THE EPIDEMIOLOGY OF HUMAN AND BOVINE TUBERCULOSIS IN JIGAWA STATE

BY

SALISU IBRAHIM

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE)

DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE
FACULTY OF VETENARY MEDICINE
AHMADU BELLO UNIVERSITY
ZARIA.

DECEMBER, 2007

DECLARATION

I hereby declare that the works in this thesis entitle THE EPIDEMIOLOGY OF HUMAN AND BOVINE TUBERCULOSIS IN JIGAWA STATE has been performed by me in the Department of Veterinary Public Health and Preventive Medicine under the supervision of Professor J.U. Umoh and Professor I. Ajogi. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree at any university.

……..
SALISU IBRAHIM (D.V.M.)

CERTIFICATION

The thesis entitled THE EPIDEMIOLOGY OF HUMAN AND BOVINE TUBERCULOSIS IN JIGAWA STATE**,** Nigeria, by SALISU IBRAHIM meets the regulations governing the award of the degree of Master of Science in Veterinary Public Health and Preventive Medicine of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

…… **……**
Professor J.U. Umoh **Date**
(Major Supervisor)

…… **……**
Professor I. Ajogi **Date**
(Member, Supervisory Committee)

…… **……**
Dr. D.H.M. Dusai **Date**
(Head of Department)

…… **……**
Professor S. Nkom **Date**
Dean, Postgraduate School

DEDICATION

This work is dedicated to my late father, Alhaji Ibrahim Saleh for being a good father in every sense of the word and also to the entire family of Sarkin Fulanin Hadejia, Alhaji Dauda A.S. Hadejia for their support and encouragement.

To my Darling wife Bilkisu Ahmed, Children Musa (Daddy) and Zakari (Mubasshir), I say thank you for the patience, understanding and encouragement I received during the entire period of this work.

ACKNOWLEDGEMENTS

My profound appreciation and gratitude goes to my supervisors, Professor J.U. Umoh and Professor Ikwe Ajogi for their inspiring guidance critical review and suggestions in carrying out this thesis.

Special thanks are extended to members of the Sarkin Fulani family, all my friends, colleagues and well-wishers for their moral support. My sincere gratitude goes to Drs. Garba A.M. Farouk, U.M. and Sani Abdullahi, also to Yusuf Hussein, Rabiu Magaji and Abdulahi Gudaji whom we lived together in the same hostel.

I want to express my deep appreciation to my wife Bilkisu and my children Musa and Zakari, my brother Usman Ibrahim for their endurance, love and encouragement, which have contributed in no small way to the successful completion of this work.

I also acknowledge and appreciate deeply the support given to me by Dr. S.I.B. Cadmus of the Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, for providing some antigens used in this study and also Malam Idris Mati who really assisted in the fieldwork.

My deep appreciation goes to Alhaji Ibrahim Hassan Hadejia the Deputy Governor of Jigawa Sate for providing me with financial assistance to fund the project and also the assistance of Alhaji Ibrahim Manzo Babura, the Head of Service, Jigawa State is hereby

acknowledged and appreciated, with out their help this work would not have been possible.

My acknowledgement will be incomplete without appreciating the tremendous contributions of Drs. J. Kabir and B.M. Jahun who were always readily available at all times, to provide me with good advice and criticisms.

To all the senior, intermediate and junior staff of the Jigawa Research Institute Kazaure, I say thank you. Also the effort of Rahila Livinus who typed this thesis is highly appreciated.

Finally, I thank the Almighty ALLAH (S.W.T.) for the skill, knowledge and strength given to me to undertake this study despite my limitations.

ABSTRACT

A cross-sectional study on the Epidemiology of Human and Bovine Tuberculosis in Jigawa State was conducted between June, 2003 and July, 2006 on households/herds of Cattle in Jigawa State, to determine the prevalence of bovine tuberculosis (BTB) and the risk factors associated with the occurrence of the disease in State. Cluster Sampling, Comparative Intradermal Tuberculin Test (CIDT) and questionnaire were used. Based on the CIDT test, the overall prevalence of the disease was 10.8%. Assessment of risk factors shows that older cattle were more affected than calves, ($p<0.01$). There were significant differences between Male and Female cattle ($p<0.05$) and between cattle with exotic blood compared to indigenous cattle ($p<0.05$). Reactivity to tuberculin did not appear to be influenced by reproductive status of the animal. The reactivity to tuberculin of pregnant cattle was not significantly different from the rest of the cows ($p>0.05$). However significantly, more lactating cattle reacted in the CIDT than did non- lactating cows ($p<0.05$). Also the result showed that there is no relationship between cattle keeping and the occurrence of TB in humans ($P>0.05$) and there is no association between herd size and CIDT test ($P>0.05$).More than half 273(62%) of the respondents knew BTB, and only 165(37.93) were conscious of its transmission from cattle to humans.

Also, a 4-year retrospective study (2003-2006) to look at the situation in humans was conducted in the state. The number of cases were 894 in 2003,975 in 2004, 1416 in 2005 and 705 in 2006.Possible risk factors were overcrowding, malnutrition, TB in the family, AIDS, smoking and poor housing. Eighty percent (80%) 0f cases were pulmonary, and the number of cases increases with age. Persistent coughing was by far the most observed clinical symptom. Form acid-fast negatives sample some were positive by culture. This shows the weakness of this diagnostic procedure, misdiagnosis a sample as negative represent a serious risk for the general populace. Efforts have to be focused on implementing more accurate diagnostic procedures.

In conclusion, if the disease is left unchecked, it may lead to a drastic increase, therefore, government has to do more on disease surveillance, control and prevention.

TABLE OF CONTENTS

	Page
Title page……	i
Declaration ……	ii
Certification ……..	iii
Dedication …….....	iv
Acknowledgements ……	v
Abstract ……..	vii
Table of contents…….	viii
List of tables……	xi
List of figures……..	xii
List of abbreviations ……..	xiii

CHAPTER ONE

1.0 Introduction ……..	1
1.1 Statement of Research Problem…….	1
1.2 Significance of study……	3
1.3 Justification……..	4
1.4 Objectives…….	4
1.5 Research Question ……..……..	4

CHAPTER TWO: LITERATURE REVIEW

2.0 Literature Review ……..	5
2.1 Historical overview…….....	5
2.2 Zoonotic TB in Humans.....	7
2.3 Epidemiology	9
2.4 Risk Factors.....	9
2.5 Animal Reservoirs.....	9
2.6 Milk Production and Animal Husbandry.....	9
2.7 Control Measure.....	10
2.8 Risk Factor…….	11

2.9 Close Physical Contact…… 11
2.10 Hygienic Practices 11
2.10.1 HIV/AIDS..... 12
2.10.2 Surveillance of TB due to *M. bovis* ……. 13
2.10.3 Animal Vaccination and Research Devt……... 13
2.10.4 Prevalence of *M.bovis* in sub-Saharan Africa..... 14
2.10.5 Livestock..... 16
2.10.6 Etiology..... 16
2.10.7 Pathogenesis..... 17
2.10.8Transmission 18
2.10.9 Animal to Animal transmission.……. 19
2.11 Animal to Human transmission…..... 19
2.11.1 Human to Animal transmission..... 20
2.11.2 Human to Human transmission .....…….. 21
2.11.3 Diagnosis..... 21
2.11.4 Clinical Examination and Necropsy 22
2.11.5 Microscopy..... 22
2.11.6 Culture on Artificial media .....…… 23
2.11.7 Molecular Diagnostics 24
2.11.8 Control and Prevention 27
2.11.9 Situation in Nigeria..... 28

CHAPTER THREE: MATERIAL AND METHODS

3.1 Study sites and samples Herds..... 30
3.2 Description of study area…..... 30
3.3 Epidemiological Design/Sample Determination..... 31
3.4 Animal Identification..... 32
3.5 Tuberculin Test.....…….. 36
3.6 Preparation and Administration of Questionnaires 36
3.7 Investigations in man..... 37
3.8 Data Analysis..... 38

CHAPTER FOUR: RESULTS

4.0 Results..... 39

CHAPTER FIVE: DISCUSSION AND CONCLUSION

5.0 Discussion and Conclusion 61

52. Summary and Conclusion 67

REFERENCES**……** 69

APPENDIX……. 78

LIST OF TABLES

4.1. *M. bovis* infections in cattle for Hadejia, Gumel and Kazaure

4.2. *M. avium* infections in cattle for Hadejia, Gumel and Kazaure

4.3. Awareness of Tuberculosis among household members

4.4. Occurrence of Tuberculosis in households in Three Emirates of Jigawa State

4.5. Prevalence and Age related differences

4.6. Effects of Herd size on the Result of CIDT Test

4.7. Distribution of Human TB cases by clinical signs

4.8. Comparison of Risk factors by Sputum Test

4.9. Risk Factors affecting the reactivity of cattle to tuberculin test in Jigawa State

LIST OF FIGURES

4.1. Knowledge of Herd owners on Tuberculosis and its zoonotic character

4.2. Distribution of cases by malnutrition from 2003 – 2006

4.3. Distribution of cases of Human TB by final outcome

4.4. Distribution of human TB by occupation

4.5. Distribution of cases by type of TB and possible risk factors

3.2 Map of Jigawa State showing study sites.

LIST OF ABBREVIATIONS

1.	WHO	World Health Organization
2.	TB	Tuberculosis
3.	BTB	Bovine Tuberculosis
4.	CIDT	Comparative Intradermal Tuberculin Test
5.	*M. avium*	*Mycobacterium avium*
6.	*M. bovis*	*Mycobacterium bovis*
7.	*M. tuberculosis*	*Mycobacterium tuberculosis*
8.	HIV/AIDS	Human Immuno – deficiency Virus/Acquired Immune Deficiency Syndrome

CHAPTER ONE

1.0 INTRODUCTION

The Global epidemic of tuberculosis (TB) is increasing. The breakdown of health services, the spread of the human immunodeficiency virus and acquired immune deficiency syndrome (HIV/AIDS) and the emergence of multi-drug-resistant TB are contributing to the worsening impact of this disease (WHO, 2000; Murray *et al*., 1990). One third of the world's population is infected with tuberculosis, and around 8 million TB cases and some 2 million deaths occur annually. Most cases and death occur in the developing countries (WHO Report, 2002).

Human and animal tuberculosis is widespread in Africa with very close genetic similarity between the causative organisms *Mycobacterium tuberculosis* and *Mycobacterium bovis* (Daborn *et al*., 1996). The presence of *M. bovis* in cattle can pose a serious health risk for man since close contact between people and animal, and consumption of raw milk form part of the society characteristics. In sub-Saharan Africa nearly two million tuberculosis (TB) cases per year occur in man and the genus Mycobacteria has pathogenic and zoonotic importance (Daborn *et al*., 1996). It is estimated that in countries where pasteurization of milk is rare and bovine tuberculosis (BTB) is common, 10% to 15% of human cases of TB are caused by *M. bovis* (Ashford *et al*., 2001).

1.1 STATEMENT OF RESEARCH PROBLEM

Bovine TB is a zoonotic disease with potential public health and socio-economic significance as it can affect international trade in animals and animal products. Bovine TB is present in almost all African countries (Anon, 1995), affecting both domestic and wild animals. Daborn and Grange (1996) reported that the disease was prevalent in 33 of 43 (88%) African member countries of the regional commission of the Office of International des Epizootes OIE). Bovine species is the natural host to the disease but a wide spectrum of domestic and wild animals, as well as man, can be infected (Thoen and Steele, 1995; Pavlik *et al*., 1999).

All species are not equally susceptible, and are often grouped into spill over hosts and maintenance hosts. Cattle and other bovine species are considered the primary and most well–known reservoirs or maintenance hosts. In countries where maintenance hosts are present endemically in the wild, infection from these populations to domestic cattle or other farm animals is difficult to avoid.

In industrialized countries, bovine tuberculosis is controlled in farm animals, due to successful policy of test and slaughter and also vaccination of the animals, as a result of which human infection is minimized. These countries are conscious of local and international implications of the disease for trading in animals and animal products, also animal TB control and elimination programs, together with milk pasteurization, have drastically reduced the incidence of the disease caused by *M. bovis* in both cattle and humans. In Africa, 85% of cattle and 82% of the human population live in areas where the disease is prevalent or only partially controlled (Theon and Steele, 1995). Animal TB is widely distributed in Africa, where control measures are not applied or are applied sporadically, pasteurization is rarely practiced. This with other reasons such as the

movement towards more intensive type of farming and the establishment of urban dairies are bringing animals closer than ever before and the lack of attention given to such chronic disease coupled with lack of manpower and resources has made the disease common (Alhaji, 1976).

1.2 SIGNIFICANCE OF THE STUDY

The first report of the existence of Bovine Tuberculosis (BTB) in Nigeria based on tuberculin test, followed by postmortem and laboratory examinations was made by Manley in 1929 (Alhaji, 1976). Recent and old reports from Nigerian abattoirs have confirmed the presence of the disease in all parts of Nigeria (Hall, 1932; Alhaji, 1976; Ayanwale, 1984; Dusai and Abdullahi, 1994; Cadmus *et al*., 1999) and also in Fulani herds as reported by (Alhaji, 1976; Ayanwale, 1984). Alhaji 1976, however, reported that most of the tuberculosis cattle slaughtered in southern Nigeria came from the Northern Provinces and from the neighboring francophone countries of Cameroon, Niger and Chad.

Bovine tuberculosis as a predominantly milk-borne zoonosis may have a significant impact on private and social costs of milk consuming societies in urban and rural areas of Nigeria, where poor economies cannot afford culling and refund practices, a strategy which leads to successful elimination of BTB in many countries in Europe. Zoonotic transmission of *M. bovis* to man could be prevented by either eradicating the disease in animals or educating people about the risk factors (consumption of raw milk).

The epidemiology of TB has been affected in recent decades by the upsurge in HIV infection. As many HIV-infected individuals are co-infected with TB, the incidence of the disease may rise in the coming years (Zumal *et al*., 1999). The correlation between

the prevalence of *M. bovis* infection in human and that in local cattle populations highlights the potential threat of this disease for humans (Daborn *et al*., 1996).

1.3 JUSTIFICATION

There is no documented information on the epidemiology of this disease in Jigawa State. This study was undertaken in order to provide epidemiological information on bovine tuberculosis in the State, to enlighten people on the significance of the disease and the fact that they are agrarian society where they thrive mainly on livestock and agriculture as a means of livelihood as well as high rate of consumption of milk and meat thus predisposing themselves to the disease.

1.4 OBJECTIVE

The objectives of this study are:

1. To determine the prevalence of BTB in Jigawa State
2. To assess the risk factors associated with tuberculosis in both cattle and human populations in Jigawa State
3. To determine the public health significance of the disease in Jigawa State.

1.5 RESEARCH QUESTION

To investigate the disease pattern in both human and cattle populations and also identify possible risk factors associated with the occurrence of the disease.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HISTORICAL OVERVIEW

Tuberculosis has been a scourge of man and other domestic animals for a long time and its exact nature remained questionable for sometimes (Collins and Grange, 1983). The disease was described in Italian writings two thousand years before Christ was born (Kleeberg, 1975). Hippocrates was the first to observed and described clinical "phthis", as tuberculosis was then referred to in domestic animals (Meyers and Steel, 1969). Sylvinus, a Roman Scientist was the first to described the nodular growth lesions characteristics of tuberculosis and termed these lesions tubercle (Ayanwale, 1984). Several English writers described the disease in different forms. Clement in 1893 for example, referred to tuberculosis's as an enemy which probably destroyed more lives annually than all of the so called scourges or wars put together (Ayanwale, 1984). An earlier observation on the nature and epidemiology of the disease was noted by Wenke who in 1846, made an observation on the higher frequency of tuberculous lymph adenitis among infants given cow milk than among those breastfed and he thus incriminated cow's milk as the most likely scourge of the disease (Shehu, 1988). A French military surgeon, Villemin, in 1868, inoculated rabbits with tuberculous materials from diseased cows and found that they developed tuberculosis. Incidentally he also observed the virulent nature of infected material in young rabbits (Collins and Grange, 1983).

In March 1882, a German scientist, who was later to be honored with the title of the father of modern clinical bacteriology named Robert Koch, observed and cultured the bacillus responsible for tuberculosis (Groscheal, 1982).

Robert Koch inoculated guinea pigs with tuberculous material and was able to prove the infectious nature of the tubercle bacilli from human and animal cases (Grosheal, 1982). Paul Erhlich discovered the acid-fast nature of Mycobacterium and Zapf proposed the specific name ‘bacterium tuberculosis, a year later. The term tuberculosis as earlier mentioned small lumps or nodules that describe the basic pathologic lesion characteristic of the disease in affected individuals (Collins and Grange, 1983).Lehmann and Nehmann assigned the species to the genus Mycobacterium.

Research work since then has been directed towards understanding the epidemiology of the disease and the means by which it can be eradicated (Alhaji, 1976). Tuberculosis (TB) is one of the most important zoonotic diseases characterized by development of slow progressive granulomatous lesions in almost all organs of the body (Pritchard, 1988; Neil *et al*., 1994). Besides its public health importance, the disease also cause heavy economic losses both human (Sundre *et al*., 1992) and to cattle population (Aliyu and Kalra, 1993). The disease occurs worldwide (Ugochukwu and Nwaneri, 1984; Blood *et al*., 1995), with lower incidence in the developed countries than in the developing countries (Lesslie *et al*., 1996). Tuberculosis in cattle is caused by Mycobacterium bovis, the usual cause of TB in cattle, which is rarely spread to humans and also transmitted between animals (Edelstien, 1995). Human immunodeficiency virus (HIV)-related TB due to *M. bovis* has been described in several regions notably in the United States (Danker *et al*., 1993) and a clear evidence of human to –human transmission occurred in Paris (Bouvet and Casaino, 1996). The disease is prevalent in Nigeria (Fasanmi, 1977; Ugochukwu and Nwaneri, 1984). Moreover, HIV pandemic has

led to a dramatic increase in the prevalence and severity of human TB (Darbon and Grange, 1993).

2.2 ZOONOTIC TB IN HUMANS

TB caused by M. bovis is clinically indistinguishable from TB caused by *M. tuberculosis* (Ayele *et al*., 2004). In Countries where bovine TB is uncontrolled, most human cases occur in young persons and results from drinking or handling contaminated milk, cervical lymphadenopathy, intestinal lesions, chronic TB (Lupus vulgaris), and other non pulmonary form are particularly common. Such cases may, however, also be caused by *M. tuberculosis*. Little is known of the relative frequency with which M. bovis causes non-pulmonary TB in developing nations because of limited laboratory facilities for the culture and typing of tubercle bacilli (Cosivi *et al*., 1998).

In regions where bovine TB has been largely eliminated, a few residual cases occur among elderly persons as a result of the reactivation of dormant lesions, the dominant lesions are reactivated as a result of disease conditions that can suppress immune system or as a result of malnutrition. Surveys in the USA, Scandinavia, and South England have shown that approximately half of these post primary cases are pulmonary, a quarter involve genitourinary tract and the remainder involves other non-pulmonary sites notably cervical lymph nodes (Grange and Yates, 1994).

Information on human disease due to *M. bovis* in developed and developing countries is scarce. From a review of number of zoonotic tuberculosis studies, published between 1954 and 1970 and carried out in various countries around the world, it was estimated that the proportion of human cases due to *M. bovis* accounted for 3.1% of all

forms of tuberculosis, 2.1% of pulmonary forms and 9.4% of extra pulmonary forms (Gervois *et al*., 1974).

Human disease caused by *M. bovis* has been confirmed in African countries. In an investigation by two Egyptian health centers, the proportions of sputum-positive TB patients infected with *M. bovis*, recorded during three observations, were 0.4%, 6.4%, and 5.4% (Elsabban *et al*., 1992). In another study in Egypt, nine of 20 randomly selected patients with TB Peritonitis were infected with M. bovis and remaining with M. tuberculosis (Edelstein *et al*., 1992).

Isolation of *M. bovis* from sputum samples of patients with pulmonary TB has also been reported from Nigeria. Of 102 *M. tuberculosis* complex, 4(3.9%) were *M. bovis* (Idigbe *et al*., 1986). Another study in Nigeria reported that one of 10 Mycobacteria isolated from sputum-positive cultures was *M. bovis* (Idris and Schnurrenberger, 1977).

In Zaire, *M. bovis* was isolated from gastric secretions in two of five patients with pulmonary TB (Mposhy *et al*., 1983). In the same study, the prevalence of the disease in local cattle was approximately 8% using tuberculin testing and isolation of *M. bovis* .In an epidemiological study in Zambia (Cook *et al*., 1996), an association between tuberculin-positive cattle and human TB was found. Households that reported a TB case within the previous 12 months were approximately seven times more likely to own herds containing tuberculin-positive cattle. Although this could be explained by zoonotic TB transmission, other factors such as transient sensitivity to tuberculin by cattle exposed to TB Patients and coincidental environmental factors favouring both human clinical TB and sensitivity to bovine tuberculin should also be considered.

2.3 EPIDEMIOLOGY

Much information on the epidemiological patterns of bovine TB has been obtained from industrialized Countries; however, some striking epidemiological differences related to both animal and human populations in developing countries require particular attention.

2.4 RISK FACTORS

2.5 ANIMAL RESERVOIRS

The widespread distribution *M. bovis* in farm and wild animal populations represents a large reservoir of this microorganism. The spread of the infection from affected to susceptible animals in both industrialized and developing countries is most likely to occur when wild and domesticated animals share pasture or territory (O'Reilly and Daborn, 1995). Wild animal TB represents a permanent reservoir of infection and poses a serious threat to control and elimination Programs. This is because vaccination and wild animals is posed with difficulty such as administering the vaccines and also maintenance of the cold chain.

2.6 MILK PRODUCTION AND ANIMAL HUSBANDRY

Milk production has increased in most developing countries as a consequence of greater demand for milk for human consumption (FAO, 1993). This increased demand for milk estimated at 2.5% per year for 1970-1988 for sub Saharan Africa (Walshe *et al*., 1991) led to increases in the number of productive animals and milk imports and intensification of animal production through the introduction of more productive exotic breeds. Although the prevalence of the disease within a country varies from area to area, the highest incidence of bovine TB is generally observed where intensive dairy

production is most common, notably in the milk sheds of larger cities (Acha and Szyfres, 1987). This problem is exacerbated where there is in adequate veterinary supervision. In addition, in some industrialized countries such as USA, where bovine TB is close to elimination, large dairy herds that are crowded together represent the main source of infection (National Research Council, 1994).

In developing countries, bovine TB infects a higher proportion of exotic dairy breeds (*Bos taurus*) than indigenous zebu cattle (*Bos indicus*) and cross breed beef cattle (Acha and Szyfres, 1987). In those areas where extensive Management is more common, animal crowding (near watering ponds, dip tanks, markets, and corals) still plays major role in the spread of the disease (Ayele *et al*., 2004).

2.7 CONTROL MEASURES AND PROGRAMS

The basic strategies required for Control and elimination of bovine TB are well known and well defined (WHO, 1967). However, because of financial constraints, scarcity of trained professionals, lack of political will, as well as the underestimation of the importance of zoonotic TB in both the animal and public health sector by national governments and donor agencies, control measures are not applied or are applied inadequately, in most developing countries (Cosivi *et al*., 1998). Successful conduct of a test and slaughter policy requires sustained cooperation of national and private veterinary services, meat inspectors, and farmers, as well as adequate compensation for the services rendered. Only few developing counties can adhere to these requirements (Cosivi *et al*., 1998).

2.8 RISK FACTORS: HUMAN POPULATION

2.9 CLOSE PHYSICAL CONTACT

Close physical contact between humans and potentially infected animals is present in some communities, especially in developing regions. For example in many parts of Nigeria cattle are an integral part of human social life. They represent wealth and are in the centre of many events and gatherings (Aliyu and Kalra., 1993). In addition, with 70% of Nigerian population working in agriculture (Aliyu and Kalra., 1993), a significant proportion of the populations are at risk for bovine TB.

2.10 FOOD HYGIENE PRACTICES

Consumption of milk contaminated by *M. bovis* has long been regarded as the principal mode of TB transmission from animals to humans (Acha and Szyfres, 1987). In regions where bovine TB is common and uncontrolled, milk-borne infection is the principal cause of cervical lymphadenopathy and abdominal and other forms of non-pulmonary TB. Although proper food hygiene practices could play a major role in controlling these forms of TB, such practices are often difficult to institute in developing countries (Ayele *et al*., 2004). It has been estimated that 90% of the total milk produced in sub-Saharan Africa is consumed fresh or soured (Walshe *et al*., 1991). Although it has been stated that Africans generally boil milk and that the souring process destroys *M. bovis* (Walshe *et al*., 1991), other sources strongly contradict these statements (Barrera and Kantor, 1987). M bovis was isolated from seven (2.9%) of 241 samples of raw milk in Ethiopia (Kidane *et al*., 2002). Both M. bovis and M. tuberculosis have been found in milk samples in Nigeria (Idrissu and Schnurrenberger, 1997) and Egypt (Nafeh *et al*.,

1992). Therefore, serious public health implications of potentially contaminated milk and milk products should not be underestimated.

2.10.1 HIV/AIDS

According to the recent WHO global estimates of the 9.4 million people infected with both HIV and TB in mid-1996, 6.6 million (70%) live in sub-Saharan Africa (Raviglione *et al*., 1988). In many developing countries, TB is the most frequent opportunistic disease associated with HIV infection (Raviglione *et al*., 1998). HIV sero-prevalence rates greater than 60% have been found in TB patients in various African Countries (Raviglione *et al*., 1995). Persons infected with both pathogens have annual risk of Progression to active TB of 5% to 15% depending on their level of immuno-suppression. Approximately 10% of non-HIV infected persons newly infected with TB become ill at some time during their lives. In the remaining 90%, effective host defenses prevent progression from infection to disease (Cosivi *et al*., 1995).

M. bovis has been isolated from HIV-infected persons in industrialized world. In France, M. bovis infection accounted for 1.6% of TB cases in HIV-positive patients. All isolated strains were resistant to isoniazid (Dupon and Ragnoud, 1992). In a Paris hospital, a source patient with pulmonary TB due to a multi drug-resistant strain of *M. bovis* led to active disease in five patients. Disease occurred 3 to 10 months after infection (Bouvet *el al*., 1993). This observation led to three concerns:

(1) Human-human *M. bovis* transmission leading to overt disease,

(2) A short interval between infection and overt disease,

(3) Disseminated mutating-resistant *M. bovis.*

In another study, conducted in San Diego, California, one of 24 adults with pulmonary TB and 11 of 24 adults with non-pulmonary TB due to *M. bovis* had AIDS. One of 25 children, a 16-year old boy with abdominal TB, was also HIV-positive (Danker *et al*., 1993). It is commonly believed that M. bovis is less virulent than *M. tuberculosis* in humans and therefore less likely to lead to overt post primary disease and that human-human transmission leading to infections disease is rare. However, difference in responsiveness of the host defense mechanisms, HIV-induced immuno suppression could well lower host defenses leading to overt disease after infection (Cosivi *et al*., 1992).

2.10.2 SURVEILLANCE OF TB DUE TO *M. bovis*

The use of direct smear microscopy as the only method for diagnosis of suspected TB, although an essential requirement of any National TB programme, could partly explain the relative low notification rate of disease caused by *M. bovis* in developing countries. Directs smear microscopy does not permit differentiation between species of the *M. tuberculosis* complex. In addition, culture and speciation are not carried out, and even when culture facilities are available, *M. bovis* grows poorly in standard Lowenstein–Jensen medium, one of the most widely used culture media (Grange *et al*., 1996).

The collection of representative data on incidence of TB due to *M. bovis* from most laboratories in developing has problem for example, poor record keeping and typing of the tubercle bacilli due to lack of materials and Equipment.

2.10.3 ANIMAL VACCINATION AND RESEARCH DEVELOPMENT

Vaccination of animals against TB would be a viable strategy in two disease control situations: in domesticated animals in developing world and in wildlife and feral

reservoirs of disease in industrialized Countries where test and-slaughter programs have failed to achieve elimination of the disease (Cosivi *et al.*, 1998).

Many issues need to be addressed before vaccination becomes a realistic option for control of disease in cattle and other animals. First, a highly effective vaccine needs to be developed. The results obtained globally with bacillus calmette-Guerin (BCG) have been sub optimal, and efficacy has varied considerably from region to region (O'Reill and Daborn, 1993, Malin and Young, 1996). Secondly, the delivery of the vaccine poses few problems in domesticated animals, but it is fraught with difficulties in wild animals. Thirdly, vaccination may compromise diagnostic tests. A vaccine that induces tuberculin reactivity would invalidate the key diagnostic tool used in control programs. Fourthly, short of performing lengthy and expensive field studies, evaluation of the protective efficacy of a new vaccine will pose serious difficulties (Cosivi *et al*, 1998).

Enzyme-linked immunosorbent assay and gamma interferon tests may prove to be more sensitive and specific than tuberculin test. Resources in most developing countries limit the use of this technique.

2.10.4 PREVALENCE OF M. bovis IN SUB-SAHARAN AFRICA

In sub-Saharan Africa, where nearly 2 million TB case occur each year, it is unknown what role *M. bovis* plays in the epidemic of TB (Daborn, 1992). However, there is substantive evidence of significant transmission of *M. bovis* in pastoral communities with close human-to-livestock contact (Mposhy *et al.*, 1983). In Sahelian countries, for example, there are large communities in which no livestock screening for bovine TB is conducted and people are exposed to direct contact with animals and consume unpasteurised milk and milk products. Due to a lack of capability to isolate and

differentiate the organism from TB cases, cases due to M. bovis are possibly underreported and may represent a significant threat to the community (Daborn, 1996).

In Nigeria, Idigbe *et al*. (1986) found *M. bovis* in 4% of patients with lower respiratory tract symptoms. Hoffner *et al*. (1993) reported isolation and biochemical characterization of *M. tuberculosis* and *M. bovis* in humans in Guinea-Bissau. Vekemans *et al*. (1999) have retrospectively analysed the TB registers of Bobo Diolulasso, Burkina Faso, which correlated prevalence of cattle-related TB in ethnic groups. In Burundi, Rigouts *et al*. (1996) isolated *M. bovis* in 38% of clinically suspected bovines. DNA fingerprinting revealed 4-8 copies of IS6110 for all *M. bovis* isolates with some degree of polymorphism. In Madagascar, a proportion of *M. bovis* (1.25%) was observed among sputum smear-positive patients and among extra-pulmonary TB patients (1.30%) (Rasolofo *et al*., 1999). Jiwa *et al*. (1999) referring to the high morbidity and mortality due to HIV/AIDS in the Kagera area of Tanzania, suggested that the presence of bovine TB in cattle necessitates further investigation into the role of animal–derived bovine TB in human health. Kazwala *et al*. (1998) emphasized that non tuberculosis complex Mycobacteria are dangerous to human health in countries such as Tanzania, where the number of people with impaired immunity due to HIV/AIDS infection is growing. Ledru *et al*. (1999) suggest that most TB cases in Africa HIV/AIDS patients are due to exogenous re-infection rather than to reactivation of endogenous *M. tuberculosis*. Considering the association of HIV/AIDS with Tb in humans, similar risk may occur in individuals exposed to infection with *M. bovis* (O' Reilly *et al*., 1995).

2.10.5 LIVESTOCK

M. bovis is endemic in Uganda. (OIE, 1992). Vekemans *et al*. (1999) reported purified protein derivative (PPD) test of cattle, with 13% positive reactions and isolation of Mycobacteria in 26% of 60 retailed milk samples collected in markets in Burkina Faso (Jiwa *et al*., 1997).

Kazwala *et al*., (1998), Isolated Mycobacteria species from the raw milk of pastoral cattle in the Southern Highlands of Tanzania.. Although the number of M. bovis positive samples was low, the habit of pooling milk may still pose a public health danger to milk consumer. In Chad Schelling *et al*, (2000) found 17% prevalence of bovine TB using the PPD tuberculin test.

2.10.6 ETIOLOGY

Bovine TB is caused by *M. bovis*. Although cattle are considered to be the primary hosts of M. bovis, the disease has an exceptionally wide mammalian host range, which includes humans (Blood *et al*., 1989; O'Reilly and Daborn, 1995). *M. bovis* is a member of a closely related group of Mycobacteria referred to as MTC, (Rastogi *et al*., 2001) which comprises *M. tuberculosis, M. africanum*, *M. bovis* and *M. microti* (Rastogi, 2001), as well as the newly characterized bacteria *M. carmetti* (Van sooligan *et al*., 1997).

M. bovis closely resembles *M. tuberculosis* and precise identification of and distinction between the two can be established by biochemical and molecular biology techniques. In the public health centers of most developing countries, Lowenstein–Jensen (LJ) medium, a medium on which *M. bovis* may grow poorly or not at all, is commonly used for the isolation of *M. tuberculosis*. Inoculated media are often incubated

insufficiently for *M. bovis* cultures to appear. This may help to explain the low number of bovine type human TB cases reported in developing countries (Grange, 1996). *M. bovis* is a robust pathogen and may survive in the environment, in buildings, on transport vehicles, on pasture and in slurry (Blood *et al*., 1995) The organism has been reported to survive in cow faeces for more than 5 months in winter, 4 months in autumn, 2 months in summer, and in soil for up to 2 years (Wray, 1975). Manure fertilization of arable land is common practice in developing countries; survival of *M. bovis* in soil and slurry therefore implies pasture and vegetable contamination, representing a potential source of infection to animals and humans, respectively (Ayele *et al*., 2005).

2.10.7 PATHOGENESIS

A generally accepted concept is that infection with *M. bovis* can become established in cattle by inhalation of tubercle bacilli, possibly a single bacillus, in an aerosol droplet (Neill *et al*., 1991) that lodges within the respiratory tract, probably the alveolar surface of the lung (Pritchard, 1988). Bacilli are phagocytosed by macrophages and subsequently interact with cells involved in innate and acquired immune responses in tissue or draining lymph nodes. Lesions can also be found in the mesenteric lymph nodes, liver, spleen, serous membranes, pleura and other organs (Blood *et al*., 1989; Neill *et al*., 1994). The role of activated mononuclear macrophages is considered most important in protecting the host against *M. bovis*. Macrophages are involved in processing Mycobacterial antigens and presenting them to T-lymphocytes, which are considered a key recognition unit in the immune response to Mycobacteria (Thoen and Himes, 1986). The characteristic lesion caused by *M. bovis* in cattle is described as having a center of caseous necrosis, usually with some calcification, with a boundary of epithelioid cells,

some of which form multinucleated giant cells and few to numerous lymphocytes and neutrophils (Thoen and Steele, 1995; Neill *et al*., 1994). Primary lesions in cattle, unlike man, are rarely contained by the immune response and dissemination from a lesion may occur by natural ducts such as bronchi, by lymphatic spread or by haematogenous spread when massive military TB occurs (Francis, 1947).

2.10.8 TRANSMISSION

There are numerous ways in which cattle can become infected with M. bovis; these can be affected by animal age and behavior, environment and climate, and prevailing farming practices. (Pollock and Neill, 2002). Under natural conditions, the main route of *M. bovis* infection in cattle is by inhalation. This mode of transmission is dominant in industrialized countries, where intensive farming is practiced. In field case studies of bovine TB in these countries, lesion distribution and pathology show predominant involvement of the upper and lower respiratory tract and associated lymph nodes (Neill *et al*., 1994 and Whipple *et al*., 1996). Confirmed tuberculin reactors frequently appear to have an absence of lung lesions; however, lesions when present within the lung parenchyma are usually too small (<1 cm) to be easily detected during meat inspection (Mcllroy *et al*., 1986).

Inhalation of *M. bovis* is the most probable and principal route to bovine infection and is facilitated by close, prolonged contact between infected and healthy animals. Ingestion of *M. bovis* directly from infected and healthy animals or from contaminated pasture, water or utensils may also be very common in some regions. While congenital infections and vertical transmission have been recorded, these routes, like genital

transmission, which occurs when reproductive organs are infected, (Neill *et al*., and 1994), are now rarely seen in regions

2.10.9 ANIMAL TO ANIMAL TRANSMISSION

Infectious animals may shed M. bovis in faeces, milk, discharging lesions, saliva and urine (Neill *et al*, 1991). Intensive livestock farming promotes close contact between animals, favouring the spread of *M. bovis*. Extensive livestock farming, however, especially transhumance with no housing system raises the question as to how bovine TB transmission can take place. Close contact between animals occurs for example at water points such as ponds, wells and streams. In Africa, grazing animals usually gather at night for protection from predators. Vaccination and artificial insemination centers, dipping tanks, auction stations, market places and transportation are the commonest animal gathering places, and again are sites where transmission of infection could easily occur. Due to the high ambient temperature in tropical zones, animals tend to concentrate under trees or other shaded areas for parts of the day, preferring to graze early in the morning and late in the afternoon. Possibly the most dangerous spots for nose-to-nose or mouth-to mouth contact between animals are salt supplementing points (Shehu, 1988). Therefore, while extensive system of farming is safer than zero level grazing systems to prevent disease transmission, some of the above situations simulate the dangers of intensive farming in relation to disease transmission (Ayele *et al*., 2004).

2.11 ANIMAL TO HUMAN TRANSMISSION

Human TB due to *M. bovis* in developing countries today is analogous to conditions in the 1930s and 1940s in Europe, where more than 50% of cervical lymphadenitis cases in children were caused by *M. bovis* infection (Cosivi *et al*., 1995).

This is exacerbated by the added burden of HIV/acquired immune-deficiency syndrome (AIDS). In industrialized countries, the incidence of TB due to *M. bovis* in humans is almost at zero level as a result of pasteurization of milk and milk products and eradication of bovine TB in cattle population (Collins and Grange, 1983). However, in developing countries, bovine TB in animals can be widely distributed in regions where control measures are not applied or are conducted sporadically and pasteurization is rarely practiced (Cosivi *et al*., 1998). Pulmonary TB due to *M. bovis* is more common in rural dwellers, as a result of inhalation of dust particles or bacteria-containing aerosols shed by infected animals, while urban dwellers acquire the infection via the gastrointestinal route and develop extra-pulmonary TB (Daborn *et al*., 1996). In countries with a relatively high prevalence of bovine TB in cattle, abattoir and farm workers are the groups most exposed to infection (Ayele *et al*., 2005).

2.11.1 HUMAN TO ANIMAL TRANSMISSION

Reports of human infection of cattle are rare (O'Reilly and Daborn, 1995). The genitourinary tract in humans is a site of non-pulmonary TB due to *M. bovis*; genitourinary TB may appear to be of little importance to epidemiologists in studying human infection, but this route of infection from man to cattle is well documented. Grange and Yates (1994) reported that farm workers urinating in cowsheds might represent source of infection for animals. An analogous situation is thought to occur in rural Africa, where patients with genitourinary TB may urinate on pasture: animals craving salt preferentially graze on this grass and may succumb to infection.

2.11.2 HUMAN TO HUMAN TRANSMISSION

Human TB caused by *M. bovis* as a result of human-to human transmission was reported in the Netherlands in 1994 (Van Soolingen *et al*., 1994). Evidence of transmission of *M. bovis* between humans is considered rare and largely anecdotal, and the rate of transmission seems insignificant compared to animal-animal or animal-to-human infection (O'Reilly and Daborn, 1995).

Human-to-human transmission of *M. bovis* is considered less efficient than that of *M. tuberculosis*, (Francis, 1995) However, transmission among HIV-infected humans, where immuno-suppression increases the susceptibility of the host organism to infection, may be different. *M. bovis* has been isolated from HIV-infected individuals in some industrialized countries, with an additional serious complication of high primary resistance to isoniazid, streptomycin, pyrazinamide (Guerrero and Fortum, 1997).

2.11.3 DIAGNOSIS

TB can be diagnosed clinically, but usually only in the later stages of the disease. The tuberculin skin test is universally recognized and is generally used for preliminary diagnosis in bovine TB control programmes. However, in developed countries meat inspection is used for diagnosis and surveillance. Other tests, such as an antibody enzyme linked immunoassay (ELISA) and the gamma-interferon assay have been used as supplementing tests in eradication and control. Assays for bovine interferon-gamma have recently been applied to indicate infection (Neill *et al*., 1994). Confirmation of infection, however, often relies on isolation and identification of *M. bovis*.

2.11.4 CLINICAL EXAMINATION AND NECROPSY

Many cattle with bovine TB are clinically normal, some cows with extensive military tuberculous lesions also appear clinically normal, but progressive emaciation unassociated with other signs should arouse suspicion of TB. Capricious appetite and fluctuating temperature are also commonly associated with the disease. Pulmonary involvement is eventually characterized by chronic cough, together with dyspnoea and other signs of low-grade pneumonia. Affected animals are docile and sluggish, but the eyes remain bright and alert (Blood *et al*., 1989). More recent studies reported by Neill et al., and Pollock and Neil indicate that the precise processes by which cattle become infected by *M. bovis* may not be completely characterized or understood.

2.11.5 MICROSCOPY

M. bovis can be demonstrated microscopically on direct smears from clinical samples, and on prepared tissue materials. Tissue smears from affected organs stained by Zieh-Neelsen (ZN) method can be used to demonstrate the presence of acid-fast mycobacterium, red bacilli on a pale blue background (Methylene blue staining), and appear on a green background if re-stained with malachite green. Examination of a haematoxylin-eosin-stained section of lesion for each case that is positive on smear is valuable. This technique is cheap, practical and a useful preliminary diagnostic step in developing countries where other laboratory facilities are not available; furthermore, identification in clinical samples and pathological specimens can be performed rapidly (Pritchard, 1988).

2.11.6 CULTURE ON ARTIFICIAL MEDIA

Specimens are taken from lesioned lymph nodes and parenchymatous organs such as lungs, liver, spleen, etc. in animals with positive intradermal skin tests but showing no gross pathological lesions, samples from the retro pharyngeal, bronchial, mediastinal and mesenteric lymph nodes are collected routinely for culture examination; the supramammary and mandibular glands and liver are sometimes included. Specimens are ground in silver sand, macerated or homogenized in a stomacher and decontaminated. Following centrifugation the sediment is often inoculated onto a set of solid media slopes consisting of egg-based media such as LJ, Coletsos base and Stonebrink's media. Slopes of these media containing pyruvate are inoculated, usually in duplicate, and an agar-based medium, such as Middlebrook 7H10 or 7H11, is also often used. Stonebrink's medium containing sodium pyruvate without glycerol is possibly the best medium. Colonies of *M. bovis* are expected to appear after 3-5 weeks of incubation at 37^{o}C (Kubica, 1984).

A radiometric culture method such as the semi automated BACTEC 460 system employing a liquid supplemented Middle brook medium can also be used. The radiometric method provides results significantly more rapidly than traditional culture, but is often sensitive to fungal contamination, particularly when certain animal specimens are used, and will grow atypical Mycobacteria or non Mycobacterial organism not restricted by the antibiotics incorporated (Kubica, 1984). The disadvantages of this method are that the BACTEC Method is more expensive, requires an instrument to read the culture vials, and involves handling of radioisotopes (Ayele et al., 2004).

Older, techniques still in use (Pritchard, 1988) such as:

(1) Bacillary morphology and growth rates;

(2) Enhancement by glycerol of growth of *M. tuberculosis* isolates and suppression of *M. bovis* isolates;

(3) Niacin synthesis by M. tuberculosis but not by *M. bovis* isolates;

(4) Enhancement by pyruvate for growth of *M. bovis*:

(5) Oxygen preference is aerobic;

(6) Growth characteristics: Both *M. bovis* and *M. tuberculosis* fail to grow at 25^{o}C and 42^{o}C and hence are strict mesophiles;

(7) Colony pigmentation: Neither *M. bovis* nor *M. tuberculosis* colconies are pigmented;

(8) Nitrate is reduced by *M. tuberculosis* but not by *M. bovis* isolates;

(9) Sensitivity to drugs: Resistance to pyrazinamide of *M. bovis* isolates and sensitivity of isolates;

(10) Susceptibility to thiophene-2-carboxylic acid hydrazide by *M. bovis* but not by *M. tuberculosis* isolates.

Other modern laboratory method can be applied to discriminate *Mycobacteria* isolates on the basis of the genomic characteristics of the organism. However, these methods are expensive for most developing countries with limited financial and technical resources.

2.11.7 MOLECULAR DIAGNOSTICS

Culture is still internationally considered the gold standard for detection of Mycobacteria; however, the intensity of labour required and the possible presence of viable non-cultivable *Mycobacterium* in some clinical specimens require more appropriate methods. Molecular diagnostic methods are in principle attractive

replacements for traditional procedures, but such tests should have demonstrable, sustained improvement in sensitivity, specificity and reproducibility. The may be convenient and less costly when used for high throughput, but the availability of appropriate resources and trained staff is important and must be considered, particularly in developing countries. There is often a tendency to underestimate the difficulties inherent in introducing and applying these technologies to pathogens such as *Mycobacteria* (Ayele *et al*., 2004).

Molecular biology techniques have now provided a means to detect and differentiate *M. bovis* isolates. Such differentiation should enable systematic epidemiological surveys to be conducted and, potentially, the origins of infection to be traced. Fingerprinting of *M. bovis* has been extremely effective using the restriction fragment analysis technique referred to as REA (Collins, 1999). However widespread adoption of the method has been curtailed by issues such as potential cost and difficulties in technology transfer. A modified method of pulse field gel electrophoresis (PFGE) for *M. bovis* has had little uptake generally, as most methods now have advanced to exploiting the repetitive DNA sequences that occur in the Mycobacterial genomes. Two types of repetitive DNA are known in bacterial genomes-dispersed repeats and tandem repeat. Dispersed repeats include mobile genetic elements, including insertion sequences (ISs) and prophages (Gordon *et al*., 1999). Most of these ISs are located in the same genome position in members of the MTC; however, there are significant differences between species that are useful for diagnostics. The insertion element IS6110, which belongs to the IS3 family, is the most abundant and best-characterised. The IS6110 copy number varies from 0 to 25 in MTC bacteria, whereas in *M. bovis* isolates the IS6110

copy number is low, often occurring singly, especially in isolates from cattle (Skuce *et al*., 1996). Interestingly, and usefully exploitable, the IS110 copy number is often higher in *M. bovis* isolates from more 'exotic animal species (Collins, 1999).

Other methods such as the spacer-oligotyping (spoligo-typing) technique, has been developed, which employs PCR amplification of the DNA sequence of the highly polymorphic direct repeat (DR) locus and reverse-cross blot hybridization to detect the presence or absence of spacer DNA sequences, mostly from *M. tuberculosis*. The polymorphism is carried by these spacers, which are variable in length (35-41 bp). Spoligotyping is easily executed and produces a simple digital pattern, but it is less discriminating than REA or RFLP (Roring *et al*., 1998). Further examination of *M. tuberculosis* and *M. bovis* isolates has revealed additional spacer sequences that may further improve discrimination. (Van Embden *et al*., 2000). Spoligotyping is possibly the most widely used typing method for differentiation of isolates belonging to the MTC; because of its simplicity it is becoming a favoured method for typing *M. bovis* isolates. The method has been employed for simultaneous diagnosis and typing of mycobacterial isolates (Roring *et al*, 1988, Kamerbeek *et al*., 1997).

Molecular technologies are currently rarely employed in developing countries, and where they are available, priority is often given to human case. In Guinea-Bissau, Kallenius *et al*. successfully differentiated *M. bovis* and *M. tuberculosis* from other Mycobacteria by combining biochemical tests with IS6110 RELP and spoligotyping (Kallenius *et al*., 1999). A recent study in Ethiopia showed the importance of molecular techniques in differentiating between *M. tuberculosis, M. africanum* and *M. bovis*, which were found to cause tuberculous lymphadenitis in humans (Kidane *et al*., 2002).

2.11.8 CONTROL AND PREVENTION

As suggested by Cousins (2001), there are various reasons for attempting to eradicate bovine TB:

1) The risk of infection to the human population;

2) Loss in productivity due to infected animals,

3) Animal market restrictions set by countries with advance.

Eradication programmes. In developing countries, bovine TB remains a major animal's health problem, mainly because these countries cannot shoulder the financial burden required t o implement a control programme and compensate for slaughtered animals. Limited access to education, poor information networks and lack of disease surveillance are other factors that limit the implementation of any such programmes.

Eradication of bovine TB using compulsory test and slaughter strategies has proven difficult even in industrialized countries, where cattle movement can usually be controlled. In some of these countries, where natural reserviours of the disease in wild animals pose a serious risk of transmission to domestic livestock, the problems have been exacerbated, and eradication programmes remain unsuccessful. In mot African countries, controlling free movement of animals within a country is difficult and movement between countries cannot be regulated, primarily due to lack of border controls. Therefore, Daborn and Grange have suggested strategic vaccination of susceptible animal in endemic areas TB is much more acceptable and practical measure and eradication is not the objective (Daborn and Grange, 1996). Development and production of an effective vaccine with appropriate methods and strategies for delivery could therefore

contribute to bovine TB control. This is obviously a task best undertaken at a global level and applied locally in appropriate scenarios.

2.11.9 SITUATION IN NIGERIA

The Prevalence of Mycobacteria in Nigeria is very low due to scarcity of information and proper documentation; this is due to the fact that despite the knowledge of their existence both in the human and animal populations as well as the environment, the literature on Mycobacteria appears to be sketchy. The relative scarcity of literature is partly due to limited number of field studies so far taken on Mycobacteria and also poor record keeping in both veterinary and Hospital records. The identification of the organisms in most cases are mostly done by direct smear examinations which stops at the generic level, this is due to the fastidious nature of the organism which also requires several weeks to grow on culture media. In fact media used for routine isolations are very expensive and not readily available. In this respect, epidemiologic assessment can only be made on the basis of the limited field surveys carried out and the scanty records from abattoirs and hospitals.

The first report of the existence of bovine tuberculosis in West Africa was in 1913 by Ziemann in Cameroons, according to the veterinary Department report, Nigeria, (Alhaji, 1976). In Nigeria, the first report of the existence of the disease based on tuberculin test results, subsequently followed by post mortem and laboratory examinations was made by Manley in 1929 (Alhaji, 1976).

Abattoir reports on Mycobacteria are found in all Parts of the Country. In Calabar abattoir between 1937-1939, 364 cases of tuberculous lesions were reported in 2300

bovine carcasses. The 1973 annual report of the then South Eastern State of Nigeria recorded tuberculous lesions from several other cases (Shehu, 1988).

In Maiduguri, the abattoir records showed that 56 cases had tuberculous lesions from the 2640 carcasses examined between 1963 and 1964 (Northern Nigeria Annual Report of the Ministry of Agriculture and Forest Resources, 1967). In general, Eid and Alhaji (1976) reported a high prevalence of tuberculous lesions from abattoir samples in the Northern Province of Nigeria.

Tuberculin testing of cattle in Nigeria was sporadic until in the 1950s when veterinary officers in the then Sokoto province were active in conducting tuberculin tests in herds around Birnin kebbi and Argungu (Shehu, 1988). This is followed by the Shika Quarterly report of March, 1957 which contained a report of tuberculin test conducted on a herd of 158 cows with negative results. Reports of bovine tuberculin test increased during the 1960s and a good number of tuberculin test surveys were undertaken there after (Eid 1976; Alhaji, 1976).

M. bovis was isolated from the sputum of a farmer with bone tuberculosis, and from milk of herd with 46% tuberculin positive reactors in four Northern States (Alhaji, 1976).

The public health implications of these findings were that the general population could become infected with Mycobacteria.

CHAPTER THREE

3.0 METHODOLOGY

3.1 STUDY SITES AND SAMPLED HERDS

The study period, covers June 2003 – July 2006. Total of 52 herds from Hadejia, Auyo, K/Hausa, Birniwa, Kazaure, Yankwashi, Gwiwa, Gumel, Maigatari, Suletankarkar Gagarawa and Roni were selected in a herd screening survey. An overview of study sites, sample size and number of animals screened is given in Table 3:1.

3.2 DESCRIPTION OF STUDY AREA

Jigawa State lies between longitude 11^{o} to 13^{o} North and latitude 8^{o} to 10^{o} east, with a landmass of 22,140 km^2 (Jigawa Agricultural and Rural Development, 2000). The state has 27 local government areas with about 350,000 of the rural households keeping livestock (Jigawa Agricultural and Rural Development, 2000). The climate of the area appears to be favourable for crop and livestock production.

The human population of the State is estimated to be 4.3million people (2006, National Population Commission). The total number of households in the area of the study was 350,000 and each household included an average of 5 individuals.

The study conducted covered twelve local governments out of the 27 local government areas of Jigawa State, including the flood plains of Hadejia River Valley which has higher altitude, is cool and receives the highest rain fall than any other part of the state, whereas the rest of the local government areas are semi-arid and dry for a longer duration within a year.

The production system observed in the state combines cereal-based agriculture and livestock farming. The farms are of small size and are characterized by a subsistence

economy. Cattle farming play a major role in the production system. The cattle population in the state during the study is 1.1million cattle heads, and the average herd size was 10 heads of cattle (JARDA, 1995). The breeds of cattle kept include Bunaji (White Fulani) and Rahaji (Red Bororo) Bunaji breed is the most important in the Southern part of the state while Rahaji is popular in the extreme Northern Part.

3.3 EPIDEMIOLOGICAL DESIGN/SAMPLE DETERMINATION

The study included 52 households that owned 922 cattle heads. Cattle in the sampled households were of both sexes and above 6 months of age. Secondary data on the human health records in the respective general hospital in the area were used to assess the status of human tuberculosis in the study area between June 2003 to July 2006.

The selection of the study sites was based on the concentration of cattle at the sites. The list of heads of the households was obtained from the zonal veterinary officers and extension agents, and was used as sampling frame; the household was the primary sampling unit. A herd was defined, in this study, owned by a household.

A multistage sampling technique was used to select the local government areas as well as the households that have herds of cattle. In the first stage, three out of five emirates in Jigawa State with the highest concentration of cattle were selected namely; Hadejia, Gumel and Kazaure. This was based on the information made available by the zonal Veterinary officers. In the second stage, four local government areas were selected using simple random sampling from Hadejia emirate, however, in Gumel and Kazaure emirates, which are made up of four local government areas each all were included in the study. In each local government area one urban and one rural area were included in the

study. In the third stage, households who own cattle and were willing to participate in the study were included.

Calculating the number of households required for this study, the formula described by Martin *et al*. (1997) was used. As a result, simple random sampling and cluster sampling to calculate sample size was used with the households as a cluster unit. In cluster sampling, to be on the safe side, 3 times as many animals were proposed to be included as for a simple random sampling method.

Briefly, because the average herd size was 10 animals per herd (Jigawa Agricultural and Rural Development (JARDA), 2000), the expected prevalence of BTB was 10% (previous study in Northern Nigeria, Alhaji, 1976). The statistical confidence level was decided to be 95%, and desired absolute precision was 5%. Accordingly, the sample determined to be 138 for simple random sampling which corresponds to 17.4 households. Conversion to cluster sampling gave 52 households (17.4 x 3 = 52 households).

3.4 ANIMAL IDENTIFICATION

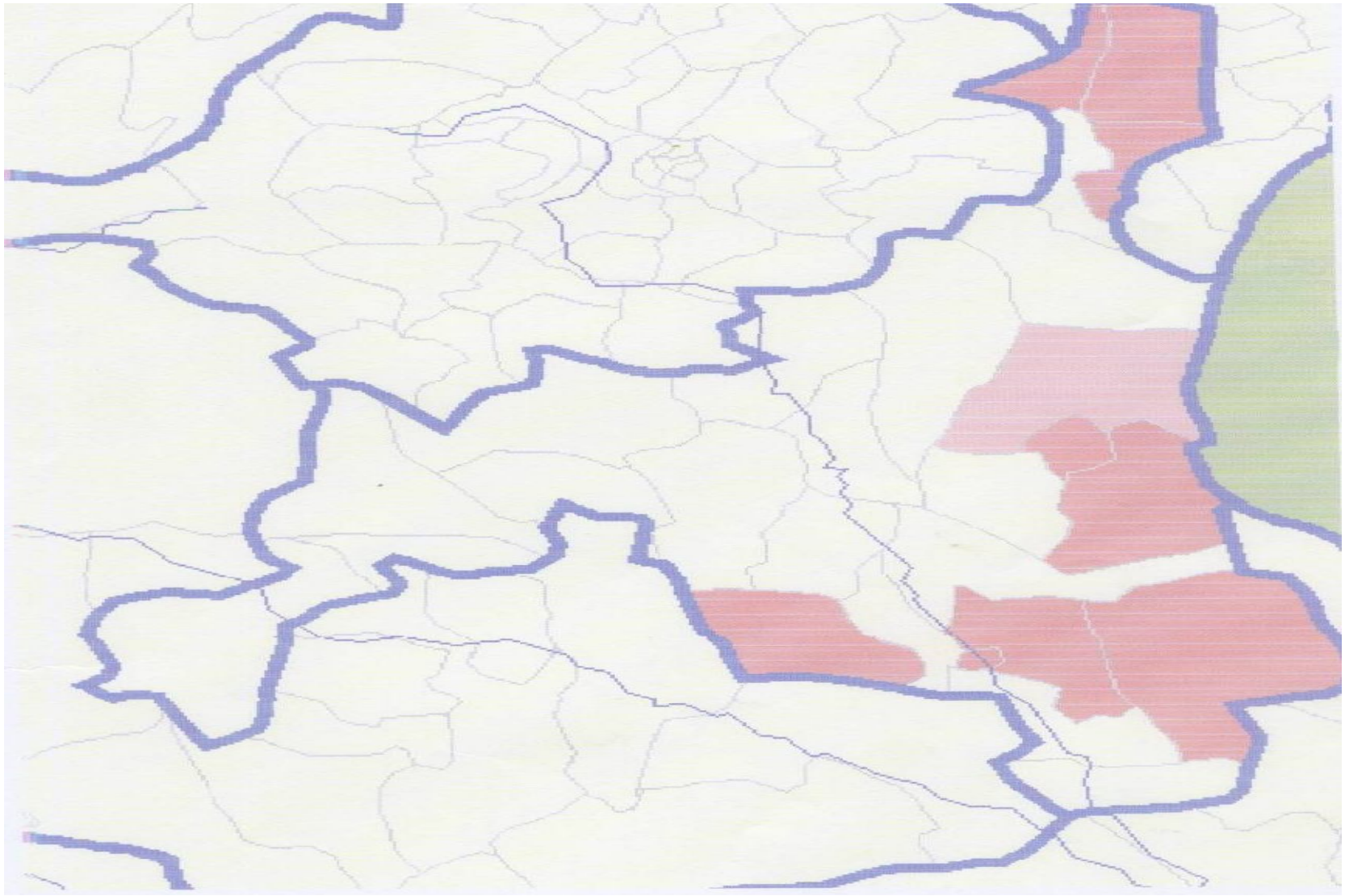
Indigenous cattle kept by pastoralists and exotic cattle kept by few farmers and government institutions were sampled. Using a multi-stage random sampling procedure, a total of 922 cattle were included in the study. Most of the exotic breeds were kept by several government institutions and progressive farmers for milk production or as breeding units for producing crosses with indigenous zebu breeds. Prior to tuberculin testing, all the cattle were serially numbered using oil based synthetic enamel paint applied at the back of the animal. The numbers were large and heavy enough that they were easily read for at least a week after application, the animals were clinically

examined, and data pertaining to the individual animals were collected. These data included the following information: identification number, location (village), breed, sex, pregnant or lactating for females.

Table 3.1 Study sites and sampled herds

Town	Location	No. of herds screened	No. of cattle screened
Hadejia	Hadejia	9	150
	Auyo	3	50
	K/Hausa	4	63
	Birniwa	5	100
Gumel	Gumel	5	70
	Maigatari	4	65
	S Tankarkar	2	60
	Gagarawa	5	61
Kazaure	Kazaure	3	63
	Yankwashi	7	90
	Roni	2	70
	Gwiwa	3	80
TOTAL	**12**	**52**	**920**

Figure 3.2 Map of Jigawa state showing study area



3.5 TUBERCULIN TEST

Cattle were subjected to the single comparative intradermal test (CIDT) as described by Monaghan *et al*. (1994). Briefly, 2500 I.U/ml; 0.1ml per dose each of bovine and avian purified protein derivatives (PPDs) obtained from Central Veterinary Laboratory, Weybridge, U.K, were injected in to the neck at least 12cm apart after shaving the sites. Readings of skin thickness were made prior to and 72 hrs after injection of the PPDs. Test results were, interpreted according to the German Tuberculosis Prescription (Fred *et al*., 2003). Three days (72 hrs) after injection, the site was measured again for swelling. When the swelling was equal to or less than 2mm, between 2mm and 4mm, and equal to or greater than 4mm the individual results were interpreted as negative, doubtful and positive, respectively. At herd level and because of the small size of herds, the result was interpreted as positive if at least one animal was diagnosed as positive.

3.6 PREPARATION AND ADMINISTRATION OF QUESTIONNAIRES

A questionnaire was prepared and administered to the fifty-two (52) households that kept cattle through spot visits. The questionnaires contained various questions on households, herd management system and history of TB in both cattle and humans were obtained from the herd owners and from respective community general hospitals. The head of the household was interviewed using a pre-designed questionnaire; questions were focused on determining the respondent's awareness about transmission of tuberculosis from cattle to humans and vice versa, habits of milk consumption and recent history of tuberculosis cases in the family.

3.7 INVESTIGATIONS IN MAN

To assess the importance of positive cases in relation to their potential risk for humans, investigation of people at risk, living in close contact their cattle was also envisaged. A questionnaire was therefore applied to selected households. In addition, the TB and Leprosy control Hospital at Hadejia which serves the whole state was visited to gather information on clinical cases of BTB in Man as well as to assess the diagnostic capacity for *M. bovis* infections.

Information about human cases of TB was obtained for a 4-year period, 2003-2006. Information was for all cases observed in the state, with a population of 4.3 million people. TB–cases were defined as patients with sputum positive to the presence of acid-fast Mycobacterium. Information obtained from case-records included individual characteristics such as location (village) age, sex, personal hygiene and nutritional status. The study also looked at social variables such as housing, and number of individuals in the house, smoking and clinical variables such as case type (new or recurrent), previous cases of TB in the family, and concurrent disease such as AIDS. Information about clinical symptoms (cough, fever, weight loss and pain in thorax) and final out come of the case (cure, quit treatment, death) was also obtained.

Risk factors were defined as follows: overcrowding, when 3 or more persons lived or sleep in a single room, the room size was estimated to be 2.2ft by 2ft, malnutrition, when the diet was considered poor in proteins and carbohydrates, poor housing when house building materials was leaves, grass and the floor was pure soils; Previous TB in the family, when the cases reported other cases in the family in the past; smoking, when the case reported smoking in the patient.

3.8 DATA ANALYSIS

The data obtained was entered into a personal computer. Analysis was done using *EPI INFO 2002 REVISION 2* statistical software. Herd level prevalence was computed as the number of herd with at least one–reactor cattle divided by the total number of herd tested. Fisher's exact test was used to analyze the variations between different factors. Odds ratio was used to assess the strength of associations of different factors to the occurrence of tuberculosis in humans. For the analysis of different risk factors on tuberculosis status of the animals, doubtful results were considered negative. P–Value of <0.05 was considered statistically significant.

CHAPTER FOUR

4.0 RESULTS

4.1 *M. bovis* infection in cattle for Hadejia, Gumel and Kazaure

Findings in comparative intradermal Test (CIDT) carried out in Hadejia, Gumel and Kazaure are shown in table 4.1. No confirmed case of *M. bovis* was found, due to lack of laboratory facilities for culture, identification and typing of the organism. All TB cases in man and animals are diagnosed as Ziel-Neelson positive, no any attempt to differentiate the species. However, few cases of cervical lymph node infections reported on the patient's records that are stated to be pathognomonic for *M. bovis* infections but none of these cases were confirmed by culturing.

4.2 *M. avium* group infections in cattle for Hadejia, Kazaure and Gumel

Table 4.2 indicates the prevalence of *M. avium* infection in the sample areas of the State. Gumel recorded the highest prevalence with 62%. This is followed by Kazaure Emirate 13.77% and the least was Hadejia with 19.85%. Abattoir records from the results obtained showed no available data on *M. avium* infection in all the study areas.

4.3 Risk factors for having Tuberculosis in the family

The study comprised 63.91% males and 36.10% females (n=435), and the proportion of households that drank milk were almost 100% in the study area. Milk was boiled by 66.67% before consumption. Of 435 households that drank milk, 89.19% preferred the milk soured or fresh.

The risk of TB in the family when sharing houses with livestock was higher than those not living with animals in the same house. The results of the questionnaires as indicated in Table 4.3, showed that among the households 273/435 (62.77%) were aware

of the disease in humans while 162/435 (37.23%) are unaware of the disease. In general, there was poor knowledge of the disease among the respondents.

Table 4.1 *M. bovis* infections in cattle for Hadejia, Gumel and Kazaure

Location	Total no. of animal in the area	No. of animals tested	No. positive (+)	Percentage (%) positive (+)
Hadejia	304,120	363	5	1.38
Gumel	72,135	256	2	0.78
Kazaure	23,082	303	3	0.99
Total	**399,337**	**922**	**10**	**1.08**

Table 4.2 *M. avium* group infections in Cattle for Hadejia, Kazaure and Gumel

Location	Total no. of animal in the area	No. of animals tested	No. positive (+)	Percentage (%) positive (+)
Hadejia	304,120	363	183	50.41
Gumel	72,135	256	127	49.61
Kazaure	23,082	303	216	71.29
Total	**399,337**	**922**	**10**	**57.05**

Table 4.3 Risk factors for having tuberculosis in family

Risk Factors	Yes	No	% (Yes)
Awareness			
Aware	273	162	62.76
Knowledge			
TB Symptoms	205	230	45.52
Can TB spread from animals to man?	198	137	47.13
Milk Consumption Habit			
Boiling	290	145	66.67
Souring	145	290	33.33
Others (Fresh)	243	192	55.86
Health Seeking Behaviour			
Seek Veterinary Assistance	175	260	40.23
Attempt to treat by owners	207	228	47.59
Cull	334	111	76.78
Slaughtering at home	297	138	68.28
Animals in the same House	257	178	59.08

Table 4.4 Demographic distribution of study population

Sample	No. of Respondent	Percentage (%)
Hadejia		
Hadejia	45	10.34
Auyo	30	6.90
K/Hausa	40	9.20
Birniwa	30	6.90
Gumel		
Maigatari	25	5.75
Sule-Tankarkar	15	3.45
Gagarawa	50	11.50
Gumel	55	12.63
Kazaure		
Kazaure	60	13.80
Yankwashi	30	6.90
Roni	30	6.90
Gwiwa	25	5.75
Occupation		
Cattle keeping only	46	63.91
Farmers and Cattle keepers	119	36.10
Sex		
Male	278	63.91
Female	157	36.10

Figure 4.1 Knowledge of Herd owners on Tuberculosis and its zoonotic character.

Herd owners knowledge in Hadejia, on TB in cattle was higher than in the other two Emirates. In Hadejia, 90/145 (62.07%) have the knowledge of the symptoms of the disease. This was followed by Gumel with 70/145 (48.285) and the least was Kazaure with 45/145 (31.03 %).

In Hadejia and Gumel, milk is boiled before consumption or taken to the market for sale while in Kazaure they don't boil milk rather they do souring.

The knowledge of transmitting the disease from animals to man or vice-versa was better in Hadejia 96/145 (66.21%) has this knowledge. This was followed by Gumel 54/145 (37.24 %) and the least was Kazaure 48/145 (33.10%).

4.4 Occurrence of Tuberculosis in Households/Herds in three Emirates of Jigawa State

Of the total number of herds visited, the number of positive cases in cattle was higher in Hadejia with 5/365 (1.37%), this was followed by Gumel 3/303 (0.99 %) and Kazaure had 2/254 (0.79 %) as shown from Table 4.5.

Among the households visited, the prevalence of the disease was highest in Hadejia 3/130 (2.31%), followed by Gumel 2/105 (1.91%) and Kazaure had 1/100 (1.00%). Comparing the number of cases in the herd with the number in the households there is no association between the occurrence of the disease in humans and cattle keeping.

Figure 4.1 Knowledge of Herd owners on Tuberculosis and its Zoonotic character

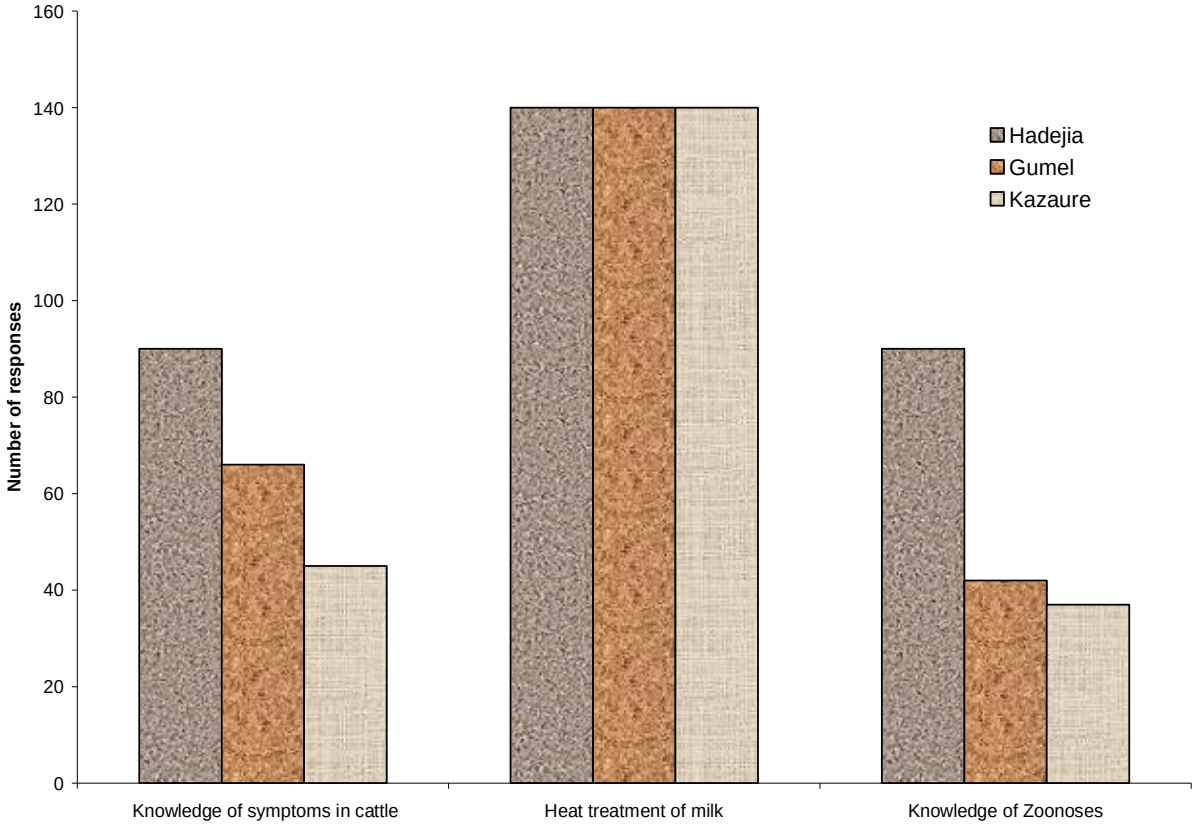


Table 4.4 Occurrence of Tuberculosis in Households/Herds in three Emirates of Jigawa State

Emirate councils	**Total number of herds**	**Total Number of households interviewed**	**Total number of positive cases in herds**	**Total number of positive cases in herds**	**Statistical Test**	**P – Value**
Hadejia	365	130	3 (2.31%)	5 (1.37%)	Fishers exact test	0.357
Gumel	303	105	2 (1.91%)	3 (0.99%)	Fishers exact test	0.386
Kazaure	254	100	1 (1.00%)	2 (0.79 %)	Fishers exact test	0.633
Total	**922**	**435**	**6**	**10**		

4.5 Prevalence and Age related differences (6months-4yrs and>4 yrs)

As indicated in Table 4.6, cattle in the age group > 4years recorded the highest prevalence with 6/417 (0.96%) while those in the age group 6months- 4 years had 4/505 (0.79 %).

4.6 Effect of Herd Size on the result of CIDT Test

The results in Table 4.7 showed that there is no association between herd size and CIDT test. Herd size having 10-50 animals had a prevalence of 7/750 (0.93%) while that with more than 50 animals recorded 3/172 (0.74%). In the number of reactors from the herds there is no significant difference in infection rate.

FIGURE 4.2 Distribution of cases by Malnutrition from 2003-2006

Figure 4.2 shows distribution of two variables (Malnutrition and No Malnutrition). Factors of malnutrition was highest among farmers, followed by students, housewife and the least was observed among civil servants.

Table 4.5 Prevalence of bovine TB and Age related differences (6months-4yrs and >4 yrs)

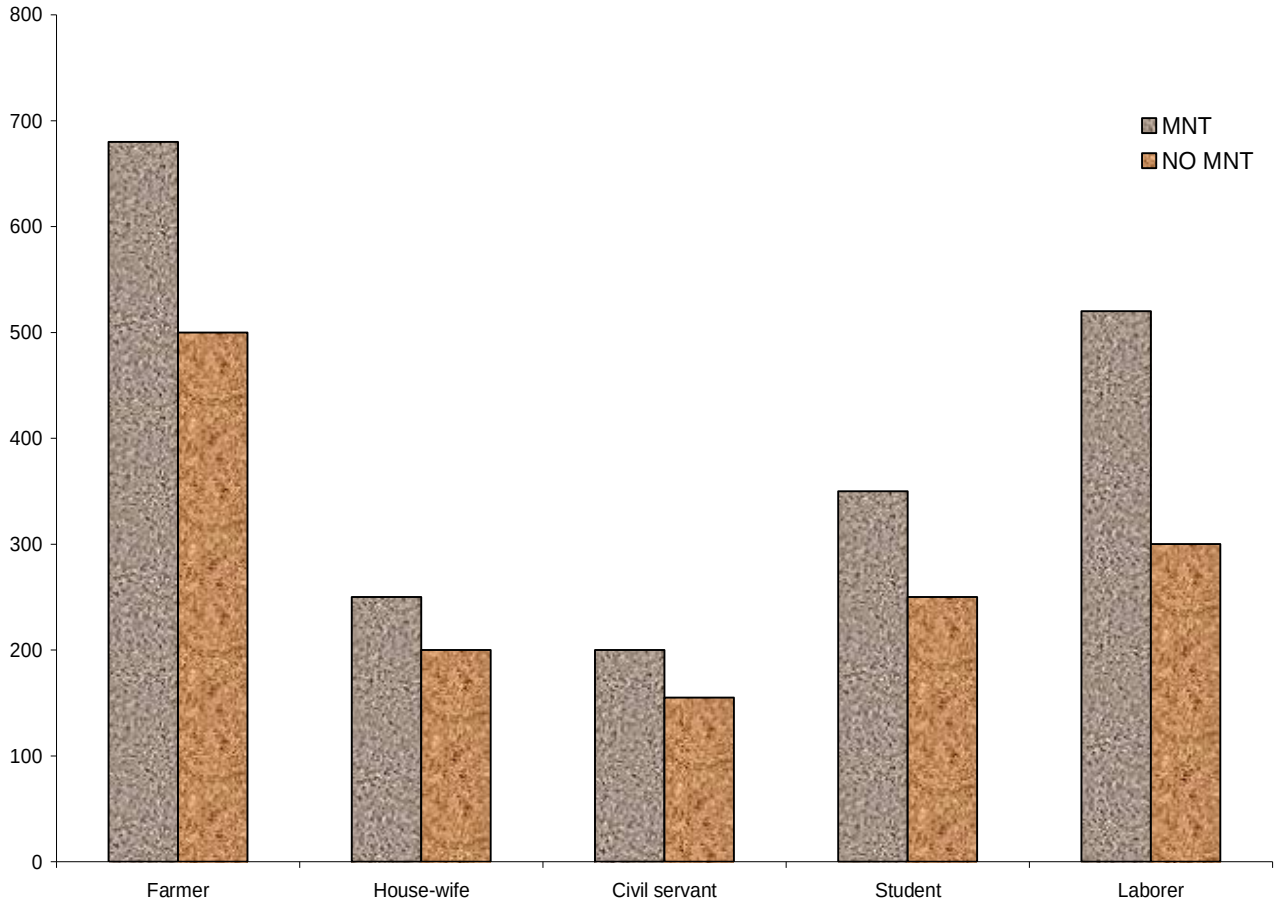
Age class	CIDT Positive	CIDT Negative	Total	Statistical Test	P-Value
6months-4yrs	4(0.79%)	501(99.21%)	505	Fishers exact test	0.265
> 4 yrs	6 (0.96%)	411(98.56%)	417		
Total	10	912	922		

*Doubtful reactors are considered negative in this study

Table 4.6 Effect of Herd Size on the result of CIDT Test

Herd size	No. of cattle Tested	CIDT Positive	CIDT Negative	P-value
10-50	750	7 (0.93%)	743(99.07%)	0.282
>50	172	3 (0.74%)	169(99.41%)	

Figure 4.2 Distribution of cases by Malnutrition from 2003-2006



4.8 Distribution of human TB cases by the most frequent observed clinical signs

From 3990 cases, it was found that 1341/3353 (39.99%) were new cases, and persistent coughing was by far the most frequent symptom among the patients 1676/3353 (49.99%) as indicated in Table 4.8. In all the five clinical signs observed from the patient's records, pains in the thorax had the least frequency 69/3353 (2.06%).

Figure 4.3 Distribution of cases of Human TB by final outcome (2003-2006)

From 340 cases, the ending-outcome information shows that 66.8% were cured while only 28.8% ended in death and only 4.4% abandoned treatment as indicated in Figure 4.3

Table 4.8 Distribution of human TB cases by clinical signs

	Symptoms						
Type of case	**Coughing**	**Fever**	**Hemopthysis**	**Weight Loss**	**Pain in thorax**	**All five**	**Total**
New	1341	804	302	634	54	218	3353
Recurrent	335	120	30	127	15	10	637

Figure 4.3 Distribution of cases of Human TB by final outcome (2003-2006)

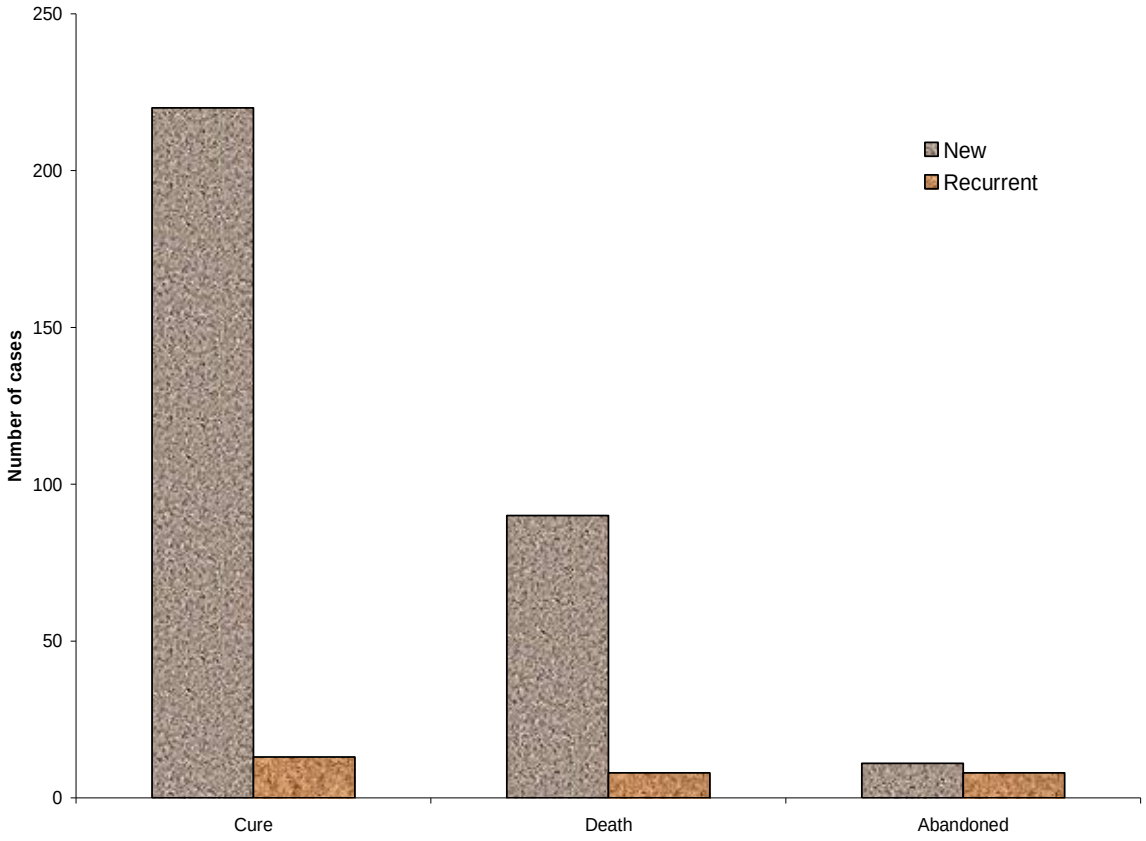


Figure 4.4 Distribution of Human TB by Occupation

Among cases for which information about occupation was available farmer, housewife and Laborers were the occupations most frequently reported (Fig 4.4).It is surprising that farmers are more affected, followed by laborers and the least were civil servants in terms of malnutrition.

Figure 4.5 Distribution of cases by type of TB and possible risk factors

In order of frequency, the most frequent type of TB as obtained in the patient's records was pulmonary tuberculosis. Those patients who were living in poor houses have the highest cases while those with concurrent infections with AIDS had the lowest frequency

Extra pulmonary cases were very little and those patients with overcrowding had the highest number of cases followed by people who suffering from TB and malnutrition.

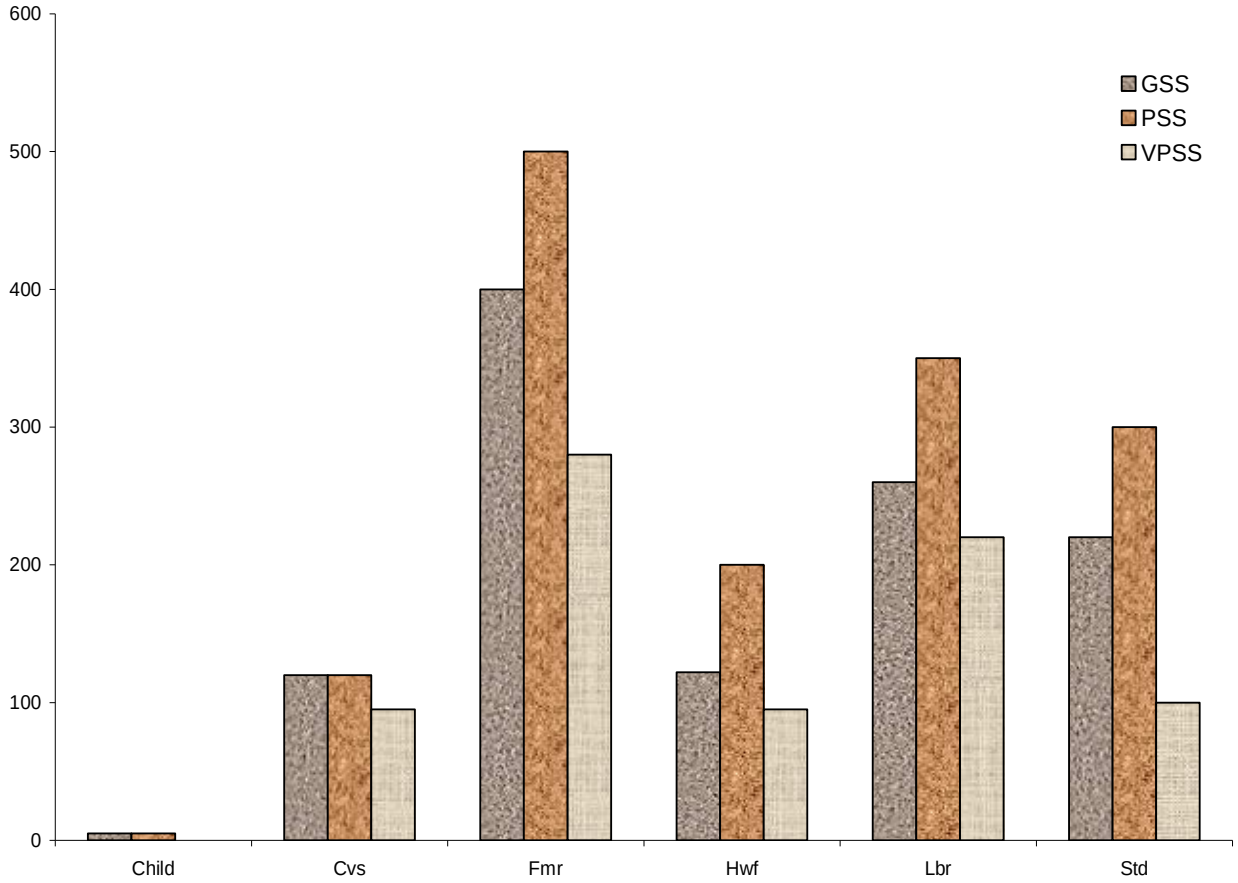
4.9 Risk factors by Sputum Test

Table 4.9 showed that were associations between all the risk factors (Sex, Overcrowding, Malnutrition, poor housing, Smoking and Type of TB) with sputum test in humans.

4.10 Risk factors affecting the reactivity of cattle to the tuberculin test in Jigawa State

Analysis of risk factors associated with the occurrence of the disease in this area (Table 4.12) revealed that the reactor rate among the age groups differ significantly ($p<0.01$), with older cattle affected than younger cattle and calves. The proportion of indigenous cattle reacting positively was significantly higher ($p<0.05$) than that of the exotic breeds. More male cattle were affected than females. There was no significant association between pregnancy and reactivity to CIDT, but significantly more lactating cows than non-lactating cows were positive.

Figure 4.4 Distribution of human TB by Occupation in Jigawa state (2003-2006)



Keys

GSS - Good Social Status

PSS - Poor Social Status

VPSS - Very Poor Social Status

CVS - Civil Servant

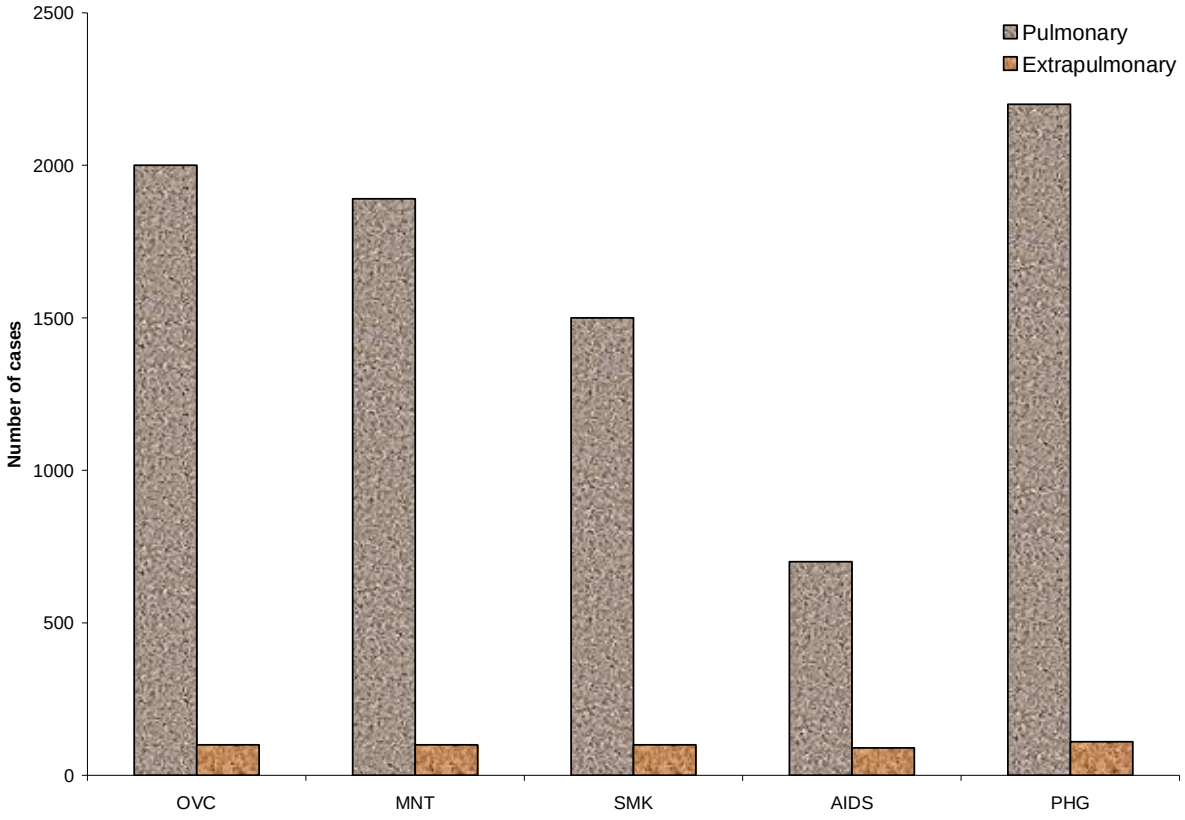
FMR - Farmer

HWF - House-wife

LBR - Labourer

STD - Student

Figure 4.5 Distribution of cases by type of Tb and possible risk factors



Keys

OVC - Overcrowding

MNT - Malnutrition

SMK - Smoking

AIDS - Acquired Immune Deficiency Syndrome

PHG - Poor Housing

Table 4.9 Risk Factors by Sputum Test

Factors	Odds Ratio	95% C.I	P-value
Sex			
Male	1.13	0.93; 1.38	<0.05
Female			
Overcrowding			
Present	1.12	0.74; 1.32	<0.05
Absent			
Malnutrition			
Present	1.01	0.85; 1.19	<0.05
Absent			
Smoking			
Present	1.02	0.87; 1.21	<0.05
Absent			
Housing			
Poor	1.13	0.95; 1.34	<0.05
Good			
Type of TB			
EPTB	4.29	1.92; 10.12	<0.05
PTB			

Table 4.10 Risk factors affecting the reactivity of cattle to tuberculin test in Jigawa State

Variable	No. of Reactors (%)	P-value
Age		
Calves <18month (n=150)	1 (0.67)	0.015
Cattle 1.5-3yrs (n=343)	0 (0.87)	
Cattle > 3yrs (n=427)	9 (1.4)	
Sex		
Female (n=639)	3 (0.46)	
Male (n=283)	7 (2.4)	0.012
Breed		
Exotic (n=72)	0 (0)	
Local (850)	10 (1.7)	0.442
Pregnancy		
Pregnant (n=153)	0(0.65)	
Non-pregnant (n=486)	10 (0.41)	0.039
Lactation		
Lactating (n=135)	8 (1.48)	
Non-lactating (n=1)	2 (0.20)	0.000

CHAPTER FIVE

5.0 DISCUSSION AND CONCLUSION

5.1 DISCUSSION

Of the 52 households and herds visited, 10 of the herds had animals suffering from tuberculosis, while 6 of the households had members with tuberculosis. This suggests that the disease is present in the state. The presence of the disease could be due to poor management practices and social habits, which allow easy transmission of the disease between animals and their keepers. High cost of veterinary care, seasonal availability of feeds with harsh climatic conditions, in addition to over whelming interest of farmers in size rather than the quality of their herd, contribute immensely to the poor management of herds as shown in this study. This invariably leads to increased exposure of the animals to the infection. Overcrowding also plays a great role in exposing individual to infection. This is because contact with infections tuberculosis means high risk of acquiring infection and developing the disease. The risk of acquiring TB infection both from animals and man increase with closeness (Maclntyre and Plant, 1998).

The observation that male animal had a higher chance of being positive than female animal was in consonance with the observation made by Markham (1952) but contrary to that of Shehu (1988) and may be related to the occupation of the male cattle. Male cattle are mostly used as oxen and therefore are kept in the herd for long in the herd thereby having more chances of being exposed to infection than female cattle. Similarly, female cattle have less frequent contact with other cattle except at grazing and watering point.

Although the current study did not classify lactating reactors according to stage of lactation a significantly higher ($p<0.05$) reactor rate was found among lactating than non-lactating animals. This observation is somewhat at variance with the finding of other studies (O" Reilly, 1987).

The observation that older cattle were found to be significantly more affected by bovine tuberculosis than young cattle is in agreement with other studies (Stamp and Wilson, 1946; Shehu, 1988). It has been argued that older cattle are positive to the tuberculin test mainly owing to increased chances of exposure rather than the slow progression of the disease (Stamp and Wilson, 1946). The preponderance of the disease among the older stock has an impact on the public health implication of the disease, because it is the older cattle that are normally disposed off for slaughter.

Majority of the household members of the herd visited, consume unpasteurized milk, which is a well-known source of infection. Consumers of unpasteurized milk and milk products are at high risk of being infected as they serve as the major vehicles/sources of infection. Milk sellers who are already infected with TB may contaminate the milk when coughing, thereby helping in the transmission of the disease (Shehu 1988).

Radostitis *et al*. (1994) indicated that Bos tarurus cattle are more prone to tuberculosis than are Bos indicus cattle. This conclusion conflicts with the results of the present study, where the exotic cattle appeared to be less affected by the .to the disease than indigenous cattle. However, this difference may have been caused by the management system rather than by breed variation. Shehu (1988) found that indigenous cattle kept under a nomadic management system were more affected than an intensive

management system and attributed the difference to the mixing of cattle from different herds and different geographical areas in the course of communal grazing.

The major finding in this study is the clinical and immunological low incidence of *M. bovis* infection the majority of the cattle population under investigation. This result was not expected since M. bovis infection are known to be endemic in cattle in other West African countries, like Ghana (Bonsu *et al*., 2000), Burkina Faso (Delafosse *et al*., 1995) and Nigeria (Alhaji, 1976). Moreover, no regular control measures are applied in the study areas.

When comparing the present findings with few historical data available, it appears that *M. bovis* infection in cattle seems to be low in Jigawa State. Alhaji (1976) reports that, knowleds (1958) reported that, out of the 45,572 cattle slaughtered at Maiduguri and Bornu provinces in 1955-57, only 12 cases of tuberculosis were diagnosed, thus confirming earlier reports of low prevalence of the disease in Northern provinces. Also in another study by Lindley (1959) puts infection rates, based on abattoir records at 7% in the southeast and 0.02% in the far north. Babalola (1974) reported that of 1,250 bovine carcasses examined at slaughter in 1974 in Bauchi, 122 (9%) had tuberculosis, which were Laboratory Confirmed. He also reported that 41.3% lesions submitted for laboratory examination proved to be norcardiosis.

When discussing the low prevalence of the infection in cattle in the presents study the phenomenon of anergy and high number of positive reaction to tuberculinisation using PPD *M. avium* in the survey in all the emirates have to be considered and may have epidemiological and diagnostic implications.

Anergy is a long recognized phenomenon in the tuberculin test, which results in false negative reactions. Recently infected cattle (<6 weeks), cattle under stress (malnutrition, gastrointestinal parasitosis and concurrent infections) and cattle with generalized severe tuberculosis are anergic (Ameni and Medhin, 2000; Lepper *et al*., 1977; Monoghan *et al*., 1994) and fail to react. Stress due to starvation (end of dry season) and concurrent infections like tick-borne diseases and high burden of gastrointestinal parasites are common in the study herds. In addition, about 30% of cattle in the peri parturient period can give false negative results returning later to a positive state (Blood and Radostis, 1989). The test is more efficient in medium or high-infected herds. In low infected population it is therefore recommended to repeat the skin test regularly or to use more sensitive test (e.g. Bovigam^{R} ELISA) to increase sensitivity.

Recent findings have shown that environmental infection with other Mycobacteria can influence the immune response to *M. bovis* to an unknown extent (Buddle *et al*., 2002; Vordermeir *et al*., 200). It is therefore assumed, that the unexpected low incidence of *M. bovis* in the study population may not reflect the true epidemiological picture. The phenomenon of interference of environmental infections with the classical infection pathway, explained by cross-immunity mechanism, has been well reported in humans (Black *et al*., 2002). The observed variation in immuno-responses to *M. tuberculosis* in man may reflect geographic variations in the exposure to environmental Mycobacteria, as it was reported recently by Black *et al*., (2002) comparing vaccinated populations in Malawi and UK. When tested with the specific antigen for *M. tuberculosis* (ESAT-6) in comparison with the PPD., a larger proportion of patient reacted positively to the PPD, a clear indication for exposure to environmental Mycobacteria. The role of the unspecific,

non-pathogenic Mycobacterial infections in the epidemiology of M. bovis was not known and may be very specific for West Africa. As described for *M. tuberculosis* (Black *et al*., 2002) and in consideration of the very close genetic similarity between M. bovis and M. tuberculosis, potential candidates for protective cross-immunity for *M. bovis* could be *M. intracellulare* and *M. marinum*.

The present study was conducted mostly on Zebu breed under traditional farming system. In herds considered as positive in this study, the numbers of positive reactors were low. The prevalence of BTB is influenced by breed of cattle and type of farming (intensive, semi intensive and extensive), housing and gathering of animals at grazing and watering areas. The fact that Zebu cattle are relatively resistant to BTB (Blood *et al*., 1995) substantiates the lower prevalence recorded by the present study. Furthermore, in the case of the traditional animal husbandry system found in Jigawa State animals are kept in open-air even at night which is expected to minimize the rate of transmission of *M. bovis*. In the study area, the structure of the herd (more animals above 5 yrs than young animals) may contribute to explain the apparently low prevalence of bovine tuberculosis. Many animals showed doubtful or non-specific reactors in high prevalence, this is due to close antigenic relationship between *M. avium* and *M. paratuberculosis*, cattle with clinical Johne's disease (caused by *M. paratuberculosis*) were found to react to avian tuberculin (Quinn *et al*., 1994). The other findings in this study may suggest the occurrence of Johne's disease in the study area. Nevertheless, clinical signs characteristic of Johne's disease, such as chronic diarrhea and emaciation, could not be statistically associated to non-specific reactors among the study animals. This corresponds with

earlier works done by Lindley (1959) and Johnson (1962) both reported the existence of Johne's disease in Nigeria.

Another assumption to explain non-specific reactors occurrence observed in Jigawa is the circulation of *M. avium* hold by poultry and possibly transmitted to cattle. Poultry keeping is commonly practiced in the study area; chicken were observed scavenging with cattle around houses. Clinical observations and postmortem examinations of poultry were not carried out in the study area albeit they could help to better understand the occurrence of the avian tuberculosis at the farm level; such searching should be implemented if further investigations are conducted in the study area.

Tuberculosis in humans presented an increasing pattern in the state for the period of 2003-2006. The increasing pattern of cases may probably be a reflection of the situation of the disease in the country. It is possible, however, that this trend is the result of the publicity given to TB in the last 10 years; more people are willing to report cases to the hospital for diagnosis of the disease. The decrease in the number of cases in 2006 was apparent because not all cases for that year had been collected at the time the study ended.

In relation to risk factors, overcrowding, malnutrition, poor housing and Previous TB in the family, four of the risk factors most frequently detected in case-records are indicators of poor social and economic status. This confirms that TB is a "low-class" disease. Improving living conditions has to be an important component in any program to reduce TB in human population. HIV/AIDS is a disease that compromises the immune system; therefore, it is not surprising that a large proportion of individuals have both AIDS and TB. If Mycobacterium persists longer in the environment, as a consequence of

more infected people or animals, the numbers of cases are expected to increase in response to a more susceptible population because of immune-compromising disease, thereby the importance of eliminating the disease from the environment.

Susceptibility to TB has been reported to increase with age (Sutherland Fayers, 1975). The finding of this study totally agrees with those reports that the number of cases of TB was larger in the older group. However, it can be noted here that, an increasing number of cases in older patients however it has been mention that the risk of developing TB is higher for adolescents and adults than among children.(Ferebee, 1974) but not age at infection has been clearly determined.

The findings obtained, showed that almost all the patients that reported to the hospital present themselves as farmers even those that are unemployed , hence the high level of frequency seen among that group.

From the acid-fast negative sputum samples cultured to double-check the results from the laboratories, samples were positive by culture these results are clear indication of the weakness of this diagnostic procedure. Misdiagnosing a sample as negative represents a serious risk for the general population. Efforts have to be focused on implementing more accurate diagnostic methods to reduce as much as possible the risk of spreading the disease to the susceptible population because of missing cases.

5.2 SUMMARY AND CONCLUSION

Bovine tuberculosis was detected in some herds in this survey, the knowledge of transmitting the disease from animals to man or vice-versa differs from one location to another. Herd owners in Kazaure emirate don’t boil milk before consumption. All TB

cases in man and animals are diagnosed as Ziel – Nelson positive, no any attempt to differentiate the species, therefore, none of these cases were confirmed by culturing.

Comparing the findings in this work, with previous study done in Nigeria, the prevalence seems low, but if left unchecked, it can be on the increase as there is no effort being done on the part of the government in the area of disease surveillance, control and prevention. It is hereby suggested that the following strategies for control and eradication should be employed in the state.

i. State – wide mass screening of cattle and identification of infected herds is required.

ii. Education of herdsmen on boiling milk before consumption, improvement of hygiene practices, sanitary measures and public enlightenment on TB is necessary.

iii. Test – and – slaughter policy is needed in very low prevalence areas.

Recommendations for further work

i. Further herds screening should be carried out in areas that were not involved in this study; this will help in providing a more comprehensive prevalence rate.

ii. Further studies should also be directed on the research on the influence of exposure to environmental Mycobacteria and their influence on the manifestation of M. bovis infection

REFERENCES

Acha, P.N., Szyfres, B. (1987). Zoonoses and Communicable.Washington. Pan American Health Organization/World Health Organization: Scientific Publication No.503.
Alhaji. (1976): Bovine Tuberculosis in four Northern States of Nigeria (Ph.D thesis) Ahmadu Bello University, Zaria, Nigeria.

Aliyu, M.M and Kalra, D.S (1993). Prevalence of tuberculosis in cattle slaughtered in Maiduguri abattoir. *Annals of Borno* 10:182-187.

Ameni, G, Medhin, G. (2000). Effect of gastrointestinal parasitosis on Tuberculin test for the diagnosis of bovine tuberculosis. *Journal of Applied Animal Research* 18 (2), 221-224

Anon, (1994). Framework for effective tuberculosis control. Geneva, Swutzerkabd: World Health Organization. 179 pp.

Ashford D.A, Whitney E, Raghunatan P. Cosivi O, (2001). Epidemiology of selected Mycobacteria that infect humans and other animals. In: Mycobacterial infections in domestic and wild animals. O.I.E, Revue Scientific et technique, Vol. 20 (1).

Ayanwale F.O. (1984). Studies on the Epidemiology of bovine TB in some states of Southern Nigeria .Unpublished Ph. D Thesis University of Ibadan, Nigeria, 184 pp.

Ayele, W.Y., Neill, S.D., Zinsstag, J. Weiss, M.G., Pavilik I. (2004). Bovine tuberculosis. An old disease but new threat to Africa. *International Journal Tuberculosis and Lung Disease*; 7:925-926.

Babalola, D.A. (1974). Diseases of thoracic organs Associated with Slaughtered cattle in Bauchi Abattoir, North West State, Nigeria. *Nigeria Veterinary Medical Association Annual Conference*; Port Harcourt.

Barrera, L., DE Kantor, I.N., (1987). Non tuberculous Mycobacteria and Mycobacterium bovis as a cause of human disease in Argentina. *Tropical and Geographical Medicine*: 39:222.

Balancou, J. Cheneau, Y (1974). Influence dela tuberculose sure le gain de poids de Zebus a'I' en grais' *Rev. Elev. Med Vet .Pay Trop*; 27:75-80.

Black, G. F., Weir, R.E., Floyd, S., Bliss, L., Warndoff, D. K., Crampin, A. C., Nigwira, B., Sichali, L., Nazareth, B., Blackwell, J. M., Branson, K ., Chaguluka, S.D., Donavan, L., Jarmen E., King, E., Fine, P.E.M., Dockrell, H.M. (2002). BCG induced increase in interferon- gamma response to Mycobacteria antigens an efficacy of BCG Vaccination in Malawi and the UK; two randomized controlled studies. *The Lancet* Vol. 359. April 20 2002.

Blood DC, Radostis OM, (1989) eds. Disease caused by Mycobacteria-IV. IN: veterinary Medicine 7th ed. London, UK: Bailliere Tindall; 7:710-740.

Blood, D.C., Gray, C.C. and Radostitis, O.M. (1995). Diseases caused by Mycobacterium Species. In Veterinary Medicine. A Textbook of the Diseases of Cattle, Sheep Pigs, Goats and Horses, 8th edition. Baillaire Tindall, Londo, PP. 80-838.

Bouvet, E. and Casaino, E.F. (1996). A nosocomial outbreak of Multi-drug resistant Mycobacterium bovis among HIV Infected Patients. A case control study. *AIDS* 7:1453-1460.

Buddle, B.M., Wards, B.J., Aldwell, F.E., Collins, D.M. DeLisle, G.W. (2002). Influence of sensitization to environmental Mycobacteria on subsequent vaccination against bovine tuberculosis. *Vaccine*, 20; 7-8, 1126-1133; 25.

Cadmus SIB, Olugasa B.O, Ogundipe GAT (1999): The prevalence and zoonotic importance of tubruclosis in Ibadan. In: Proceedings of the 36th Annual conference of the *Nigerian Veterinary Medical Association* Kaduna, 25th -31st October 1999,8-10.

Cook A.J.C., Tuchili, L.M; Buve, A., Foster, S.D; Goolfrey-Fausett, P., Pandy, G.S., McAdam, K.P.W.J (1996). Human and Bovine tuberculosis in the Monze district of Zambia: a cross-sectional study. *British Veterinary Journal*, 152:37-46.

Cousins D.V. (2001). Mycobacterium bovis infection and control in domestic livestock *Review of Science and Technology office of International Epizootic*. 71-85.

Collins, C.H., Grange, J.M. (1983). The bovine tubercle bacilli. Applied Bacteriology. 55:13-29.

Collins, D.M. (1999). DNA typing of Mycobacterium bovis strains from the castle point area of the Wairarapa. *Newzealand Veterinary Journal*. 47:207-209.

Collins H.C. and Grange, J.M. (1983). The Tubercle Bacillus: A Review of Journal of *Applied Bacteriology* 55:13 – 29.

Cosivi, O., Meslin, F.X., Daborn, C.J., Grange, J.M. (1995). Epidemiology of Mycobacterium bovis infection in animals and humans, with particular reference to Africa, *Review of Science Technology office International, Epizootic*, 14: 733-746.

Cosivi, O., Grange, J.M., Daborn C.J., et al., (1998). Zoonotic tuberculosis due to Mycobacterium bovis in developing Countries. *Emerging Infectious Diseases*; 4:59-70.

Daborn, C.J. and Grange, J.M.. (1993). HIV/AIDS and its implications for the control of animal tuberculosis. *British Veterinary Journal*. 149 405-417.

Daborn, C.J. (1992). Bovine tuberculosis in the tropics –a call to arms. In: Tacher G, Leteneur, L. eds. Proceedings of the Vllth international conference of the Institute of Tropical veterinary medicine. Yamousss Oukro, Cote d'lvoire: Institute of the Institute of Tropical Veterinary medicine. Yamouss Oukro, Cote d'lvoire: *Institute of Tropical Veterinary medicine*, 359-68.

Daborn, C.J., Grange, J.M., Kazwala, R.R. (1996). The bovine tuberculosis cycle-an African Perspective. *Journal of Applied Bacteriology*,149:405-417.

Danker, W.M., Wafaker, N.J., Essey, M.A., Moses, K. Thompson, M. and Davis, E.E. (1993). Mycobacterium bovis infection in Sandiego: a Clinicoepidemiological study of 73patients and a historical review of a forgotten pathogen. *Medicine* 72:11-39.

Dupon, M., Ragnaud, J.M. (1992). Tuberculosis in Patients infected with human immunodeficiency Virus infection. A retrospective multicentre study of 123 cases in France. *Quarterly Journal of Medicine* (New Series 85); 306:719-30.

Dusai D. HM, Abdullahi DA. (1994). Current Status of bovine TB at Sokoto abattoir. *Tropical Veterinarian*. 12, 134-137.

Edelstein, R.M. (1995). Tuberculosis in cattle in Africa Control Measures and implications for human health. Proceedings of the international conference held at the *International Livestock Research Institute* (ILRI). 25-31. Addis Ababa, Ethiopia.

Fasanmi, E.F. (1977). The increasing importance of Zoonoses in some Countries. *Nigerian Veterinary Journal*. 6:5 10.

Ferebee, S.H., (1970). Controlled chemoprophylaxis studies in tuberculosis ; a general review, *Advanced Tuberculosis Research* 17: 28-106.

Food and Agricultural Organization (1993). Production Vol. 47 Rome: Food and Agricultural organization of the United Nations. FAO Statistic Series No. 117.
Francis J. (1947). Bovine tuberculosis including a contrast with human tuberculosis. London, UK; Staples Press Ltd, 220pp.

Fred, U; Susanne, M, Alphonse, G; Correia, N.P. Mamady, K. (2003). Risk associated with *Mycobacterium bovis* infections detected in selected study herds and slaughter cattle in 4 Countries of West Africa. *International. Trypanotelorance Centre*, Banjul, Gambia.

Gervois M, Vaillant, J.M. Fontaine J.F., Laroche, G., Dubois, G. (1974) Epidemiologie, de infection humaine par *Mycobacterium bovis*. Archivio Monaldi per latisiologia ele Malattie dell apparato respiratorio. 27:294-317.

Grange, J.M., Yates, M.D., de Kantor, I. (1996). Guidelines for speciation within the Mycobacterium tuberculosis complex. 2nd ed. Geneva: World Health Organization; Unpublished Document WHO/EMC/Zoo/96.4.

Grange, J.M. (1996). The future and the challenge. Mycobacteria and human disease and ed. London, U.K: *Arnold*, 2:7-10.

Grange, J.M., Yates, M.D. (1994): Zoonotic aspects of Mycobacterium bovis infection, *Veterinary Microbiology*. 40.137-51.

Guerero, A., Cobo, J., Fortun, J., et al., (1997). Nosocomial transmission of *Mycobacterium bovis* resistant to 11 drugs in people with advanced HIV-1 infection. *Lancet*, 350:1738-1742.

Gordon, S.V., Heym, B., Parkhill, J., Barrell, B., Cole, S.T. (1999). New insertion sequences and a novel repeated sequences in the genome of *Mycobacterium bovis* H37Rv. *Microbiology*,145:881-892.

Groscheal, M.H.D. (1982). The Etiology of Tuberculosis. A tribute to Robert Koch on the occasion of the Centenary of his discovery of the tubercle bacillus: *American Society for Microbiology News*: 48:248 – 250.

Hall G.N (1932): Tuberculosis in cattle its occurrence in Northern Nigeria. *Veterinary Journa*l. 88,327-331.

Hoffner, S.E., Hjelm, U., Kallenius, G., (1993). Susceptibility of *Mycobacterium malmoenense* to antibacterial drugs and drug-combinations. *Antimicrobial Agents Chemotherapy*, 37:1285-1288.

Houde C, Dery P. (1988). *Mycobacterium bovis* sepsis in an infant with human immunodeficiency virus infection. *Pediatric Infectious Disease Journal*, 7:810-2.

Idigbe, E.O., Anyiwo, C.E., Onwujekwe, D.I. (1986). Human Pulmonary infections with bovine and atypical Mycobacteria in Lagos. *Nigeria Journal of Tropical Hygiene*, 89;143-148.

Idrisu, A., Schnurrenberger, P. (1977). Public health Significance of bovine tuberculosis in four northern states or Nigeria: a Mycobacteriologic Study. *Nigerian Medical Journal* 7:384-7.

Jigawa Agricultural and Rural Development (2000). Diagnosis of Jigawa Agriculture, *Institute for Agricultural Research*, Ahmadu Bello University, Zaria 5,215-218.

Jiwa, S.F.H., Kazwala, R.R., Aboud, A.A. O., Kalaye, W.J., (1997). Bovine tuberculosis in the Lake Victoria Zone of Tanzania and its possible consequences for human health in the HIV/AIDS era. *Veterinary Research Communication*, 21:533-539.

Johnson, R.H. (1962) A note on Johne's disease in Nigeria. Bulletin of Epizootic Disease in Africa. 10:507-510.

Keet D.F., Kriek NPJ, Penrith ML, Michel A, Huchzermeyer H. (1996). Tuberculosis in buffaloes (syncerus caffer) in the Kruger national park: Spread of the disease to other species. *Onderstepoort Journal Veterinary*, 63:239-244.

Kazwala, R.R., Daborn, C.J., Kusiluka, L.J, Jiwa, S.F., Sharp, J.M; Kambarage, D.M. (1998). Isolation of Mycobacterium species from raw milk of pastoral cattle of Southern Highlands of Tanzania. *Tropical Animal Health Production*, 30:233-239.

Kubica, G.P., Clinical Microbiology. In; Kubica GP, Wyne I.G, (1984). eds. The Mycobacteria, a Source book, part A. New York, NY: Marcel Dekker, 680 pp.

Kamerbeek, J., Schools, L., Kolk, A., et al., (1997). Simultaneous defection and strain differentiation of Mycobacterium bovis for diagnosis and Epidemiology. *Journal of Clinical Microbiology*, 35:907-914.

Kallenius, G., Koivula, T., Ghebremichael, S., et al., (1999). Evolution and clonal traits of Mycobacterium bovis complex in Guinea-Bissau. *Journal of Clinical Microbiology*, 37:3872-3878.

Kidane, D., Olobo, J.O., Habre, A., et al., (2002.). Identification of the causative organism of tuberculous lymphadenitis in Ethiopia by PCR. *Journal of Clinical Microbiology*, 40:4230-4234.

Ledru, E., Ledru, S., Zoubga, A. (1999). Granuloma formation and tuberculosis transmission HIV/-infected patients. *Immunology Today*, 20:336-337.

Lepper, A. W.D., Pearsono , C.W., Corner, L.A., (1977). Anergy to tuberculin test in beef cattle. *Austrailian Veterinary Journal*, 53, 214-216.

Lesslie, I.W., Hebert, C.N and Freridis, G.W.(1996). Practical applications of bovine tuberculin PPD in testing cattle in Great Britain. *Veterinary Record*. 98:170-172.

Lindley, E.P (1959) Bovine Tuberculosis in Nigeria. West. African Medical Journal. III: 266-271. Malin A.S., Young D.B. Designing a vaccine for tuberculosis. Unraveling the tuberculosis genome can we build a better BCG? *British Medical Journal* 1996; 312: 1495.

Malin, A.S. and Young, D.B. (1996). Designing a vaccine for tuberculosis. Unraveling the tuberculosis genome can we build a better BCG? *British Medical Journal*. 312:1495.

Mellroy, S.G., Neill, S.D., Mccracken, R.M., (1986). Pulmonary –lesions and *Mycobacterium bovis* excretion from the respiratory –tract of tuberculin reacting cattle. *Net Record*, 18:718-721.

Markham, A.E.G., (1952). Bovine tuberculosis in the Southern Highlands Provence of Tanganyika. Ph.D thesis, University of London.

Mposhy, M., Binemo-Madi, C., Mudakikwa, B. (1983). Incidence de al tuberculose bovine sur la santedes populations du Nord-Kivu (Zaire). *Review of Medical Veterinary Parasitology Tropical*. 36:15-8.

Nafeh, M.A., Medhat, A., Abdul-Hameed, A.G., Ahmad, Y.A., Rashwan, N.M., Strickland, G.T. (1992). Tuberculous Peritonitis in Egypt: The Value of laparoscopy in diagnosis. *American Journal of Tropical Medical Hygiene*. 47:470-7.

National Research Council, (1994). Livestock disease eradication: evaluation of the cooperative state-Federal Bovine Tuberculosis Eradication Program. Washington. National Academy Press.

Neill, S.D., Pallock, J.M., Bryson, D.B. and Hanna, J. (1994). Pathogenesis of *Mycobacterium bovis* infection in cattle. *Veterinary Microbiology*. 40 (1/2): 41-52.

Neill, S.D., Cassidy, J. and Hanna, J. (1994). Detection of *Mycobacterium bovis* infection in skin test negative cattle with an assay for bovine interferon-gamma. *Veterinary Records*, 135:134-135.

O'Reilly, L.M., Daborn, C.J. (1995). The epidemiology of Mycobacterium bovis infections in animals and Man: a review. *Tubercle and Lung disease*, 76 (Suppl 1) 1-46.

O' Reilly, L.M., (1987). Laboratory studies on tuberculous cows to determine to determined the influence of parturition and puerperium on the intradermal tuberculin response. In: Proceedings of the Scientific Meeting of Tuberculosis in Animals of the *International Union Against Tuberculosis and Lung Diseases*, Paris.

Pavlik I, Machackova M. Ayele WY, (2002). Incidence of bovine tuberculosis in wild and domestic animals other than cattle in six central European countries during 1990-1999, *Veterinary Medical Czech*; 47: 122-131.

Pallock, J.M., Neill, S.D., (2002). Mycobacterium bovis infection and Tuberculosis in cattle. *Veterinary Journal*. 163:115-127.

Pritchard, D.G (1988). A century of bovine tuberculosis 1888-1988. Conquest and controversy. *Journal of Comparative Pathology*. 99:357-397.

Quinn, P. J., Carter , M.E., Markey, Y.B., and Carter, G.R., (1994). Clinical Veterinary Microbiology, Mosby Year Book Europe Ltd. London, 156-169.

Raviglione, M.C, Snider, D.E., Kochi, A., (1995). Global epidemiology of tuberculosis. *Journal of American Medical Association*, 273:220-6.

Rigouts, L., Maregeya, B., Traore, H., Collart, J.P., Fissette K., Portaels, F., (1996). Use of DNA restriction fragments typing in the differentiation of *Mycobacterium bovis* complex isolates from animals and humans in Burundi. *Tubercle lung Disease*, 77:264-268.

Rastogi, N., Legrand, E., Sola, C. (2001). The Mycobacteria. An introduction to nomenclature and pathogenesis. Review of Science and Technology Office of *International Epizootic*. 20:21-54.

Rasolfo-Razanam parany, V., Menard, D., Rasolona Valona, T., et al., (1999). Prevalence of *Mycobacterium bovis* in human pulmonary and extra-pulmonary tuberculosis in Madagascar. *International Journal of Tuberculosis and Lung Disease*, 3:632-634.

Roring, S; Brittain, D., Bunschoten, A.E., et al., (1998). Spacer-oliog typing of *Mycobacterium bovis* isolated compared to typing by restriction fragment length polymorphism using PGRS, DR and IS6110 probes. *Veterinary microbiology*, 61:111-120

Schelling, E., Diguimbaye, C., Daoud, S. (2000). Zoonoses in nomadic populations of chad-prelininary results obtained in humans and livestock. In: Salman M.D., Paul S. Ruch-Gallie R, eds. Proceedings of the 9th conference of the *International society of veterinary Epidemiology and Economics*, 6-11. (Abstract N0 396).

Shehu, L.M., (1988.). Survey of Tuberculosis and Tubercle Bacilli in Fulani herds, "nono" and some herdsmen in Zaria Area, Nigeria. M.Sc Thesis, Ahmadu Bello University Zaria.

Snedecor, G.W. and Cochran, W.G. (1980). Statistics Methods. 7th edition Iowa State university press. Ames.

Stamp, J.T, and Wilson, A. (1946). Some aspect of pathogenesis of bovine tuberculosis based on abattoir returns. *The Veterinary Records*. 58, 11-15.

Sundre, P., Ten Dam, G. and Kochi, A (1992). Tuberculosis. A global over view of the situation today. Bulletin of World Heath. Organisation. 70:149-159.

Sutherland, I. and Fayers P.M., (1975). The association of the risk of infection with age. *Bulletin of International Union Tuberculosis*. 50;71-81.

Sjogren, I., Hillerdal, O. (1997). Bovine tuberculosis in Man-re infection or endogenous exacerbation. *Scandinavian Journal of Respiratory Disease*. 59:167-170.

Skuce, R.A., Brittain, D., Hughes, M.S., Neill, S.D. (1996). Differentiation of Mycobacterium bovis isolates from animals by DNA typing. *Journal of Clinical Microbiology*, 34:249-2474.

Thoen, C.O., Steel, J.H., (1995). eds. *Mycobacterium bovis* infection in animals and humans. Arnes, 1A: lowa Sate University Press; 355 pp.

Thoen, C.O; Himes E.M., (1986). Pathogenesis of Mycobacteirum bovis infection. Programme of Veterinary Microbiology. *Immunology*, 2:198-214.

Torning, K., (1965). Bovine tuberculosis. *Disease of the Chest*, 50:241-246.

Ugochuckwu, E.I and Nwaneri, B.C (1984). Analysis of Common diseases of livestock in Ibadan (1975-1982) *Nigerian Veterinary Journal* 13:43-45.

van Sooligen, D., Hoogenboezem, T., De Haas, P.E.W. et al., (1997). A novel pathogenic taxon of the Mycobacterium bovis complex, *M. canetti*. Characterization and exceptional isolate from Africa. *International Journal of Systemic Bacteriology*, 47:1236-1245.

van Embden, J.D.A, van Gorkom, T., Kremer, K., Jan Sen, R., Vander Zeijst, B.A.M. Schouls, L.M. (2000). Genetic variation and evolutionary origin of the direct repeat locus of *Mycobacterium bovis* complex bacteria. *Journal of Bacteriology*, 182:2393-2401.

Vekemans, M., Cartous, M., Diagbouga, S., et al., (1999). Potential source of human exposure to Mycobacterium bovis in Burkina Faso, in the context of the HIV epidemic. *Clinical Microbiological Infection*. 5:617-621.

Vordermeir, H.M., Whelan, A., Cockle, P.J., Palmer N., Hewinson, R.G. (2001). Use of synthetic peptides derived from the antigens ESAT-6 and CFP-10 for differential diagnosis of bovine tuberculosis in cattle. *Clinical and diagnostic Laboratory Immunology*. 8: 3, 571-578;57.

Walshe, M.J; Grindel, J, Nell, A., Bachmann, M., (1991). Dairy Development in Sub-Saharan Africa. Washington DC: World Bank. African Technical Dep. Series, World Bank Technical Paper No. 135.

World Health Organization. Third Report of the Joint FAO/WHO expert Committee on Zoonoses. Geneva: The organization; 1967 *Technical Report Series* No. 378.

World Health Organization (1990). Tuberculosis Fact Sheet 14, Geneva.

World Health Organization Report (2002). Global Tuberculosis Control, Surveillance, Planning and Financing. WHO/CDS/TB/2002.

Wray, C., (1975) Survival and spread of pathogenic bacteria of veterinary importance within the enviroment. *Veterinary Bulletin*. 45:543-550.

Whipple, D.L., Bolin, C.A., Miller, J.M (1996). Distribution of lesions in cattle infected with Mycobacterium bovis. *Journal of Veterinary Diagnostic Investigation*. 8:351-354.

Zumal A, Squire SB, Chintu C, Grnage JM. (1999). The tuberculosis pandemic. Implications for health in the tropics. *Trans Royal Society of Tropical Mediccal Hygiene*. 93:113-117.

APPENDIX

EPIDEMIOLOGY OF HUMAN AND BOVINE TUBERCLOSIS IN JIGAWA STATE

QUESTIONAIRE

INFORMATION REQUIRED

1. Location ----------
2. Total number of Cattle ----------
3. Number of Animals ----------
4. Do you raise cattle together with (i) Other livestock Yes ( ) No ( )
   (ii) Chicken Yes ( ) No ( )
5. Do you slaughter animals at home Yes ( ) No ( )
6. If yes (5) are the animals inspected for disease Yes ( ) No ( )
7. Do you boil milk before consumption Yes always ( ) Yes Sometimes ( )
   No ( )
8. If yes (7) how do you do it: Boiling ( ) Souring ( ) Any other ( )
9. What do you do when you suspect that an animal is infected with TB
   Attempt to treat by owner ( ) Seek Veterinary attention ( ) Cull ( )
10. Total number of people in the households ----------
11. Any member of the household with TB? 1 ( ) More than 2 ( ) None
12. Are they aware of the clinical signs/ symptoms associated with TB (e.g.
    cough, emaciation, nodular lesions etc)
13. In case cows showing symptoms is she milked for human consumption.