ECONOMIC IMPACT OF BOVINE BRUCELLOSIS IN NIGERIA

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To my wife, Lydia, with love.

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ABSTRACT

Bovine brucellosis is reported to be endemic in Nigeria with a high prevalence in government ranches. The exact economic and public health impacts are yet to be assessed. The influence of extensive husbandry and herd size on the transmission of brucellosis are considered. The implications of brucellosis in the livestock development strategies of Nigeria are discussed and the hazards associated with dairy developments highlighted. Limited vaccinations in addition to extensive education and hygiene are reviewed as options for control.

A representative pilot survey of brucellosis is proposed to evolve the most cost effective policy for a brucellosis control programme in Nigeria.

CHAPTER ONE

INTRODUCTION

Bovine brucellosis (Bangs disease), contagious abortion of cattle is caused by Brucella abortus. The disease is characterised by abortion in late pregnancy with a reduction in productivity of infected herds. The importance of bovine brucellosis is primarily due to economic losses in the livestock industry in the form of loss of calves through abortions, decline in milk production and infertility due to repeat breeding. Brucellosis is an occupational hazard and is transmitted to man by the intake of unpasteurised milk and milk products and contact with infected animals.

Bovine brucellosis is widespread and is of major socio-economic importance in countries where the livestock industry is intensively managed. Its impact in developing countries remains to be assessed.

The disease is reported to be endemic in Nigeria with a varied geographical distribution. The prevalence of the disease is higher in valuable animals kept on government ranches and Livestock Investigation and Breeding Centres (LIBCs) but reported to be low in nomadic and semi-nomadic herds (Esuruoso, 1979; Eze, 1982). The government, LIBC and ranches are important nuclei of livestock production in Nigeria from which improved breeds are sold to farmers. Milk from such parastatal farms is supplied to nearby urban centres. The high reported infection rate of brucellosis in the government farms may not reflect the infection rate in cattle kept more extensively. Hence the exact prevalence of the disease in the national herd and the economic losses are not known.

Other than the report of Collard (1962b) of brucellosis infection rates among healthy people associated with livestock, little is known about the impact of the disease on public health in Nigeria. However, many people take unpasteurised milk and milk products and the potential hazard is clear.

This study reviews the status of bovine brucellosis in Nigeria, its effects on livestock productivity and public health. The possible implications of the disease in the livestock development programmes are discussed. Options for control based on the present known status of brucellosis and the uniqueness of the livestock production systems in Nigeria are reviewed. A proposal for the evaluation of the disease in Nigeria is made.

CHAPTER TWO

REVIEW OF THE STATUS OF BOVINE BRUCELLOSIS IN NIGERIA

2.1 Epidemiology

Bovine brucellosis is caused by Brucella abortus and is characterised by abortion in late pregnancy, retained placenta and metritis with a subsequent reduction in fertility due to increased calving interval, repeat breeding and hygroma which may cause lameness. The male may have orchitis and epididymitis. The incidence of brucellosis varies in distribution within individual countries and among different types of husbandry systems.

The disease is of major zoonotic importance causing undulant fever in man. With the exception of laboratory acquired infections, every human case has an animal origin. No documented lateral spread among humans has ever been reported (FAO/WHO, 1971; Alton, 1974; Hungerford, 1973).

2.1.1 Aetiology and reservoirs

Aetiology: Brucella abortion is host specific primarily to cattle and water buffaloes and does not readily transfer to other animals (Alton, 1974). Natural infections in cattle with Brucella species other than Br. abortus are rare (Nicoletti, 1980).

Reservoirs: Br. abortus occurs naturally in sheep and goats exposed to infected cattle and the disease can be produced experimentally. The natural occurrence of the disease in sheep and goats in association with infected cattle has significant implications

for brucellosis eradication (FAO/WHO, 1971; Blood, Henderson and Radostits, 1983). Dogs are reported to be mechanical and biological carriers of Br. abortus. FAO/WHO (1971) reported that recent work had demonstrated that dogs can transmit Br. abortus to cattle. Br. abortus occurs in deer, moose, camels, bison and horses but there is no evidence of them being a source of infection to cattle (Blood et al., 1983). Many non bovine species such as the hippopotamus and water buck are reported as hosts for Br. abortus. Infection in these animals is not common and clinical symptoms are infrequent (Nicoletti, 1980). Br. abortus agglutinins have been detected in the sera of African bovidae, such as eland, impalas, gazelles and wildebeests but isolation of brucella organisms has never been reported (FAO/WHO, 1971). Nicoletti (1980) suggested that in the wild African buffalo transmission of Br. abortus may occur to and from cattle.

2.1.2 Mechanisms of transmission

Cattle: Brucella abortus organisms are most concentrated in the gravid uterus, the fetus and fetal membranes of infected cows hence these are major sources of infection. Excretion of viable organisms occurs mainly around parturition or abortion and afterwards until involution of the uterus occurs. Excretion in the milk is a source of infection for calves (Blood et al., 1983). Cows may excrete intermittently for months, even years. Ingestion is considered the most common means of transmission and occurs at grazing or during consumption of feed and water contaminated by aborted fetuses and fetal membranes from infected cows. On ingestion,

Br. abortus readily penetrates via the oral mucosa and tonsils (Blood et al., 1983). In addition to the primary route of transmission other routes are inhalation, conjuctival exposure and direct skin penetration. Other less common routes are the intramammary inoculation during milking and reproductive tract (Nicoletti, 1980; Stableforth, 1960).

Infected bulls whose semen have brucella organisms rarely transmit infection at coitus but infection by artificial insemination may occur when semen is deposited in the uterus (Madden, 1984).

The spread of brucellosis from one herd to another and from one place to another is almost always due to the movement of infected animals. The trend towards larger herd size results not only in a greater probability of infection but also in a higher prevalence and greater difficulty in eliminating the disease (Meyer, 1982). This is due to the increase in the exposure potential of herds to brucellosis (Brinley-Morgan, Mackinnon, Lawson and Cullen, 1969; Nicoletti, 1980).

Infection of man: The usual vehicles of infection to man are unpasteurised milk and milk products such as butter and cheese. Vegetables contaminated by infected animal faeces and urine and infected sources of drinking water are additional pathways of infection to man. Contact with brucellae from vaginal discharges, fetuses and placentas is of particular importance among high risk occupational groups such as veterinarians, herdsmen, abbatoir and dairy workers (Thimm, 1972; Madden, 1984). Infection in humans can also be contracted by inhalation and through accidental inoculation. However,

Bothwell (1960) emphasized unpasteurised milk as the major source of infection to man when he demonstrated that 70% of cases of human brucellosis in England were contracted from consumption of raw milk.

Survival of Brucella organisms: The ability of Brucella organisms to survive in aborted materials allows indirect transmission to take place quite readily. Brucella organisms are susceptible to heat, sunlight and standard disinfectants. They are killed by boiling for a few seconds and by pasteurisation. Sunlight kills them in a few hours. However, Siegmund (1979) reported the isolation of brucellae from fetuses and manure that had remained in a cool environment for more than two months. In a hot environment however, the brucella organisms may not survive for more than three days (Edelsten, 1984).

2.1.3 Incubation period and latency

The incubation period is the period from exposure to infection to the time at which clinical or serological evidence indicates that infection has occurred. The period varies and is affected by several factors such as gestation, exposure dose, vaccination status and other unknown host resistance influences (Nicoletti, 1980). The length of incubation is inversely proportional to the stage of fetal development at the time of exposure (Brinley-Morgan et al., 1969), a range of 53-251 days is reported (Thomson, 1950; cited by Brinley-Morgan et al., 1969).

The variable incubation period and the difficulties of diagnosing infection until after serological or clinical manifestations

have occurred are among the most serious technical problems in the control of brucellosis (Brinley-Morgan et al., 1969; Nicoletti, 1980). The exposure dose is of particular importance hence the need for hygiene even with vaccination as a control measure (Stableforth, 1960).

Calves may acquire infection in vitro or by ingestion of contaminated milk but remain negative serologically until sexually mature or pregnant at which time they abort or have an infected calving during the first pregnancy. This type of infection in calves is referred to as latent infection (Nicoletti, 1980; Madden, 1984). However, in general, young calves do not retain infections. Wilesmith (1978) after a thorough epidemiological study estimated that only 2.52% of heifers born to serologically positive dams reacted in early adulthood and constituted a risk to established herds as replacements.

Bull calves tend to be susceptible at a younger age than heifers but infertility is not a normal sequel (Rankin, 1966).

2.1.4 Chronic carrier stage and excretion

Excretion of large numbers of organisms takes place at the time of parturition or abortion. The number of organisms decreases rapidly when the fluids and membranes of gestation disappear. Most cows abort once, then the disease enters the chronic carrier stage which is clinically symptomless. However, organisms may be harboured in supramammary lymph nodes and the udder with intermittent excretion in milk. The cow does not usually excrete organisms from the genital tract until the succeeding gestation. During this subsequent pregnancy

she may or may not abort but she will often be infectious at the time of early or normal calving (Nicoletti, 1980). This chronic carrier stage exists almost indefinitely in most animals. Ten to fifteen per cent of infected cows are reported to spontaneously recover (Brinley-Morgan et al., 1969).

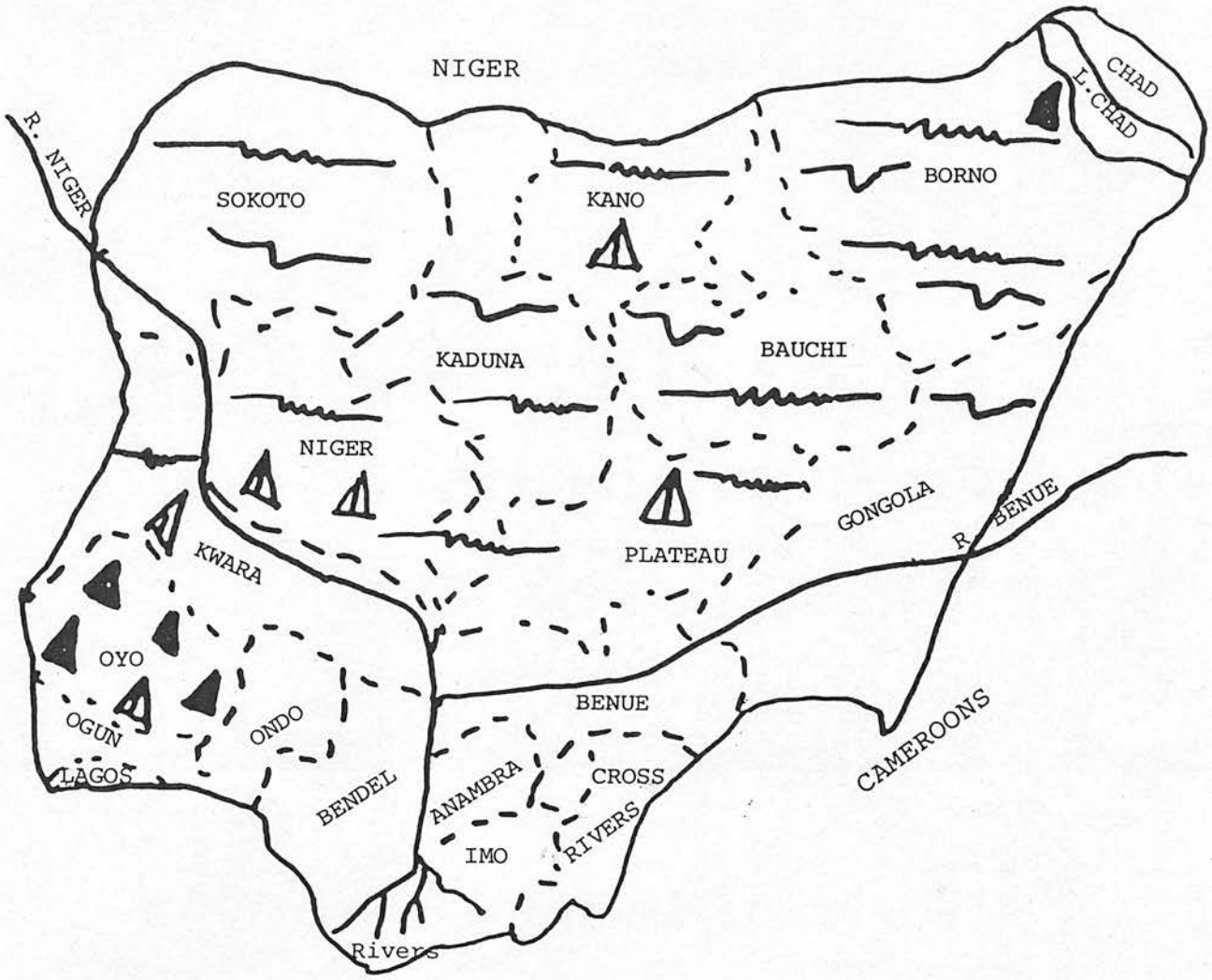
2.2 Prevalence of Bovine Brucellosis in Nigeria

The earliest reference to the occurrence of bovine brucellosis in Nigeria was the report of ten cases of contagious abortions reported in 1927 (Vet. Annual Report, 1927; cited by Banerjee and Bhatty, 1970). Esuruoso (1974b) carried out slaughter surveillance and serological testing of indigenous, exotic and mixed herds across the country. The slaughter surveillance and the serological testings of animals in herds showed a prevalence of brucellosis of 207/1186 and 376/803 respectively. In addition to the previous reports of brucellosis, Esuruoso (1974b) reported that brucellosis was endemic in Nigeria with varied prevalence rates in different parts of the country and in different husbandry systems in the same area (Figure 1).

2.2.1 Prevalence in ranches

In 1934 the prevalence of bovine brucellosis among government ranches was reported at 15% (cited by Banerjee and Bhatty, 1970). The prevalence of brucellosis in ranches in Zaria, Kaduna State was reported at 48.8% in 1957 (cited by Esuruoso, 1974b). By the 1960s the infection rate in the same ranches as in 1934 was reported at 4.9% (cited by Banerjee and Bhatty, 1970).

Figure 1 Distribution of bovine brucellosis in Nigeria



Locations of herds with high prevalence (20-60%)

Location of herds with low to moderate prevalence (1-20%)

Sources of trade cattle prevalence 6.3%

Nomadic herds prevalence 4-8.6%

(Adapted from Esuruoso, 1974b)

In a serological survey of 5,000 sera from five Northern States, Banerjee and Bhatty (1970) reported the prevalence of brucellosis among government ranches at 3.74%. Esuruoso and Hill (1971) reported an infection rate of 35% in Western State government ranches.

Following occasional abortions and infertility, an investigation of an experimental ranch (Zebu and Muturu) was conducted by serology. An infection rate of brucellosis was recorded at 26% (Esuruoso and Van Blake, 1972). A beef ranch in Lagos State of 500 pure N'dama cattle was reported at 1.5% infection rate in 1973 but 79.70% in 1975 (Esuruoso, 1974a; Esuruoso and Ayanwale, 1980; Table 1). The phenomenal rise in the prevalence rate from 1.5% in 1973 to 79.70% in 1975 was reported to be due to a few infected cows that were left within the ranch (Esuruoso and Ayanwale, 1980). The great variability among the reports could be due to different diagnostic techniques and interpretations by the different authors (Nuru and Schnurrenberger, 1975).

Nuru and Dennis (1975) conducted a serological survey using 1147 sera from 266 breeding herds in the Northern States and reported an infection rate of 3.6% on government ranches and LIBCs (Table 2). A serological study and isolation of Brucella abortus from cattle in government ranches and LIBCs was carried out in five Northern States. Twenty-seven (38%) out of 71 samples were positive serologically for brucellosis and 15.5% isolates were obtained (Bale and Kumi-Diaka, 1981). Eze (1982) reported that brucellosis is on the increase in Nigeria and that the Rivers Niger, Benue and Lake Chad basins as well as government ranches have the highest infection rates of 60%.

Table 1 Prevalence of brucellosis in Nigerian ranches (1934-1982)

Year	Test	Reported Prevalence Rates N. States %	S. States %	Reference
1934	Serology	15.0		Banerjee & Bhatty (1970)
1957	"	48.8		Esuruoso (1974b)
1960s	"	4.9		Banerjee & Bhatty (1970)
1970	"	3.74		Banerjee & Bhatty (1970)
1971	"	0.2	35.0	Esuruoso & Hill (1971)
1972	"		26.0	Esuruoso & Van Blake (1972)
1973	"		1.5	Esuruoso (1974a)
1975	"	3.6	79.70	Nuru & Dennis (1975); Esuruoso & Ayanwale (1980)
1981	"	38.0		Bale & Kumi-Diaka (1981)
1981	Isolation	15.5		Bale & Kumi-Diaka (1981)
1982	Serology	60.0	60.0	Eze (1982)

↓ Same ranches

Table 2 Brucella agglutination titres in sera from breeding cows in six Northern States of Nigeria (1972-1974)

State	No. of herds tested	No. of animals in herd	No. of samples	S A T	
				No. positive	% sera positive
North East	53	2 247	177	8	4.5
North West	72	1 832	151	5	3.3
North Central	45	1 954	149	1	0.7
Benue Plateau	33	2 508	159	6	3.8
Kano	22	599	29	0	0.0
Kwara	30	1 724	140	37	26.4
Sub total	255	10 864	805	57	7.1
Government ranches	11	2 642	227	12	3.6
Total	266	13 506	1 142	69	6.0

(Adapted from Nura and Dennis, 1975)

2.2.2 Prevalence in dairy units

In 1967, 109 calves were imported from the USA as calves and used as the foundation stock of Ikenne Dairy Multiplication Unit (IDMU) in Western State. In April 1968, 8/31 (25.8%) pregnant heifers aborted and 50% of the aborted cows were reported serologically positive for brucellosis (Esuruoso and Hill, 1971). This was followed by further investigations on IDMU and three other dairy farms all in Western State.

The Moor Plantation Dairy Herd (MPDH) in Ibadan is made up of exotic animals which were vaccinated as calves in the USA. The Iwo Road Commercial Dairy Herd (IRCDH) in Ibadan was established from the IDMU and MPDH stock. The fourth dairy herd, the University of Ibadan Dairy Herd (UIDH) was reported to have been vaccinated irregularly (Esuruoso and Hill, 1971). The three herds are reported to be government owned and the fourth was an experimental herd. Esuruoso and Hill (1971) reported 56/185 (30.3%) of animals examined in the four herds positive serologically to brucellosis (Table 3).

Following reports of occasional abortions and infertility in government dairy herds in Lagos State, Esuruoso and Ayanwale (1980) reported infection rates of 15.5% (11/71) and 50% (5/10) in two dairy herds.

2.2.3 Prevalence in extensive settled herds

These are beef herds with permanent posts to which they return daily after range grazing. Extensive settled herds are found all over the country especially in the Northern States.

Table 3 Brucellosis survey in dairy herds - Western State (1969

Herd	No. of animals examined	No. positive	No. doubtful	No. negative	% positive
UIDH	35	8	18	9	22.8
IDMU	44	15	15	14	34.4
IRCDH	31	11	10	10	35.5
MPDH	75	22	32	21	29.33
TOTAL	185	56	75	54	30.3

UIDH - University of Ibadan Dairy Herd

IDMU - Ikenne Dairy Multiplication Unit

IRCDH - Iwo Road Commercial Dairy Herd

MPDH - Moor Plantation Dairy Herd

(Adapted from Esuruoso and Hill, 1971)

Esuruoso and Van Blake (1972) carried out serological examinations on 10% of two extensively settled beef herds in Lagos State. Brucellosis infection rates were reported at 2.5% and 14.71%. In another serological examination of three beef herds which were privately owned in Lagos State, Esuruoso and Ayanwale (1980) reported a prevalence of 14.3% (3/21) to 46.5% (131/282). Although records were not kept the farmers are reported to have observed stillbirths and that up to 50% of their breeding cows did not calve annually (Esuruoso and Ayanwale, 1980).

2.2.4 Prevalence in extensive nomadic herds

Banerjee and Bhatty (1970) reported the prevalence of bovine brucellosis at 8.6% in unvaccinated Fulani nomadic herds from a serological survey in five Northern States. In another serological survey (1972-74) in the Northern States, Nuru and Dennis (1975) reported the overall prevalence of brucellosis among the nomadic herds at 7.1% (57/805). However, Esuruoso (1974b), Sansi (1976) and Eze (1982) reported the prevalence of brucellosis in the extensive nomadic herds at 4%.

2.3 Geographical Distribution and Prevalence

Esuruoso (1974b) conducted slaughter surveillance and serological testing of different herds across the country in order to determine the prevalence of brucellosis. An indicated high prevalence of 21-60% was reported among breeding cows and heifers in the Western States as compared to 0-20% in the Northern States.

Bacteriological investigation of abortions (1968-1973) in five herds in the Western States were positive for Br. abortus in 13.2% of cases (Esuruoso, 1974b).

The Western States have humid and subhumid types of climate which may favour the survival of Brucella organisms on pasture for longer periods than in the Northern States where it is semi-arid and sunny (Esuruoso, 1974b). Siegmund (1979) suggested that Brucellae can survive on pasture in a cool environment for two months. Thimm (1972) suggested this with a similar higher prevalence of brucellosis in a moderately warm and humid climatic zone of West and Southern Uganda.

Nuru and Dennis (1975) reported varied prevalence of brucellosis in the Northern States with Kwara State, a major trade cattle route, having the highest prevalence of 26% followed by the North Eastern State with 4.5% (Table 2). Borno State (part of the north east) is quite arid. Temple and Thomas (1983) suggested that concentration at watering points could increase the risk of the spread of communicable diseases among livestock and lead to higher prevalence rates.

2.4 Influence of Nomadic Husbandry on Prevalence

The prevalence of brucellosis in Fulani nomadic herds is reported to be 8.6% (Banerjee and Bhatty, 1970), 7.1% (Nuru and Dennis, 1975) and 4% (Eze, 1982).

It is expected that under extensive husbandry management, the prevalence of brucellosis in nomadic and semi-nomadic herds should be very low or negligible. However, favourable conditions for dissemination exist.

Infected aborted fetuses and fetal membranes play an important role in dissemination of infection through the contamination of pasture and watering points. The nomadic Fulani herdsmen allow calves to suckle for over one year. If the dam is infected then the calf, when sexually mature, would become infected (Banerjee and Bhatty, 1970). In addition, Madden (1984) and Nicoletti (1980) emphasized possible latent infection in heifers and bull calves when fed on infected milk.

Stableforth (1960) suggested that intramammary transmission of brucella organisms from one infected cow to another in a herd occurs freely at milking. Hand milking is routinely done two times per day with no hygiene. This exacerbates the transmission of brucella organisms from one cow's udder to another (Banerjee and Bhatty, 1970).

The nomadic Fulani cull their breeding cows only when infertile. Hence if the cause of the infertility was brucellosis and the animal was a chronic carrier it may have excreted and infected many cows in the herd.

El-Nasiri (1960) reported the prevalence of brucellosis at 13.9% in Fulani cattle herds in Southern Sudan. The condition in Southern Sudanese Fulani cattle herds in the dry season (convergence at water points) and at night resemble those in Northern Nigeria (Banerjee and Bhatty, 1970).

2.5 Effect of Brucellosis on Livestock Productivity

Bovine brucellosis results in the loss of calves from abortion and reduced milk yield. Productivity is reduced due to chronic mastitis, repeat breeding and a resulting poor conception rate with long calving intervals.

2.5.1 Loss of calves

Nuru and Dennis (1976) conducted an extensive survey on abortion and reproductive performance in six Northern States. A total of 383 calves were aborted. The lowest incidence was in nomadic herds and the highest on government ranches (Table 4). The majority of abortions on non parastatal farms were not reported. No causative agent was incriminated. However, from a similar survey Nuru and Schnurrenberger (1975) reported a high prevalence of brucellosis on government ranches and a low prevalence rate in nomadic herds.

A 29-39% abortion rate was reported in Pota beef ranch (Esuruoso and Ayanwale, 1980). Economically such an abortion rate is a great loss. Hubbert and Hagstad (1979) suggested in the first year of infection with brucellosis 60% of pregnant cows may abort.

From a population of eight million cattle in Nigeria, Esuruoso (1979) estimated five million breeding females, out of which 1-2 million would be heifers. Due to the high reported brucellosis prevalence rates in Nigeria, Esuruoso (1979) estimated that 50% of the 1-2 million pregnant heifers may abort annually and that 50% of 3.4 million cows may suffer infertility problems. The loss of calves per annum was estimated from the aborting 0.6 million pregnant heifers

Table 4 Occurrence of abortions in Northern States (1972-1973)

State	No. of herds	No. of breeding cows >3.5 years +	No. of Abortions Observed (Length of time since abortion)				Total No. of abortions observed	% of total abortions/ breeding cows
			< 6 months	7-12 months	2 years	> 2 years		
North East	64	1 360	33	11	73	0	117	8.6
North West	90	1 725	11	14	10	13	48	2.8
North Central	55	1 480	4	18	19	10	51	3.4
Benue Plateau	34	1 608	9	17	6	1	33	2.1
Kano	36	373	3	2	1	1	7	1.9
Kwara	30	1 029	46	19	7	0	72	7.0
Government ranches	10	1 395	16	20	11	8	55	3.9
TOTAL	319	8 970	122	101	127	31	383	4.3

(Adapted from Nuru and Dennis, 1976)

(600,000 calves) and from the 1.7 million cows which may suffer infertility problems. The monetary value of the calf losses is put at ₦ 17.8 million per annum.

2.5.2 Repeat breeding

Various problems of infertility and high return rates were reported in three government ranches and three private dairy herds in Lagos State (Esuruoso and Ayanwale, 1980). There are very few reports on infertility in the Nigerian Livestock Industry. In a study in India, Purbey and Sane (1978) reported a 47% conception rate after abortion when animals were served on first heat. The average number of services required per conception was reported as 2.1. The conception rate of 47% was reported to be low compared to 60% observed in normal herds.

2.5.3 Loss of milk

The Nigerian zebu cow under traditional management produces an average of 700 l of milk per lactation (Esuruoso, 1979). He suggested that the milk loss due to the effect of brucellosis can be estimated from 60% of 0.6 million (360,000) heifers and 10% of 3.4 million (340,000) cows. The total loss in milk production from brucellosis is estimated at ₦ 111.30 million per annum.

2.5.4 Hygromas

The incidence of lameness due to brucellosis has not been reported per se. However, Eze (1978) reported isolation of Brucella organisms from hygroma fluid collected from government ranches in the Plateau, Niger, Bornu and Kano States of Nigeria.

Thus the exact quantitative effect of brucellosis on cattle productivity in Nigeria is unknown. However, Esuruoso (1979) estimated that brucellosis is costing the Nigerian livestock industry ₦140.80 million per annum. The estimate was based on the reported high prevalence of brucellosis in Nigeria which may be unrepresentative of all herds. In addition the estimates of abortion rates in heifers (50% of all heifers) are possibly very high. Although this may occur in totally susceptible herds in the first year they are exposed to infection, a degree of resistance will develop in the herd subsequently. Abortion rates often drop to around 10-20% (Edelsten, 1984).

2.6 Public Health Significance

2.6.1 Effect on man's health

Brucellosis is a debilitating disease in man causing undulant fever. The disease can be acute, subacute or chronic. Acute and subacute brucellosis are accompanied by fever followed by relapses or recovery. Either form of the disease can have articular and neurological complications. The chronic form is characterised by a state of hypersensitivity and may persist for several years.

2.6.2 Prevalence

Very little information is available about human brucellosis in Nigeria. Two cases of undulant fever were clinically diagnosed by the Nigerian Medical Authorities in 1931 (cited by Banerjee and Bhatty, 1970). Of the 340 sera of Fulani men from Katsina Province, Collard (1962a) reported an infection rate of 2.4%. Of 3 232 sera

of healthy persons in four provinces in the North and Ibadan, infection rates of 25%, 29%, 35% and 9.1% were reported for Gwoza, Shuwa, Kanuri and Fulani tribes respectively, 18% for rural and 25.1% for urban Yoruba. The highest incidence of 1/40 titres against Brucella abortus was reported in Borno State where the cattle:human population ratio is the highest in Nigeria (Collard, 1962b; Figure 2). The sex, age and the occupation of the people sampled were not reported.

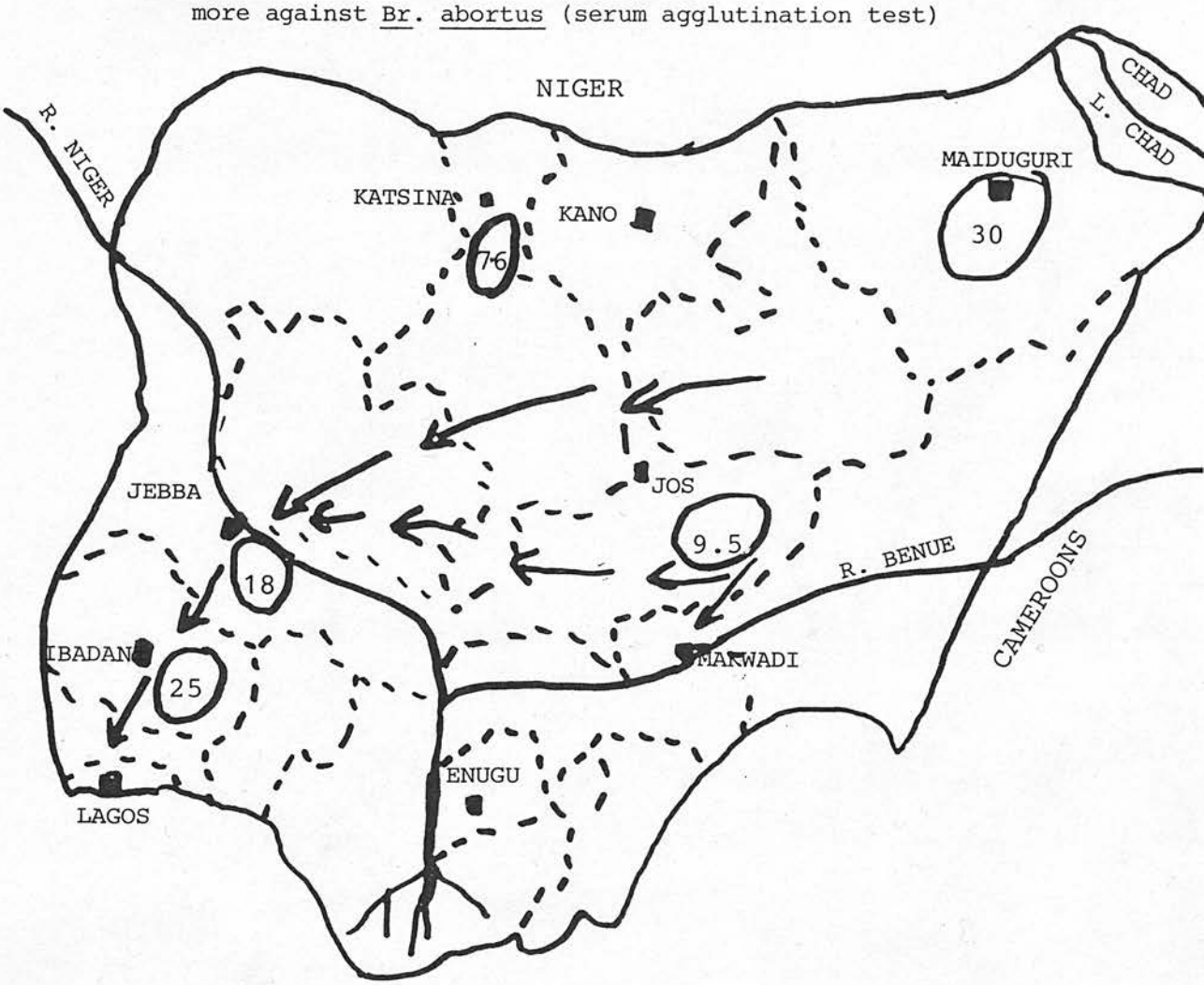
The reported infection rates may not be representative of the tribes. However, the infection rates have highlighted the possible exposure through contact with infected animals and the consumption of unpasteurised milk and milk products.

Many people consume unpasteurised milk and milk products in Nigeria. The prevalence of brucellosis is reported to be high in the Nigerian livestock industry. This calls for an accurate evaluation of the sources of infection to man in order to evolve an appropriate control measure.

2.7 Existing Brucellosis Control in Nigeria

In the control of bovine brucellosis several measures such as education, vaccination, hygiene and test for slaughter should be considered as well as cattle movement control. Vaccination with S19 results in a significant reduction in abortions caused by brucellosis. Sixty-five to 75% of vaccinated animals are resistant to most kinds of exposure. The remaining 25-35% may become infected but don't abort (Blood et al., 1983; Madden, 1984).

Figure 2 Percentage of healthy persons with a titre of 1/40 or more against Br. abortus (serum agglutination test)



Major cattle trade routes

(Adapted from Collard, 1962b)

In Nigeria during the late 1940s, despite adoption of a test and slaughter policy, bovine brucellosis on government ranches was on the increase due to a lack of thoroughness in its implementation. Consequently vaccination with S19 was recommended in 1946 (cited by Banerjee and Bhatty, 1970). By the 1950s the infection rate fell to under 5%. This was attributed to strict husbandry measures and improvements in management in addition to S19 vaccination (Nuru and Schnurrenberger, 1975). Unlike the government ranches vaccination has never been applied to the nomadic and semi-nomadic herds.

By 1974 calfhood vaccination on ranches became limited and irregular (Esuruoso, 1974b). Irregular S19 vaccination was incriminated in the high prevalence of brucellosis reported in the University of Ibadan Dairy Farm. Bale and Kumi-Diaka (1981) suggested that the existence and maintenance of the disease in the LIBCs may be due to poor fencing, movement and contact of animals with nomadic cattle. Buying in without adequate quarantine of animals is another important factor in the spread and maintenance of infection in the LIBCs (Bale and Kumi-Diaka, 1981).

Esuruoso (1979) advocated education and vaccination for the control of brucellosis in Nigeria at a cost of ₦15 million in the first phase. Thenceforth an annual surveillance cost of ₦1.5 million was recommended.

CHAPTER THREE

DISCUSSION - THE IMPLICATION OF BRUCELLOSIS IN NIGERIA

In spite of the numerous reports, no systematic surveys of the prevalence of bovine brucellosis have been made in Nigeria. The reports may be biased towards the few ranches that were already known to have been infected. However the indicated prevalence among these valuable herds has highlighed the possible seriousness of brucellosis in the livestock development strategy of Nigeria.

Similarly, the reported prevalence rates of bovine brucellosis are not representative of all extensive nomadic herds in Nigeria. The reported prevalence in these herds may have minimal economic impact compared to other diseases such as rinderpest and nutritional problems.

The public health hazards from direct contact with infected cows and the exposure to brucellosis through the intake of unpasteurised milk and milk products from such infected herds are yet to receive attention.

3.1 Government Ranches and Private Farms

It is important to realise that the future of livestock development in Nigeria rests with the private settled livestock farmers. Such farmers acquire improved breeds from government ranches.

A high prevalence of bovine brucellosis has been reported in government ranches. This has resulted from irregular vaccination, poor fencing hence contact with nomadic and semi-nomadic herds which

may be infected and buying in of replacements with inadequate brucellosis surveillance. The seriousness of the high prevalence of brucellosis in such valuable animals lies with the private farmers who may have production losses on acquiring the disease.

The trypanotolerant N'dama and Muturu breeds have good productive traits (Roberts and Gray, 1973a,b; ILCA, 1979b). The N'dama has been chosen by the Federal Government of Nigeria for use to upgrade the local Muturu and the Keteku breeds and is widely accepted by commercial farmers. Brucellosis may possibly be disseminated to private farms through the sale of the N'dama bulls and heifer calves from such infected government farms. This may disable the exploitation of the excellent production traits of these valuable animals.

In India, Sharma, Sethi, Yadav and Dube (1979) ascribed the increase in the prevalence of bovine brucellosis in India to intensification of cross-breeding programmes, poor hygiene standards and practically speaking a lack of brucellosis control even on government farms.

Unless effective control measures against brucellosis are implemented the efforts of upgrading the productivity of private herds with improved breeds could be jeopardized by the escalation of brucellosis. This may disable the livestock production strategy of the Federal Government.

3.2 Dairy Development and Public Health

The Federal and State Governments of Nigeria plan to encourage the development of dairying. It is reported that Nigeria spent ₦22.4 million foreign exchange on the importation of dairy products

in 1971 (Davis, 1973). In the 1975-80 Third National Development Plan substantial funds were allocated to the development of the dairy industry. This is to be based on imported exotic breeds mainly Friesians and Brown Swiss to be crossed with White Fulani (ILCA, 1979a).

Davis (1973) made various recommendations to the Federal Government on dairy development. Establishment of more urban dairies and development of favourable areas for milk production in Jos and Mambilla Plateaux were recommended.

Various State Governments have plans for integrated dairy developments such as Bauchi State plans at Ningi and Gombe. Banerjee and Bhatty (1970) reported that the potential danger of human brucellosis is great with the development of a dairy industry in Nigeria.

Other areas for dairy development are the Obudu cattle ranch in Cross Rivers State, Wase Grazing Reserve in Plateau State which has 20 000 head of cattle settled plus 10 000 nomadic (Davis, 1973; Pullan, 1978; Synge, 1980). Runka Grazing Reserve is to be developed to supply milk to Kano, Funtua and Kaduna. The milk collection centre at Mokwa in Niger State is to be developed. Borgu Emirate in Kwara State, a major trade cattle route (Collard, 1962b; Esuruoso, 1974b) with many settled cattle, and surplus milk from which cheese is sold to Ilorin and Ibadan was to be developed.

The existing Kaduna, Kano and Maiduguri dairies which collect milk from the nomadic and semi-nomadic herds are to be expanded. Urban dairies which would be managed on zero grazing are to be set up at Sokoto, Benin, Port Harcourt and Calabar (Abdulkardir, 1983).

The implications of brucellosis in this nationwide chain of dairies is of great economic potential and public health significance. The establishment of urban dairies and those at Jos and Mambilla Plateaux may result in some degree of intensification. This will increase contact with possible increased brucellosis prevalence rates and consequent production losses.

Most of the urban dairies would be pasteurising the milk before selling it to the public. The risk to the farmer, his family and others handling raw milk or infected meat needs to be controlled through hygiene and care. Similarly the risk of brucellosis in traditional market routes due to the intake of inadequately soured milk or butter from infected milk could be controlled through extensive education.

The impact of brucellosis on human health in Nigeria may be significant but it has not been reported. The incidence of human brucellosis in Britain for instance could have been high but because until 1960 brucellosis was not a notifiable disease, it was recorded to be low. By 1961, 101 people were reported as infected with three deaths. Animal handlers accounted for 18-34% of the human cases (Madden, 1984).

3.3 Nomadic and Trade Cattle

There is much pressure on the dry season grazing areas in the subhumid parts of Nigeria and the river basins "fadama" due to crop agriculture. The nomadic and semi-nomadic pastoralists may either be forced to settle or concentrate in marginal areas and at watering points in grazing reserves. Under such circumstances the dissemination

of brucellosis may be enhanced especially at watering points and the prevalence may increase. This would worsen the already low reproductive performance of the nomadic herds as reported by Lamorde and Weinman (1972). Education of the pastoralists about the importance of brucellosis and how simple hygiene measures would help control the disease may be necessary.

About 20% of Nigeria's trade cattle come from neighbouring countries (Esuruoso, 1974b). Some of these trade cattle end up in breeding herds. Thimm and Nauwerch (1974), Gidel, Albert, Mao and Ratif (1974) reported that bovine brucellosis is endemic in the whole of the West African region. There is a need therefore to prevent contact of breeding herds which are actively attempting to control brucellosis with infected trade cattle.

3.4 Animal Draught Power

Mixed farming is well established in the Kano agricultural development area. The density of total livestock units per hectare is higher in the Kano close settled zone than elsewhere, demonstrating the importance of livestock in the intensive farming systems (Hendy, 1977). Many of these cattle are used as work oxen and because the State is already overstocked the scope for livestock development appears to be only in the further development of the use of animal draught power (Tyler, 1984).

Under such circumstances the health of the draught animals throughout the year, but especially in the working season, is emphasized (Smith, 1984).

The prevalence of bovine brucellosis which causes hygroma and which may result in lameness is reported in Kano State (Eze, 1978; Bale and Kumi-Diaka, 1981). The stocking rate in this part of the country is on the increase and the prevalence of brucellosis may also increase. The fact that hygroma is very conspicuous means that basic education of farmers would certainly alleviate the problem.

It is important to control brucellosis because the significance of the disease is not just due to economic losses as in mastitis, abortion and infertility, but also the extent to which it acts as a disabling factor holding back potentially advantageous changes in agricultural development (Davies, 1979) such as the use of draught power as well as its public health importance.

CHAPTER FOUR

REVIEW OF OPTIONS FOR THE CONTROL OF BRUCELLOSIS IN NIGERIA

4.1 Education

4.1.1 Publicity for government support

It is the responsibility of the Veterinary Department of the Ministry of Agriculture to increase the awareness of the importance of brucellosis in both political and medical quarters (Adlam, 1979). The economic losses in the livestock industry and the hazards to public health should be emphasized (Madden, 1984).

In Nigeria the reported high prevalence of brucellosis in government ranches and its implication in livestock development programmes should be stressed.

The control strategy should be made clear and the rationale should be understood by the government and its superiority to others, based on the local situation applied. The detailed estimation of finance, manpower and other required resources may have to be made. Adlam (1979) suggested that estimates will be more accurate if associated with a definite timetable.

4.1.2 Awareness amongst livestock farmers and the public

Herdsmen: Most livestock farmers don't know the socio-economic impact of bovine brucellosis *per se*. Education of the herdsmen concerning the hazards associated with handling infected fetuses, placentae and tissues should be combined with the explanation of potential economic losses. The herdsmen should be educated on basic hygiene whereby aborted materials could be properly disposed of.

The contamination of pasture and watering points could then be minimised. Eze (1982) suggested advising the pastoralists to cull infertile cows and those with hygromas.

Livestock producers must be convinced of the economic advantages for any control programme to succeed. Their co-operation is very vital (Nuru and Dennis, 1976; Eze, 1982; Nicoletti, 1984). In a study in the Somali Democratic Republic, Hussein, Singh and Haji (1978) reported that a programme of education on sanitary measures played an effective role in lowering the prevalence of brucellosis from 39% in 1974 to 11.9% by 1978.

The community: The community should be educated on the danger of consuming unpasteurised milk and milk products. Where pasteurisation is not practicable, simple boiling should be encouraged (FAO/WHO, 1971).

High risk groups: One way of reducing risk of infection in abbatoirs could be to encourage workers to wear masks. However, this would almost certainly be unacceptable and unrealistic. Both abbatoir and dairy workers should be educated not to roll cigarettes with contaminated hands or use pressure hoses on the floor where an infected cow aborted until disinfected (Alton, 1981; Hubbert and Hagstad, 1979).

Veterinary and para veterinary workers in the field and in the laboratories should use hand gloves for the collection of specimens. When handling specimens in the laboratory protective clothing including gloves and face masks need to be worn (Alton, Jones and Pietz, 1975).

4.1.3 Extension services

Education is considered the most important option for the control of brucellosis in Nigeria. An effective extension service is required with motivated personnel and a good means of communication to the community. Good supportive services from the government are necessary.

The extension agents should know the culture of the herdsmen, be interested and identify with them and other groups at risk to brucellosis in the society. Extension workers are expected to be humble and of high credibility (Adams, 1982; Smith, 1975).

There should be better supervision of field staff. Regular meetings or seminars involving senior controlling officers help maintain morale and motivation (Adlam, 1979).

An effective means of communication is essential. Radios and mobile cinemas could be quite cheap and useful in creating an awareness of brucellosis. Radio programmes should be well prepared and the message should be simple, clear and dynamic (Chain, 1979). The mobile cinema could be organised in villages. The features and the language should be local.

Group meetings may be arranged among the nomadic pastoralists with the assistance of their leaders "Ardo" who may act as liaison officers and contact agents. Davidson (1979) and Krishan (1965) emphasized the value of traditional leaders in extension. During the meetings ideas can be exchanged. Pastoralists are said to be conservative and rigid but once they are convinced they accept the new concepts of disease control quite readily (Morley, Mitchell, Napthine, Gillick and Hass, 1979).

The extension work should be co-ordinated by the Animal Health Department in liaison with the Medical Health Services.

4.2 Hygiene

Strict hygiene measures are necessary in conjunction with vaccination for brucellosis to be effectively controlled in government ranches and LIBCs (Eze, 1982).

Arrangements should be made for pregnant cows to calve away from the rest of the herd. Impending abortions are of particular importance and they have to be detected early and isolated from the herd. There must be proper disposal of aborted fetuses, placentae and uterine discharges. Thimm (1972) suggested adequate disinfection of infected milking and calving sheds, stables and equipment to be instituted on farms.

4.3 Vaccination

4.3.1 S19 calfhood vaccination

S19 calfhood vaccination should be carried out on government ranches, multiplication units and well managed farms. Progressive farmers near clinics may be offered vaccination by the Veterinary Department. At the inception of the vaccination programme, the vaccination could be offered free as an incentive. The nomadic herds should be left out in the meantime.

A block calfhood vaccination of all heifer calves 3-8 months of age should be instituted using S19 vaccine (Alton, 1978). A full dose of not less than 50×10^9 viable Brucella cells in 5 mls administered as a single dose subcutaneously at the upper one-third of the

lateral surface of the shoulder or immediately posterior to the shoulder (FAO/WHO, 1971). The vaccination could be carried out twice a year with a view to covering the emerging calf crops.

S19 vaccinated calves remain resistant to infection with virulent Br. abortus for seven years or five lactations and probably longer. This depends on the immunogenicity of the vaccine and the response of the host (Alton, 1975; 1981).

S19 vaccination in bulls is not recommended because orchitis and lowered fertility may develop from the vaccination (Blood et al., 1983).

4.3.2 Adult vaccination

Reducing the dose of S19 vaccine to one twentieth of the normal full dose or 3×10^8 viable cells per vaccinal dose is recommended for the vaccination of adult cattle (Alton, 1981). The vaccine is administered subcutaneously or intradermally which reduces the serological response with no apparent effect on the immunity. However, a sharp reduction in the level and persistence of antibody production is noticed (Alton, 1978). The problem of titres produced by vaccination can be largely eliminated by using reduced doses of S19 vaccine.

Alton (1978) suggested that vaccinating adult cattle is an economical, efficient and practical method of reducing the prevalence of brucellosis and still allows the detection of infected animals.

The use of single S19 vaccine full doses in calves and reduced doses in adults is cost effective. It means stocking only one type of vaccine rather than two if 45/20 vaccine was to be used for adults.

The use of S19 vaccine alone is much more convenient and eliminates the extra costs involved in the use of 45/20 vaccine. This is because the 45/20 vaccine is killed in adjuvant hence two inoculations are required six weeks apart (Madden, 1984) with annual booster injections.

The 45/20 vaccine produces much more severe reactions up to 8 cm in diameter at the injection site (Blood et al., 1983). These may persist as granulomas. It is expensive and farmers don't generally accept it (Alton, 1978).

Generally, vaccination as a control measure needs to be continued until the estimated infection prevalence (number of reactors detected in one year expressed as a percentage of the total number of breeding cattle) is less than 0.2% (Roe and Morris, 1976; Alton, 1978; 1981). When such a level of prevalence is reached, test and slaughter may be opted for. However, this may not be cost effective, also the transition period from vaccination to non vaccination prior to implementing the test and slaughter programme poses many problems and often a flare up of infection occurs. Hence vaccination coupled with hygiene should be continued to keep down the prevalence rates.

The adult vaccination should be limited to highly infected herds only until the S19 calfhood vaccination has provided enough protection.

4.4 Movement Control

Hanson and Hanson (1983), Esuruoso (1974b), Meyer (1982) and Madden (1984) emphasized the importance of cattle movement control as a major factor in addition to hygiene and vaccination in the control of bovine brucellosis.

Before importing exotic breeds of animals each animal should be tested for brucellosis in the herd of origin. On arrival the animals should be quarantined until heifers are calved down and been tested. This is because many latent infections become seropositive at this time. The imported animals after testing, should be vaccinated before being moved with other animals (Thimm, 1972).

All government farms should institute a strict control of cattle movements by the use of effective fencing. In badly infected herds replacements should be avoided until the infection rate subsides (Madden, 1984).

Esuruoso (1974b) suggested a critical evaluation of animals being sold to farmers from government farms. Such animals should be certified free of brucellosis by serological tests using the RBP test and confirmed with CF tests. Three tests at 60 day intervals should be conducted. Only animals that are negative on three consecutive tests should be sold to farmers (Meyer, 1982; Madden, 1984).

Private dairy and beef extensive settled farmers should be encouraged to restrict movements. Replacements should come from brucellosis free herds. Cows should be tested and quarantined for 30 days before mixing with the rest of the herd (Adlam, 1978; Nicoletti, 1984).

Before the implementation of the options for control, a feasibility survey of brucellosis in the livestock production system is required. Esuruoso (1979) estimated such a feasibility study in Nigeria at ₦0.3 million. A representative pilot survey might suffice.

CHAPTER FIVE

PROPOSAL FOR THE EVALUATION OF BOVINE BRUCELLOSIS IN NIGERIA

5.1 Objectives

A representative pilot survey on the Jos Plateau is proposed with the following objectives:

To assess the influence of herd size and husbandry on the prevalence of brucellosis.

To evaluate the role of milk in the transmission of brucellosis to man.

5.2 Background

Nomadic, semi-nomadic and extensive settled livestock husbandry systems are practised on the Jos Plateau. It is also a major nomadic cattle route to and from the southern subhumid dry season grazing areas of Nigeria (Synge, 1980). The White Fulani (Bunaji) is reported to be the most widely distributed type of zebu throughout Northern Nigeria (FAO, 1975, cited by Pullan, 1978). Pullan (1978) confirmed similar findings on the Jos Plateau.

Extensive settled Fulani livestock husbandry has been in practice on the Jos Plateau for a longer period than other parts of Nigeria (Synge, 1980). The Jos Plateau (due to its climate and altitude) and other highland areas such as the Mambilla Plateau have been recommended by Davis (1973) to the Nigerian government as centres for dairy development.

Much work has been done and reported on the Jos Plateau in connection with herd sizes and structure (Pullan, 1978; Synge, 1980),

cattle population and seasons of calving (Lamorde and Franti, 1975; Synge, 1980), percentage of breeding cows per herd and the age at calving (Nuru and Dennis, 1976; Synge, 1980). Hence basic data and information on livestock performance under traditional husbandry systems on the Plateau are available in the literature.

Although the Jos Plateau is a small part of the cattle raising area of Nigeria a pilot brucellosis survey in such an area could give pointers to the potential implications that brucellosis may pose in the light of settlement with an increase in herd sizes and the dairy developments proposed in Nigeria. The Jos Plateau is convenient for the survey since the National Veterinary Research Institute (NVRI) is on the plateau at Vom.

The Jos Plateau is part of the Plateau State of Nigeria and covers an area of 8600 km^2. The rainfall lasts from April to October. Most of the cattle on the Jos Plateau are of the White Fulani breed with a few Mutura and a few herds of exotic breeds on government farms and research stations (Synge, 1980).

Both nomadic and extensive settled Fulani herds are found on the Plateau in the rainy season. Synge (1980) reported the cattle population on the Jos Plateau during the rains at 402 100 ± 53 300 with a density of 46.76 head/km^2. The mean herd sizes of nomadic and extensive settled Fulani herds are 108 and 189 respectively (Synge, 1980). In a similar study at Ruma Kukar-Jangarai, Kaduna State where 62 settled and semi-settled households were sampled Awogbade (1982) reported a mean herd size of 158 ± 191.8 and a median of 69.8. Awogbade (1982) reported a range of less than 50 to 621 head of cattle per household.

Pullan (1978) reported the average number of breeding cows over three years old at 45% of each Fulani herd. Synge (1980) reported the calving rate of the White Fulani at 40%. Lamorde and Franti (1975) from an extensive questionnaire survey on the Jos Plateau reported that the peak of calving was at the beginning of the rainy season. This was confirmed when Pullan (1978) reported that most calving in the White Fulani on the Plateau occurred in April and May.

In order to carry out the proposed evaluation it is impossible and economically prohibitive to test all animals. The most cost effective option therefore is to test samples obtained from a representative sample of animals in the area.

5.3 Methods

Random sampling where feasible within a stratified population is to be used. Leech and Sellers (1979) suggested that the idea of random sampling is to give each sampling unit an equal chance of being selected. Logistically and administratively this method of random sampling within an already stratified population is easy to manage. This is because travel is reduced and education programmes can be pinpointed to participants (Hanson and Hanson, 1983). In animal health surveys in the developing countries, the practical sampling options available are usually limited. Accurate lists of livestock owners are rarely available and population distribution is rarely uniform and is influenced by several factors such as tsetse fly distribution, grazing areas in the dry season and watering points. Hence strict random sampling may not be possible (Broadbent, 1979).

On the Jos Plateau where random sampling is not feasible quota sampling with large numbers of quality interviews should be used.

5.3.1 Sampling frame and units

It is proposed that the sampling frame be the local government areas (LGAs) while the sampling units be the cattle herds. The sampling strata are the extensive settled and nomadic husbandry systems.

From each of six randomly selected LGAs, four herds from each strata, extensive settled and nomadic husbandry, are to be selected for interview and testing. The selection of herds should be as far as possible covering the whole range of herd sizes. Thus a total of 48 herds, 24 herds from each stratum are to be selected.

The survey should be conducted between May and June. This is because all the nomadic herds would have returned to their posts on the Plateau from their dry season grazing areas. Secondly, any brucella infected lactating cow would be most likely to excrete Brucella organisms in the milk at that time.

5.3.2 Sampling and tests

Fifty percent (50%) of all lactating cows from each selected herd are to be bled and tested using the Rose Bengal Plate test. The RBP test is specific for Br. abortus, rapid, simple and allows economical screening of a large number of samples (Chantal, Bornarel and Akakpo, 1978; Newton, Jones, Connor, Davidson and McGovern, 1974; Sacco, 1976).

Fresh milk samples should be sampled from each herd and cultured for Br. abortus. Similarly, soured milk should be sampled from markets where the same herds sell their milk and also cultured for Br. abortus organisms.

5.3.3 Questionnaire survey

A properly prepared and simple questionnaire (Table 5) is required to be used concurrently on all herds being sampled. The use of questionnaires has long been recognised as a relatively cheap and rapid way of obtaining information and data from population samples. However, its limitations must be borne in mind (Perry, 1982).

Most nomadic Fulani are illiterate but knowledgeable about their animals and can be expected to give fairly accurate information if judiciously questioned by experienced animal health staff (Nuru and Dennis, 1976). The Fulani do not keep records so information about abortions, infertility and cattle numbers may not be accurate.

In addition there are always suspicions that the interviewer's motives may be other than stated and the owner may hold back information because of fear of cattle taxes or for other reasons known to himself (Stenning, 1959).

During the implementation of the brucellosis survey the local name of the disease should be used among the Fulani and the non Fulani pastoralists (Perry and McCauley, 1984). Simple specific obvious clinical signs such as hygroma could be used to describe the disease (Domenech, Lucet and Coudert, 1982).

Table 5 Questionnaire survey on abortion and infertility

1. Owner of the herd	
2. Extensive settled/Nomadic	
3. Village	
4. LGA	
5. Number of abortions in last 2 years	
6. Stage of pregnancy at abortion (Trimeters)	
7. Number of repeat breeding	
8. Number infertile	
9. Milk market	
10. Dry season grazing area	
11. Number of breeding cows > 3 years	
12. Herd sizes	
0-30	
31-60	
61-90	
91-120	
121-150	
151-200	
200 +	

Design and techniques of the questionnaire survey: One interrogator and assistants should be used so that differences observed can be attributed to real variation and not variations in interview technique. This has the disadvantage of needing more time (Perry, 1982) and where many ethnic groups exist such as on the Jos Plateau the interrogator must be fluent in more than one language.

Though a written prepared format is important it must be reconciled with the need to minimize the writing of each response and to make the interview as informal as possible (Perry and McCauley, 1984). There should be no rush. Customs often require considerable time on introductions during which the purpose, significance and possible usefulness of the survey should be fully explained and the confidence of the farmers gained (Nuru and Dennis, 1976; Perry and McCauley, 1984). Perry (1982) reported the need for 1-1½ hours per interview in Zambia.

Pastoral farmers are suspicious of visitors asking questions particularly if they are connected with goverment organisations (Nuru and Dennis, 1976; Perry and McCauley, 1984). The presence of foreigners must be avoided so that results are not biased.

While foreigners asking questions are suspect (Stenning, 1959) those asking questions about livestock numbers are doubly suspect (Perry and McCauley, 1984). Hence questions about numbers should be kept until the end of the interview once the confidence of the pastoralist has been secured (Perry, 1982; Table 5). Experience shows that the interviewer's assistant could count the herd silently once all the animals were in the Kraal.

Awogbade (1982) suggested that surveys should cover specific periods of time and all data collected should relate to that time. Thus the use of "Have you ever seen this disease?" should be avoided (Perry and McCauley, 1984).

Herd visits must be arranged two days in advance for the owner to be there and to gather maximum information. It would be expensive to go without pre-arrangement and possibly not see the herd *in situ* or even meet the owner (Perry and McCauley, 1984). Experience shows that if the owner is not present neither the wife/wives nor the children will answer any questions on the health and productivity of the herd.

5.4 Staff and Equipment

5.4.1 Staff

In Plateau State there are State veterinary staff, the Federal Livestock Department staff, Jos Zonal Office and those of the National Veterinary Research Institute (NVRI), Vom. These three institutions could judiciously spare some staff without any disruption to their routine services for the survey. Gittinger (1972) suggested that since the deployed staff are already employed their opportunity cost in terms of salaries to the scheme would be zero. However, some incentives may have to be provided to the staff.

5.4.2 Equipment

A veterinary diagnostic laboratory, transport, coleman boxes and sampling kits are required for the evaluation exercise. The NVRI, Vom which is situated on the Jos Plateau would carry out all

the diagnostic tests required. It is expected that the rest of the equipment for the brucellosis survey would be provided by the three institutions mentioned above.

5.5 Results and Discussion

5.5.1 Results

The results from the survey would be analysed statistically to see whether a large herd size is significantly different from a small herd size in the prevalence of brucellosis in the extensive husbandry systems. The possible extent of dissemination of infection could be traced to dry season grazing areas. The milk culture would show whether both or either fresh and sour milk contain Brucella organisms or not.

5.5.2 Discussion

If a large herd size is found to be significantly different from a small herd size in the prevalence of bovine brucellosis, it highlights the potential of high infection rates that may arise with any trend towards larger herd sizes and settlement programmes. The desirability of settling the Fulani cattle owners was stated in the Second National Development Plan (1970-74). Similarly, there is a danger associated with the concentration at watering points during the dry season which increases contact resulting in higher exposure potential to brucellosis.

If Brucella abortus organisms are cultured from milk, particularly from the soured milk, the danger associated with the intake of unpasteurised milk is established.

In summary, the results of the survey may be useful in designing a policy for the control of bovine brucellosis in the livestock industry and in man. In addition more watering points may be recommended.

CHAPTER SIX

CONCLUSION

Bovine brucellosis is endemic in Nigeria with varied prevalence among different husbandry systems. The socio-economic impact of the disease is not known. The high prevalence reports on ranches are not representative of the extensive systems due to the lack of systematic surveys.

The indicated high prevalence of brucellosis among valuable herds may affect the livestock development strategies of Nigeria. The low prevalence of brucellosis in the extensive husbandry systems may increase due to the trends towards larger herd sizes with settlement.

Effective control measures are required to avoid the disabling implications in the livestock development programmes and the danger to public health. Extensive education of the herdsmen and the community, hygiene and restricted vaccination to special ranches may be cost effective in the Nigerian situation.

With the rational use of available manpower and resources, brucellosis could be evaluated using a representative pilot survey. It is hoped that the results would help design a policy for the control of bovine brucellosis in Nigeria.

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