 - 1989	Ministry of Agriculture, Eastern Ethiopia	As field veterinarian, treatment and control of animal diseases
1990 - 1992	Dire Dawa regional Veterinary laboratory, Eastern Ethiopia	As junior research officer, conduct diagnostic and preliminary surveys
1993 - 1994	Tigray Bureau of Agriculture and Natural resources, Northern Ethiopia	As regional team leader, over all planning and management of animal health activities
1995 - early1998	Mekelle regional Veterinary Laboratory, Tigray; Northern Ethiopia.	As senior research officer conduct diagnostic and preliminary research works related to practical field problems

3. Language skill

Tigrigna	Mother tongue
Amharic	Writing and speaking
English	Writing and speaking
Deutch	Fair

4. Research out puts

- Prevalence of bovine schistosomiasis in and around Baher Dar, North west Ethiopia (Seminar paper)

- The efficiency of flumethrine pour on (Bayer product) under Wolaita field condition, Southern Ethiopia (1986, DVM thesis)

- Tigray region livestock development strategy, Animal health component (1996),Ethiopia

- A Study of bovine clinical dermatophilosis in southern part of Tigray region, Ethiopia (Msc. Thesis)

Signed Declaration Sheet

I the under signed, declare that the thesis is my original work and has not been presented for a degree in any University.

Name: EnQuebaher KASSAYE

Signature:

Date of Submission: November 15 | 1999

This thesis has been submitted for examination with our approval as University advisors.

Dr. Irmgard Moser: Irmgard Moser

Dr. Moges W / Meskel:

c-

DATE DUE	BORROWER'S NAME

A study of bovine clinical dermatophilosi
in southern Part of Tigray Region, Eth.

Enquebaher Kassaye