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STRATEGIC TICK CONTROL FOLLOWING IMMUNISATION OF CATTLE AGAINST EAST COAST FEVER IN THE CENTRAL Rift VALLEY REGION OF KENYA

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LUTTE STRATEGIQUE CONTRE LESTIQUES APRES L’IMMUNISATION DES BOVINS CONTRE LA FIEVRE DE LA COTE-EST DANS LA REGION CENTRALE DE LA VALLEE DU RIFT AU KENYA

Résumé

Au total, 118 bovins Frisons et croisés (Charolais x Frison) ont été immunisés, selon la méthode "infection et traitement", contre la fièvre de la Côte-est (FCE) en utilisant Theileria parva (T. parva) Markebuni dans trois fermes situées dans la commune de Rongai du district de Nakuru de la région centrale de la Vallée du Rift au Kenya. Cent-dix-huit autres bovins Frisons et croisés (Charolais x Frison) étaient utilisés comme témoins et n’étaient pas immunisés. L’objectif de l’étude était d’établir l’efficacité de Theileria parva Markebuni (stabilat 316) et l’effet de la baisse de la fréquence de la lutte contre les tiques sur le nombre de cas de FCE et d’autres maladies transmises par les tiques chez les animaux immunisés. On a recueilli des données sur le nombre de cas de FCE et d’autres maladies transmises par les tiques, et sur le nombre de tiques sur les animaux dans les groupes immunisé et non-immunisé sous différentes méthodes de lutte contre les tiques. Après l’immunisation, 3 des animaux (2,5%) ont réagi au vaccin et développé la FCE clinique; ils ont été traités avec succès au buparvaquone, tandis que 111 des bovins (94%) avaient des antécors anti- T. parva. Huit semaines après l’immunisation, la fréquence de la lutte contre les tiques a été réduite pendant 28 semaines dans une ferme et durant 45 semaines dans les deux autres fermes. Cinquante-neuf des animaux immunisés et 59 des bovins non-immunisés ont pris un bain toutes les 3 semaines (bain stratégique), tandis que les autres 59 animaux immunisés et 59 bovins non-immunisés ont pris un bain chaque fois que les infestations totales de tiques atteignaient 100 sur un seul animal du groupe (bain tactique). Trois cas de FCE ont été signalés chez les bovins immunisés comparé à 9 cas chez les animaux non-immunisés. Deux des cas se sont produits dans le groupe soumis au bain stratégique; 10 cas chez les bovins soumis au bain tactique. Au terme de l’étude, il y avait, en outre, pendant 52 semaines un suivi des bovins dans deux des trois fermes. Trois cas de FCE clinique étaient signalés chez les animaux non-immunisés, alors qu’aucun cas de maladie n’a été constaté chez les bovins immunisés.

Mots-clés: Fièvre de la Côte-est; Theileria parva; stabilat 316; baisse de la fréquence de la lutte contre les tiques.

Abstract

A total of 118 Frisian and cross-breed (Charolais-Frisian crosses) cattle were immunised by the infection-and-treatment method against East Coast fever (ECF) using Theileria parva (T. parva) Markebuni in three farms located in Rongai Division of Nakuru District of the Central Rift Valley region, Kenya. Another 118 Frisian and cross-breed (Charolais-Frisian crosses) cattle were used as controls and not immunised. The objective of the study was to establish the efficacy of Theileria parva Markebuni (stabilate 316) and the effect of reduced frequency of tick control on the number of ECF and other tick-borne diseases among the immunised animals. Data were collected on the number of cases of ECF and other tick-borne diseases and the number of ticks on the animals among the immunised and non-immunised groups under tick control regimes. Following immunisation, three of the animals (2.5%) reacted to the vaccine and developed clinical ECF and were treated successfully with buparvaquone while 111 of the cattle (94%) had antibodies to T. parva. Eight weeks after immunisation, tick control frequency was reduced for 28 weeks in one farm and for 45 weeks in the other two farms. Fifty nine of the immunised and 59 of the non-immunised cattle were dipped once every three weeks (strategic dipping) while the other 59 of the immunised and 59 of the non-immunised were dipped whenever the total tick infestations reached 100 on a single animal in the group (tactical dipping). Three cases of ECF were reported in the immunised cattle compared to nine cases in the non-immunised animals. Two of the cases occurred in strategically dipped-group while ten cases occurred in tactically-dipped cattle. At the end of the study, there was a further 52 week monitoring of the cattle on two of the farms. Three cases of clinical ECF were reported in the non-immunised animals while no case of the clinical disease was recorded among the immunised animals.
Introduction

East Coast Fever (ECF) is a major constraint to livestock production in East and Central Africa. The disease is caused by a protozoan parasite *Theileria parva* and is transmitted to cattle by the three-host tick, *Rhipicephalus appendiculatus*. Intensive acaricide application has remained the method commonly used to control ECF and other tick-borne diseases. Chemotherapeutic drugs are also used to treat the disease and are more successful if diagnosed early.

One alternative strategy to control ECF is the infection-and-treatment immunisation method where the animal is infected with live *Theileria parva* parasites and simultaneously treated with long acting oxytetracyclines. The resulting immune response coupled with sublethal natural challenge protects the animal against the disease for the rest of its life. The method has been applied in several field trials in East Africa with varying degrees of success using selected stocks of *T. parva*. Irvin *et al.* isolated and characterised a *Theileria* parasite stock from Kilifi District of the Coast Province of Kenya referred to as "*Theileria parva* Marikebuni" and has been demonstrated to have wide immuno-protective properties. This stock provides good protection against severe challenge from other stocks from Kilifi District. Cross-immunity experiments under laboratory conditions have shown that *T. parva* Marikebuni cross protects with some 28 isolates of *T. parva* from the Coast, Rift Valley, Nyanza and the Central Provinces of Kenya. However, this was the first time that *T. parva* Marikebuni was used under field conditions outside the Coast and Central regions of the country to immunise cattle against ECF.

Besides reduced risk of mortality from ECF, the other benefit to farmers following immunisation against ECF is the reduction in costs attributed to tick control and subsequently the increased productivity. Immunised cattle have been shown to record higher weight gains than the non-immunised cattle in high ECF risk areas irrespective of the tick control method. However, the risk from other tick-borne diseases such as anaplasmosis, babesiosis and heartwater, may limit adoption of a reduced tick control strategy following immunisation against ECF. There is also little information on the optimum intervals that can be adopted before immunised animals may be at risk from heavy tick challenge.

The objective of the study was to establish whether *T. parva* Marikebuni parasite stock (stabilate 316) protected cattle against the local strains of *T. parva* in the Rongai area of Nakuru District and the associated decrease in the number of ECF cases.

Materials and Methods

Study area

The study was carried out in Rongai Division of Nakuru District in the Central Rift Valley region of Kenya. The study area is located about 20 km West of Nakuru Town (179 km North-West of Nairobi) and lies at a latitude of 0° 15'S and longitude 36° and an altitude of 1,890-2,100 metres above sea level. The area receives a mean annual rainfall of 850-950 mm and a mean annual temperature of 19°C (17°C to 28°C). The area falls under the low highlands subhumid (LH3) agro-ecological zone.

Experimental design

The trial was implemented in three phases between March 1997 and March 1999. The first phase comprised of collection of farm biodata and selection of the farms. The second phase involved immunising the animals against ECF (using the Marikebuni stabilate 316) while in the third phase (post immunisation phase) of the study, the cattle were subjected to reduced frequency of tick control.

Phase 1—Collection of farm biodata and selection of farms

The first phase comprised of holding single subject interviews with the farmers using questionnaires to get information on the farm size, number of animals on the farm, farming practices and the number of cases of tick-borne diseases recorded during the previous year. The information generated was used in the selection of the farms that were used in the study. A total of eight eligible farmers were interviewed. The selection criteria for the farms included availability of at least 200
target animals (calves and yearlings), functional
dip, a high potential incidence of ECF based on
seroprevalence, morbidity and mortality risk
records. The farmer had to consent to the
immunisation and subsequent changes in the tick
control programme. The farmer also had to accept
associated risks like loss of milk production,
reactions to the vaccine and to allow total
separation of the study animals from the herd
during the entire period of the study.

Based on the above criteria, three farms were
purposively recruited (Mwathii, Karanja and
Bomet farms) located within a radius of 7 km
from one another. The farms were coded as farms
1, 2 and 3 respectively. Two hundred and thirty
six calves and yearlings were recruited into the
study from the three farms, as detailed below.

Farm 1 was approximately 1,000 acres in size.
This farm practised mixed farming with crops
being the major activity. The farm had 350 cattle,
all of them Friesian on a free grazing system.
Ninety six animals (calves and yearlings) were
randomly recruited into the study.

Farm 2 was approximately 300 acres in size.
About 15% of the land was under crops while the
rest was under animal husbandry. The farm had
201 cattle comprising mainly of Ayrshire and a
few Friesian breeds on a free grazing system.
Eight four animals were randomly recruited into
the study.

Farm 3 was approximately 3000 acres in size.
The farm practised mixed farming, but the major
activity being the keeping of dairy cattle. There
were 300 head of cattle mainly Friesian and
Charolais-Friesian crosses kept on a free grazing
system. Fifty six animals were randomly recruited
into the study.

From each farm, the selected animals were
randomised into four groups of equal size. The
randomisation was blocked on body weights within
the farm and accomplished using a table of
random numbers for groups of consecutively-
ranked weights in groups of four (one animal to
each treatment group). The animals were either
dipped strategically (once every three weeks) or
tactically when the total number of adult ticks (of
all species) counted on half of the body reached
or exceeded 50 on an individual animal.

Group 1: Immunised and dipped strategically.

Group 2: Immunised and dipped tactically.

Group 3: Not immunised and dipped
strategically.

Group 4: Not immunised and dipped tactically.

Phase 2-Immunisation phase

Immunisation was done using *T. parva*
Markebuni stabilate 316 at a dilution of 1:40. The
stabilate was stored in 0.5 ml aliquots in plastic
straws and kept in a portable liquid-nitrogen
container. The plastic straws were removed from
the nitrogen container and thawed by rubbing
between the palms of the hand and dispensed
into a universal bottle. The dilution was made
using Eagles Minimum Essential Medium with
3.5% w/v bovine plasma albumin to which 7.5%
v/v glycerol was added.

The stabilate was inoculated subcutaneously
below and in front of the left prescapular lymph
node. A long acting oxytetracycline formulation
(Tetroxy® LA; Bimeda chemicals, Dublin, Ireland)
was used as a blocking agent at 20 mg per kg
body weight administered intramuscularly. Rectal
temperatures were recorded on alternate days
between day 14 and 28 post-immunisation. Blood
smears and pre-scapular lymph node biopsies
were taken from any animal with temperature
above 39.4°C, stained in Giesma and examined
for the presence of theilerial piroplasms and
schizonts respectively. Blood smears were also
examined for other haemo-parasites such as
anaplasma and babesia. Any immunised animal
developing a febrile response with a high theilerial
schizont parasitosis for at least three days was
designated as an “ECF reactor”. “Reactors” were
treated with buparvaquone (Butalex®, Pitman-
Moore, Harefield, U.K.) at a dosage of 2.5 mg/kg
body weight while cattle showing clinical
anaplasmosis were treated with imidocarb
dipropionate (Imizol®, Pitman-Moore, Harefield,
U.K.). Animals in all treatment groups were bled
at the beginning of the trial (day 0) and day 35
after immunisation to determine the levels of
antibodies to *T. parva*. Antibody titres were
determined by the Indirect Fluorescent Antibody Test (IFAT)\textsuperscript{14}. The IFAT has a specificity and sensitivity of 90\% and 80\% respectively.

**Phase 3-Post-immunisation phase**

This phase started eight weeks after immunisation. The phase lasted 45 weeks on farm 1 and farm 3 while on farm 2 the trial was terminated during the 30\textsuperscript{th} week of the phase due to reasons unrelated to the experiment. Each of the three farms’ dips were emptied and filled with Triatix\textsuperscript{\textregistered} (12.5\% w/v Amitraz, Coopers, Kenya) at the beginning of this phase. Triatix was chosen because the marketing company had an efficient dip management network in the country and no tick resistance to any of the amitraz products had been reported in the study area. Dip samples were tested every three weeks and correct dip strengths maintained throughout the trial period. Tick counts of the adult stage (of all tick species) were carried out on half the body of any 20 animals that happened to be herded into the crush at the time of the tick counts per treatment group every three weeks just before dipping. The total tick infestation was estimated by doubling the figure. Tick identification was done visually during the tick counts.

All the study animals were dewormed at the beginning and after six months with oxendazole 2.265\% w/v (Systamex\textsuperscript{\textregistered}, Coopers, Kenya) at a dosage of 1 ml / 9 kg/body weight.

All animals were monitored daily for signs of clinical disease. Blood samples were taken from any animal with clinical symptoms of ECF or any other tick borne disease. Appropriate treatment was given depending on confirmed diagnosis. Necropsies were performed by a veterinarian on the animals that died irrespective of the cause. All animals were bled every six weeks to determine antibody levels to ECF using the IFAT.

At the end of this phase, all the control animals together with the rest of the farm animals that had not been immunised (except a few of the animals that were either pregnant or ill) on farm 1 and farm 3 were immunised against ECF. The dipping regimen for all the animals was changed to once very three weeks. The animals were observed for another 52 weeks for tick-borne diseases and tick infestations.

Comparisons of the number of cases of ECF and other tick-borne diseases between the treatment groups were analysed by Chi-square ($\chi^2$) using the 2 x 2 tables. The mean half body counts under the two tick control regimes (tactical and strategic) were compared using a paired t-test. A probability value of less than 5\% was used to denote a significant difference.

**Serology**

Forty randomly selected animals on each farm were bled for serological testing to verify exposure to *T. parva*. Antibodies to *T. parva* were determined using the Indirect Fluorescent Antibody Test (IFAT) with *T. parva* schizont antigen\textsuperscript{14}. Farms with 20-50\% seropositivity to *T. parva* were selected while farms with a seropositivity of less than 20\% were considered not ideal for the trial as either the tick control was stringent or the tick challenge was too low. A seropositivity of more than 50\% was not ideal as most of the animals had been exposed to *T. parva* and hence were probably immune to the local strains of the parasite.

**Results**

Pre-immunisation serology of the 236 cattle showed that 28.8\% (34/118) of the immunised animals and 23.7\% (28/118) of the non-immunised animals had antibodies to *T. parva* respectively. Five weeks after immunisation 95\% (112/118) of the immunised cattle and 27.1\% (32/118) non-immunised animals were sero-positive respectively. Only 2.5\% (3/118) of the immunised animals reacted to the immunisation and developed clinical ECF and were treated successfully. To achieve adequate protection of the immunised animals, a seroconversion of at least 90\% is required at the dilution used in the experiment (1:40) and the acceptable reactor rate should not exceed 10\% of the immunised animals.

**Number of cases of tick-borne diseases during the post-immunisation phase**

A total of 12 cases of clinical ECF were recorded on the three farms during the trial (Table 1). Three cases of the disease occurred in the immunised animals while the other nine cases occurred in the non-immunised animals (irrespective of the dipping regime). One case each occurred in the immunised and non-immunised animals under the strategic dipping regime. There were ten cases of ECF in the non-immunised animals under tactical tick control.
compared to two cases in immunised animals under the same tick control regime.

Anaplasmosis was the only tick-borne disease confirmed in two of the three farms. Four and two cases occurred in strategically and tactically dipped animals respectively (Table 2).

**Table 1: ECF cases in immunised and non-immunised animals**

<table>
<thead>
<tr>
<th>Immunisation Against ECF</th>
<th>Tick control</th>
<th>Trial farm</th>
<th>Total cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farm 1 N=24</td>
<td>Farm 2 N=21</td>
<td>Farm 3 N=14</td>
</tr>
<tr>
<td>Yes Strategic</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Yes Tactical</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No Strategic</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No Tactical</td>
<td>0</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 2: Anaplasmosis cases in immunised and non-immunised animals**

<table>
<thead>
<tr>
<th>Immunisation Against ECF</th>
<th>Tick control</th>
<th>Trial farm</th>
<th>Total cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farm 1 N=24</td>
<td>Farm 2 N=21</td>
<td>Farm 3 N=14</td>
</tr>
<tr>
<td>Yes Strategic</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yes Tactical</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No Strategic</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>No Tactical</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 3: Tactical dippings during the post immunisation phase**

<table>
<thead>
<tr>
<th>Farm code</th>
<th>No. of tactical dippings</th>
<th>Time period (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>from the start of the phase to the dipping</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>12 and 21</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>36</td>
</tr>
</tbody>
</table>

**Tick counts**

Only four tick species (Rhipicephalus appendiculatus, Boophilus decoloratus, Rhipicephalus evertsi and Hyalomma marginatum) were observed on the cattle on the farms during the trial. A total of 10 R. appendiculatus and 14 B. decoloratus were observed on eight of the trial animals on the first day of the tick control relaxation phase. The highest count on an individual animal was five ticks. No ticks were observed on the other trial animals.

*Rhipicephalus evertsi* was the most abundant tick species on strategically dipped animals (Figure 1) while *Boophilus decoloratus* was the most abundant species among the tactically dipped animals (Figure 2). The maximum half body count on an individual animal among the strategically dipped animals was 42 while the highest count on the tactically dipped animals was 208. There was a small peak for this tick species between June and August while a much bigger peak occurred between October and November.

*Rhipicephalus evertsi* was the second most abundant species on tactically dipped animals with a maximum half body count of 30 (Figure 2). The mean half body counts ranged between 0.02 and 6.66. The tick numbers peaked between March and May.

*Rhipicephalus appendiculatus* numbers were low throughout the trial under both dipping regimes. The mean half body counts ranged between 0 and 0.70 (Figure 1). The highest count on an individual animal was 14. Most of the infestation took place between January and March. Very few *Hyalomma marginatum* ticks were recorded. A total of 14 ticks were observed with the highest count on an individual animal being three. There were two tactical dippings on farm 2, one on farm 3 and none on farm 1 during the trial (Table 3).

During the 52 week observation period at the end of the trial, there was no substantial increase in the tick loads. There were three cases of ECF among the non-immunised animals. No case of ECF was recorded among the immunised animals.
Figure 1: Mean half body counts on strategically dipped cattle

Figure 2: Mean half body counts on tactfully dipped cattle
Statistical analysis

Using the Chi-square test ($\chi^2$), the number of cases of ECF between the immunised and non-immunised groups (irrespective of the dipping regime) were compared. There was no significant difference in the number of cases of ECF between the two groups ($\chi^2=3.11$, $P<0.05$). There was also no significant difference in the number of cases of anaplasmosis between the tactically and strategically dipped animals ($\chi^2=2.74$, $P<0.05$). Tactically dipped animals had a significantly higher mean half body tick counts than the strategically dipped animals $t$-test ($P<0.05$).

Discussion

Prior to the trial, there was intensive tick control on the three farms (although farm 3 was using under strength acaricide). The low tick burdens on the farms at the start of the trial could be partly explained by the intensive tick control on the farms. The temperature and rainfall pattern of the area provide marginal conditions for *R. appendiculatus* (allowing only a short seasonal peak activity of the ticks between January and March). The dymex model\textsuperscript{15} does predict low tick loads for the entire Nakuru District throughout the year. Total tick burdens were maintained at very low levels in animals dipped once every three weeks. Although tick burdens were significantly higher in tactically than in strategically dipped animals, the levels were still low on all the three farms. There was a total of three tactical dippings on the three farms during the 45 weeks of tick challenge. The three dippings would compare to 52 conventional regular once weekly dippings suggesting that tick control may be reduced drastically in Nakuru District. The degree of relaxation of acaridical control in an area where cattle have been immunised against ECF will depend on the intensity of tick challenge and the presence of other tick-borne diseases\textsuperscript{11}. At low levels of acaricide use, loss in productivity because of tick infestation is not significant if other tick-borne diseases can be controlled.

Although the number of cases of ECF recorded during the study were too few to establish the efficacy of the ECF vaccine (Marikebuni stabilate) in the area, tick control frequency in Rongai could be reduced under the prevailing level of tick challenge to once every three weeks without exposing the animals to an increased risk of contracting tick-borne diseases. A study on both small scale and large scale farms did show that the most preferred ECF control strategy taking into account the farmer’s risk preference is immunisation with 75% reduction in the cost of acaricide use\textsuperscript{10}.

In spite of the fact that the cost/benefit aspect of immunising against ECF under reduced tick control in Rongai was not addressed by the study, from the number of tactical dippings carried out and the number of cases of tick borne diseases recorded, it appears possible to achieve a 75% reduction in the costs of acaricide use in the area. Depending on the frequency of acaricide use, the annual costs of controlling ticks on cattle in the country range between Kshs. 850 to 3,300 per animal (Veterinary Department, personal communication). At a relaxed tick control frequency of once every three weeks, this results into a 67% reduction in acaricide costs. Thus the farmers will save between Kshs. 567 and 2,300 per animal. Large scale farmers in the area with more than 500 animals will save up to a million shillings annually, thereby greatly improving their net incomes.

There are also indirect benefits to be derived from reduced tick control frequency. These include decreased loss of animal traction time spent trekking to and from the dip tanks. There is also less stress on the animals as a result of the decreased frequency in going through the dip tanks or spray races. Besides, the farmers will be able to cut down on human labour. Decreased use of acaricides will result into less environmental pollution.

A longer term study may be necessary to establish the efficacy of the vaccine in the area. A parallel study using the same design (Wanjohi et al., unpublished) carried out in Kitale, in the North Rift Valley region but in the same agroecological zone (LH3) where the tick challenge was higher demonstrated that the vaccine provided adequate protection against ECF. There is thus evidence that under field conditions, *T. parva* Marikebuni is efficacious in locations like Trans Nzoia District some 800 kilometres from the area where the parasite was isolated in the Coast Province.
It is only after the efficacy of the vaccine has been established in the Rongai area that general recommendations may be made as to the appropriate dipping interval for the area. In the mean time, the farmers (who have immunised their animals against ECF) could be helped (cautiously) to save on the acaricide and therefore increase their net incomes by continual monitoring of the level of tick challenge at the farm level and adjusting the dipping regime accordingly to avoid outbreaks of tick borne diseases.

Acknowledgements

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References


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BOVINE TUBERCULOSIS: A CROSS SECTIONAL AND EPIDEMIOLOGICAL STUDY IN AND AROUND ADDIS ABABA

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TUBERCULOSE BOVINE : UNE ETUDE TRANSVERSALE ET EPIDEMIOLOGIQUE A ADDIS ABEBA ET DANS SES ENVIRONS

Résumé

Un examen avec la tuberculine a été fait à Addis Abéba et dans ses environs en Ethiopie, afin de déterminer la prévalence de la tuberculose bovine. Au total, 1.241 animaux étaient testés à la tuberculine avec une seule expérience à la tuberculine cervicale intradermique. L’information épidémiologique a également été recueillie en tenant compte des facteurs choisis pour leur importance épidémiologique et des modes d’élevage du bétail local. Des échantillons de lait et/ou de prélèvements nasal étaient en outre collectés des animaux qui ont réagi à la tuberculine. La proportion inégale, le test $\chi^2$ et les régressions logistiques simples et multiples par étapes étaient appliquées pour analyser les données.

Parmi les bovins testés, 128 (10.31%) avaient une réaction positive, 47 troupeaux (40%) avaient des animaux positifs. Les bovins des grands troupeaux et ceux des troupeaux élevés dans de mauvaises conditions avaient beaucoup plus de réactions positives ($P < 0.05$). Le risque d’avoir une réaction positive variait également avec l’âge et l’état des animaux. D’autres facteurs tels que l’emplacement, la race, l’état physiologique et la conformation ne semblaient pas beaucoup contribuer à l’infection tuberculeuse dans la zone couverte par l’enquête. Environ 9% des animaux qui ont réagi (n = 91) excréttaient des mycobactéries. Quatre des souches étaient des Mycobacteria bovis parmi lesquelles deux étaient à croissance rapide, tandis que les deux autres n’ont pas pu être déterminées même si elles étaient parmi les souches à croissance lente.

Les résultats de cette enquête confirment l’hypothèse selon laquelle l’infection tuberculeuse bovine est toujours associée aux facteurs de risque habituels, à savoir : la taille du troupeau, les conditions d’élevage et l’âge de l’animal.

Abstract

Tuberculin testing was carried out in and around Addis Ababa region of Ethiopia to determine the prevalence of bovine tuberculosis. A total of 1,241 animals were tested by means of the single intradermal cervical tuberculin test. Epidemiological information was also collected, taking into account factors chosen for their epidemiological importance and of the local livestock husbandry characteristics. Milk and/or nasal swab samples were additionally collected from tuberculin reactors. Odds Ratio, $\chi^2$-test, simple and multiple stepwise logistic regressions were applied to analyse the data.

Of the cattle tested, 128 (10.31%) were positive reactors; 47 (40%) herds contained positive animals. Cattle in larger herds, and in herds under poor management conditions were more likely to give positive reactions ($P < 0.05$). The risk of a positive reaction varied also with the animal’s age/parity. Other factors, such as mixing, location, breed, physiological state and body condition scores did not appear to significantly contribute to tubercular infection in the study area. About 9% of the reactors (n = 91) excreted Mycobacteria. Four of the isolates Mycobacterium bovis, two were rapid growers, and the other two isolates could not be determined although they were among the slow growers.

The results of this survey support the hypothesis that bovine tubercular infection is still associated with the classical risk factors: herd size, management condition, and age of the animal.

Introduction

Ethiopia possesses the highest number of livestock in Africa, with an estimated 33.8 million cattle. Despite this huge resource, Ethiopian livestock productivity is lower than the African average. The major biological constraints contributing to low productivity include the low genetic potential of the animals, poor nutrition and prevailing diseases.

Programmes in the country are now aimed at encouraging milk production through smallholder
and other dairy schemes to answer the increased demand for milk and milk products. This increased demand will be partly met by an intensification of animal production. Unfortunately enough, animal tuberculosis has shown close links with intensive management systems, and can spread rapidly when there is inadequate veterinary supervision\textsuperscript{1,2}.

Bovine tuberculosis caused by \textit{M. bovis}, has been eliminated as an animal health problem, in most of the developed countries, but still remains one of the most prevalent and devastating diseases of cattle in developing countries. Jointly with other diseases, it seriously affects the productivity of the livestock industry in these countries, by reducing milk production, the food value of carcass, and reproduction\textsuperscript{3,4}. While these bottlenecks relate to the development of the dairy industry throughout the world, the disease attains much of its importance from being a zoonosis, causing human tuberculosis.

In developing countries, especially Africa where \textit{M. bovis} infection is present in various animal species, there is a substantial lack of knowledge of the distribution, epidemiological patterns and zoonotic implication of this important disease. Animals gathering at watering points, markets, and in pens overnight, can play a key role in the maintenance and spread of \textit{M. bovis} under traditional farming conditions\textsuperscript{4}. With increased sizes of cattle herds and intensified production in many developing countries, these classic conditions prevail and are aggravated in the virtual absence of adequate monitoring and control measures for the widespread transmission of \textit{M. bovis} to human populations. A further cause of considerable concern is that a significant amount of milk produced is being marketed through unsupervised and informal channels. In line with this Yehualashet\textsuperscript{5} was able to isolate \textit{M. bovis} from four of 31 milk samples in Ethiopia, indicating the risk of transmission to humans, especially to children\textsuperscript{6}.

It has been stated that tuberculosis infects a third of the world human population, and in some African countries the incidence is said to have doubled in the last decade\textsuperscript{5}. The dramatic increase in reported cases of human tuberculosis caused by \textit{M. tuberculosis} associated with HIV\textsuperscript{7,8}, has suggested that there might be a similar increase in the incidence of human tuberculosis caused by \textit{M. bovis} and \textit{M. avium} complexes, also in association with HIV infection. Such an increase would inevitably result in the transmission of the disease from human beings, not only to other human beings but also to animals, thereby further increasing the level of \textit{M. bovis} (and other Mycobacteria) in the environment. On the assumption that infection due to tubercular and other atypical Mycobacteria might be common in cattle as well, the present investigation was undertaken to determine the prevalence and gather information on risk factors for bovine tuberculosis in cattle, to isolate and identify Mycobacteria from secretions of animals and, to relate the laboratory findings with some zoonotic aspects of the disease.

\section*{Materials and Methods}

\subsection*{Study Area}

The study was conducted in Addis Ababa, between March and July, 1999. According to the 1994 census, there were 58,568 heads of cattle

<table>
<thead>
<tr>
<th>Zone</th>
<th>No. of Woredas/ districts</th>
<th>No. of farms</th>
<th>Proportion</th>
<th>No. of cattle</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>9</td>
<td>5.52</td>
<td>85</td>
<td>6.28</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>9</td>
<td>5.52</td>
<td>67</td>
<td>4.95</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>68</td>
<td>41.72</td>
<td>487</td>
<td>35.97</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>55</td>
<td>33.74</td>
<td>453</td>
<td>33.47</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>21</td>
<td>12.88</td>
<td>257</td>
<td>18.98</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1</td>
<td>0.61</td>
<td>5</td>
<td>0.37</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>163</td>
<td>100</td>
<td>1,354</td>
<td>100</td>
</tr>
</tbody>
</table>
in the area, distributed in 5,167 farms. The average animal number per farm was 11.36. In the same year, 163 private dairy holders founded the Addis Ababa Dairy Producers Association. These dairy farms make up about 2.32% of the total and are distributed unevenly in different zones (Table 1). The dairy animals kept are primarily pure breed exotic cattle, which have been produced through artificial insemination.

**Cattle Selection**

Two zones (3 and 4, Table 1) were selected from the six zones, on the ground that about 76% of the farms registered under the Association are located there. Within the two zones, all farms and all animals within each farm were selected for the study. Five herds containing Boran, and Friesian/Jersey-Boran crosses and belonging to one national research station were additionally included. The single intradermal cervical tuberculin test was performed on all the study animals.

**Data collection**

Each of the farms was sequentially numbered according to the date and time of visit. The size of the farm, farm condition and location were recorded. The owners were also interviewed for the duration of the dairy operation and for the possibility of introducing animals from other farms. In each of the farms, animals were identified by the owners/workers. The individual animal ear tag number or the animal's name was recorded and each animal was given a sequential identification number within the herd. Breed and sex were recorded. Age was recorded for young animals, and parity was registered for cows. In case of uncertainty as to the animal's age or parity, this particular information was omitted from the analysis.

Body condition scoring was made using a method developed for dairy cattle. Anatomical structures such as the tail head, brisket and transverse processes of the lumbar vertebrae, the ribs and hips were used as references for body condition scoring.

**Tuberculin Test**

Cattle were restrained and the hair was clipped from the lateral side of the middle part of the neck. Each of the animals was then injected with bovine purified protein derivative (PPD), prepared from strain AN5, produced by W.D.T., Hoyerhagen, Germany. Pre-set syringes (0.1 ml) were used to inject 50,000 I.U. of tuberculin per ml, intradermally with a short sterile needle inserted obliquely into the deeper layer of the skin on the neck. The skin fold thickness was measured prior to and approximately 72 h post injection using a dial type caliper and recorded. An increase in skin fold thickness of four units and above was taken as a positive reaction.

**Bacteriology**

Milk samples, from tuberculin reactors were collected from previously washed udders into 50 ml sterile universal tubes as previously described. Nasal swabs were also taken using sterile cotton tipped applicator sticks into 20 ml centrifuge tubes. The samples were kept in a cool box and transported to the laboratory, stayed overnight at 4°C prior to processing for subsequent cultivation. Processing for cultivation was conducted in the Microflow Biological Safety Cabinet (MDH Ltd., Hampshire).

For cultivation, about 30 ml of the milk sample was transferred into a sterile tube and centrifuged at 3,000 g for 15 minutes at 4°C. The supernatant was discarded, part of the sediment was used to make smears for direct microscopy and the remaining sediment response-suspended using 2 ml of sterile water. The swab was also put in a sterile tube into which 2 ml of sterile water was added. Into each tube with milk and swab, 2 ml of sodium hydroxide (NaOH, 2%) was added for decontamination and left at room temperature for 15 minutes. Neutralization was effected with concentrated HCl using phenol red as an indicator.

Neutralized suspensions were similarly centrifuged (as above), the supernatant discarded and about 2 ml of the sediment used as inoculum. Primary isolation of Mycobacteria was done on standard Lowenstein-Jensen (LJ) medium, and on LJ medium without glycerol but supplemented with 0.4% pyruvate. For cultivation, about 1 ml of the sediment from each sample was seeded onto the surface of each of the culture medium and incubated at 37°C, at an angle for the first
week and in upright position for up to eleven weeks observation for visible growth. Smears from the sediment before decontamination and from cultures with evidence of growth were taken, air dried and heat fixed by passing several times through the bunsen flame. The smears were stained by the Ziehl-Nielsen method for microscopic examination of acid-fast bacilli as described. Positive cultures were sub-cultured onto another set of media and incubated for another four to six weeks for further identification. Identification of isolates of mycobacteria was based first on growth on the LJ medium colony morphology. Further characterization was done using nitrate reduction and niacin production tests as previously described.

Data Analysis

The prevalence rate was calculated on the basis of tuberculin reactivity, dividing the number of reactors by the total number of animals tested. Similarly, herd level prevalence was computed as the number of herds with at least one reactor divided by the total number of herds tested. For statistical analysis a two-stage process was applied. In the first stage measures of association between each determinant and the outcome variable were calculated as an unadjusted odds ratio (OR). These were tested for statistical significance by a $\chi^2$ test for independence (Statgraphics Plus 2.1 and Microsoft Excel). In the second stage, putative risk factors were evaluated using unconditional multiple logistic regression, using SPSS. Reduction procedure module was built, by use of the stepwise backward procedure, with removal based on the likelihood-ratio statistic and $P<0.05$.

Results

Herd Level Characteristics

During the survey 93 herds from commercial ‘Dairy Association’ and five herds from the National Research farms were tested. Table 2 gives the number of farms selected in each zone and summarises the tuberculin test results. Herd size showed significant association with tuberculin reaction of animals ($\chi^2=25.71; p<0.001$; Table 3-a). Additional test involving regression and correlation between herd size and proportion of reactors (Figure 1) also indicated moderately strong positive correlation ($r=0.55$).

Reactor rates of 54.3% and 44.4% were recorded for farms under poor and good management conditions, respectively. These rates differ significantly ($p=0.02$, Table 3-b). Mixing of animals from different farms (purchase, grazing, mating, etc.), location and operation years of the farms did not seem to be significantly associated with tuberculin sensitivity in the multivariate analysis (Table 3-b) although in the univariate analysis (Table 3-a) older farms and farms in which mixing of animals is practised possess higher proportion of reactors.

Animal Level Characteristics

During the survey 1,241 cattle were tested. Of these 128 reacted to the test, giving an overall reactors rate of 10.31% (Cl=8.7-12.1). Parity specific rates, showing significant variation ($\chi^2=39.57, p<0.001$) are illustrated in Figure 2 and Table 4-a.

Reactors rate observed for animals in different physiological states, i.e., open (non-milking, non-pregnant), milking, pregnant, and milking and pregnant was depicted on Table 4-a. These rates did not significantly differ when young animals were excluded from the analysis. Similarly, breed and body condition scores did not seem to be

<table>
<thead>
<tr>
<th>Zone</th>
<th>Tested</th>
<th>Positive</th>
<th>(95% CI)</th>
<th>$\chi^2$</th>
<th>Tested</th>
<th>Positive</th>
<th>(95% CI)</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>42</td>
<td>15</td>
<td>35.7 (21.6-52.0)</td>
<td></td>
<td>501</td>
<td>38</td>
<td>7.6 (5.3-10.03)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>46</td>
<td>22</td>
<td>47.8 (32.9-63.1)</td>
<td></td>
<td>378</td>
<td>56</td>
<td>14.8 (11.3-18.8)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>10</td>
<td>100 (71.5-100.0)</td>
<td></td>
<td>362</td>
<td>34</td>
<td>9.4 (6.83-13.1)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
<td>47</td>
<td>48.0 (37.8-58.3)</td>
<td>13.37</td>
<td>1,241</td>
<td>128</td>
<td>10.31 (8.7-12.1)</td>
<td>12.64</td>
</tr>
</tbody>
</table>

| (0.001) | (0.002) |
Table 3-a: Association between positive reaction to the tuberculin test in a farm and recorded variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Tuberculin Test</th>
<th>% positive (95% CI)</th>
<th>Odds Ratio</th>
<th>χ² (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
<td>(95% confidence interval)</td>
<td></td>
</tr>
<tr>
<td>Farm operation in years</td>
<td>&lt;10&quot;</td>
<td>6</td>
<td>24</td>
<td>20.0 (7.7-38.6)</td>
</tr>
<tr>
<td></td>
<td>10-20</td>
<td>20</td>
<td>16</td>
<td>56.0 (38.1-72.1)</td>
</tr>
<tr>
<td></td>
<td>&gt;20</td>
<td>20</td>
<td>11</td>
<td>65.0 (45.4 - 80.8)</td>
</tr>
<tr>
<td>Location</td>
<td>Peri-urban</td>
<td>29</td>
<td>34</td>
<td>46.0 (33.4 - 59.1)</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>18</td>
<td>17</td>
<td>51.4 (34.0 - 69.6)</td>
</tr>
<tr>
<td>Herd size</td>
<td>&lt;10&quot;</td>
<td>19</td>
<td>44</td>
<td>30.1 (19.2 - 43.0)</td>
</tr>
<tr>
<td></td>
<td>10-24</td>
<td>15</td>
<td>7</td>
<td>68.2 (45.1 - 86.1)</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>13</td>
<td>0</td>
<td>100 (75.3 - 100)</td>
</tr>
<tr>
<td>Mixing of Animals</td>
<td>No</td>
<td>21</td>
<td>36</td>
<td>36.8 (24.4 - 50.7)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>26</td>
<td>15</td>
<td>63.4 (46.9 - 77.8)</td>
</tr>
<tr>
<td>Management Condition</td>
<td>Poor</td>
<td>19</td>
<td>16</td>
<td>54.3 (36.7 - 71.2)</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>26</td>
<td>35</td>
<td>44.4 (31.9 - 57.5)</td>
</tr>
</tbody>
</table>

* For farm establishment and herd size, the risk for each category is compared with a baseline group.
** Risk Ratio, Odds Ratio could not be calculated, 0 in one cell.

Table 3-b: Multiple logistic regression analysis at the herd level

<table>
<thead>
<tr>
<th>Variable</th>
<th>Log Likelihood Ratio (LR)</th>
<th>-2 Log LR</th>
<th>DF</th>
<th>Significance of Log LH ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation years</td>
<td>-43.006</td>
<td>3.239</td>
<td>2</td>
<td>0.1980</td>
</tr>
<tr>
<td>Herd size +</td>
<td>-57.825</td>
<td>25.061</td>
<td>2</td>
<td>0.0000</td>
</tr>
<tr>
<td>Management condition +</td>
<td>-46.567</td>
<td>5.614</td>
<td>1</td>
<td>0.0178</td>
</tr>
<tr>
<td>Mixing</td>
<td>-43.760</td>
<td>1.507</td>
<td>1</td>
<td>0.2196</td>
</tr>
<tr>
<td>Location</td>
<td>-41.387</td>
<td>0.055</td>
<td>1</td>
<td>0.8138</td>
</tr>
<tr>
<td>Zone +</td>
<td>-48.222</td>
<td>8.925</td>
<td>2</td>
<td>0.0115</td>
</tr>
</tbody>
</table>

+ Variables proved significant

Eight of the cultures yielded Mycobacteria, 16 were contaminated and 67 were negative. Four of the isolates were identified as *M. bovis*. Two of the positive cultures showed rapid growth and were confirmed by microscopy; however, further identification was not possible as they were overgrown by contaminants. Likewise, two other positive cultures failed to show a workable size.

Significantly associated with the test outcome (Table 4-b).

**Bacteriology cultures**

Samples for culture on LJ medium were obtained from 91 animals. Acid fast bacilli were not found in any of the inoculates prior to culture.
of colonies in the subsequent subculture and were discarded.

Discussion and Conclusions
The overall tuberculin reactors rate in this study of 10.31% is slightly lower than a previous report\(^6\). The lower prevalence rate may be due to the fact that the earlier investigation had come from samples from unusually high prevalence farms (large size government farms instead of small or medium size private farms).

The proportion of farms giving a positive reaction varied significantly between investigated zones (Table 2). This is in agreement with previous reports\(^{14,15}\) in which it was stated that the large body of data arising from tuberculosis control programmes in cattle showed substantial variation in both incidence and prevalence rates between geographical regions and between farms.
### Table 4-a: Distribution of tuberculin test results for 1,241 cattle in and around Addis Ababa according to physiological state, parity, body condition scores and breed of animal

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test Result</th>
<th>Odds Ratio</th>
<th>(confidence limits)</th>
<th>$\chi^2$-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological state</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>open</td>
<td>5</td>
<td>56</td>
<td>8.20</td>
<td>18.50</td>
<td>0.001</td>
</tr>
<tr>
<td>milking</td>
<td>65</td>
<td>304</td>
<td>14.16</td>
<td>2.8 (1.72-4.67)</td>
<td>2.5 (1.23-4.08)</td>
</tr>
<tr>
<td>pregnant</td>
<td>20</td>
<td>180</td>
<td>10.00</td>
<td>1.9 (1.02-3.59)</td>
<td></td>
</tr>
<tr>
<td>milking &amp; pregnant</td>
<td>15</td>
<td>105</td>
<td>12.50</td>
<td>2.5 (1.23-4.08)</td>
<td></td>
</tr>
<tr>
<td>young*</td>
<td>22</td>
<td>379</td>
<td>5.49</td>
<td>1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
<td>38.16</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>young*</td>
<td>7</td>
<td>203</td>
<td>3.33</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>heifers</td>
<td>22</td>
<td>241</td>
<td>8.37</td>
<td>2.7 (1.12-6.26)</td>
<td></td>
</tr>
<tr>
<td>parity 1 &amp; 2</td>
<td>59</td>
<td>248</td>
<td>19.22</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>parity 3-5</td>
<td>28</td>
<td>211</td>
<td>11.72</td>
<td>4.84 (1.37-5.86)</td>
<td></td>
</tr>
<tr>
<td>Body Score</td>
<td></td>
<td></td>
<td></td>
<td>1.26</td>
<td>0.53</td>
</tr>
<tr>
<td>poor</td>
<td>30</td>
<td>224</td>
<td>11.81</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>medium*</td>
<td>56</td>
<td>502</td>
<td>10.04</td>
<td>0.9 (0.58-1.36)</td>
<td></td>
</tr>
<tr>
<td>good</td>
<td>16</td>
<td>106</td>
<td>13.11</td>
<td>1.1 (0.59-2.16)</td>
<td></td>
</tr>
<tr>
<td>Breed</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>0.002</td>
</tr>
<tr>
<td>local</td>
<td>9</td>
<td>35</td>
<td>20.45</td>
<td>4.8 (1.90-11.90)</td>
<td></td>
</tr>
<tr>
<td>exotic</td>
<td>107</td>
<td>837</td>
<td>11.33</td>
<td>2.3 (1.29-4.23)</td>
<td></td>
</tr>
<tr>
<td>cross*</td>
<td>14</td>
<td>239</td>
<td>5.53</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* The risk for each category is compared with a least reacting group in a series.

### Table 4-b: Multiple Logistic Regression Analysis at the Animal Level

<table>
<thead>
<tr>
<th>Variable</th>
<th>Log LR</th>
<th>-2 Log LR</th>
<th>DF</th>
<th>Significance of Log LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td>-240.767</td>
<td>2.936</td>
<td>2</td>
<td>0.2304</td>
</tr>
<tr>
<td>Parity/age group +</td>
<td>-243.764</td>
<td>8.929</td>
<td>3</td>
<td>0.0302</td>
</tr>
<tr>
<td>Body condition</td>
<td>-239.575</td>
<td>2.936</td>
<td>2</td>
<td>0.7590</td>
</tr>
<tr>
<td>Status</td>
<td>-240.144</td>
<td>1.690</td>
<td>4</td>
<td>0.7925</td>
</tr>
</tbody>
</table>

* Variable proving significant
within regions. As herd size increased, so did the risk of cattle within the herd showing a positive reaction. The proportion of reactors also varied correspondingly with herd size, showing a moderately strong positive correlation. This result is consistent with previous reports\textsuperscript{2,14} and may arise from the fact that because of increased contact, lateral spread of infection within a herd may be flavoured increasing the probability of infection than is usually the case with small size herds.

There are numerous reports documenting that poor housing and other poor managerial inputs predispose to tubercular infection\textsuperscript{2,16,17}. There is also some evidence that an animal's resistance to tuberculosis is reduced by a shortage of feed and/or an unbalanced diet, attributable to a deficiency of protein, minerals and vitamins in the diet\textsuperscript{18}. Accordingly, in the current study herds under poor management conditions were shown to have significantly higher rate of reactors than those under good management.

In contrast to the reported observation\textsuperscript{17}, mixing of animals did not seem to be associated with increased risk of tuberculosis although a high proportion of farmers in the study area share bulls and purchase in-heifers from a common source. Accordingly, older farms and recently established farms did not significantly differ in infection rates, as a result of this high mixing practices.

Reactors rate for farms located in the vicinity of the city (urban) was slightly higher than those located at the periphery (peri-urban). It is likely that once confined, as is usually the case with intensive farming systems, animals remain susceptible, irrespective of the location.

The survey revealed a very low reactor rate for young animals. This finding is in consent with many works\textsuperscript{1,8}. Similarly, in agreement with the work of Cook et al.\textsuperscript{14}, lower reactors rate was also observed for older animals. It is possible that in the young animals infection might have not been acquired, but the older ones might have lived with the disease for some time; as the disease is frequently progressive in cattle\textsuperscript{1,15,19}, the presence of progressive lesions provides sufficient repeated antigenic stimulation and leads to the temporary depression of skin reactivity\textsuperscript{12,20}. This situation is frequently observed with tuberculin testing in short period intervals\textsuperscript{21,22}.

Physiological status of the animals was not seen to be significantly associated with the test outcome, when young animals were excluded from the analysis. This supports the findings of Cook et al.\textsuperscript{14}, but it is at variance with those of Francis et al.\textsuperscript{23} (1978) and Wood et al.\textsuperscript{22} (1991), who claimed that pregnant animals show lower reactivity as a result of stress-induced immune suppression\textsuperscript{22,23}.

In agreement with a previous report\textsuperscript{15}, body condition scores were not seen to have an effect on tuberculin reactivity. This finding is in contrast to the established fact that poor nutrition predisposes to tubercular infection\textsuperscript{16,17,24}.

Breed based analysis indicated no significant superiority of the local, autochthonous cattle. This contradicts with earlier reports\textsuperscript{2,5}. Previous work\textsuperscript{17,25} reported not only higher prevalence rates in local Zebu cattle, but prevalence in cross-bred cattle also was lower than in pure breeds; these results agree with the current report.

In this study, 8.7% of 46 combined milk and nasal swabs, and 6.1% of 33 nasal swab samples did contain tubercle bacilli. This isolation rate was relatively high in comparison to other works\textsuperscript{5,11} and may be attributed to the fact that milk and nasal swab samples were combined for individual animal in most cases.

Although the number of \textit{M. bovis} positive samples was low, it indicated that the habit of pooling milk in Addis Ababa area does pose a great public health danger to milk consumers. Kleeberg\textsuperscript{26} has indicated that one cow can excrete enough viable bacilli to contaminate the milk of up to a hundred cows, when their milk is pooled.

Isolation of \textit{Mycobacterium} from 6.1% of the nasal swabs taken is lower than findings in other reports\textsuperscript{27}. This figure could be expected to increase, perhaps dramatically, by sequential sampling, a technique consistently recommended for the detection of tuberculosis in human cases where morning pooled samples are taken over several days.

The results of the study support the
hypothesis that in the urban and peri-urban dairy production systems of Addis Ababa, bovine tuberculosis is associated with classical risk factors of herd size, herd management and age of infected animals. It was not possible to obtain data on the level of mycobacterial infection in dairy farming families, but human tuberculosis is on the increase in African countries, running concurrent with increasing prevalence of HIV-infection. A proper assessment of the contribution of bovine mycobacterioses in Ethiopia to the overall number of human infections will therefore require further work in the field.

Acknowledgements

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References


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LES MALADIES CUTANÉES DES BOVINS DANS LES PARCOURS DU SUD DE L’ETHIOPIE : ASPECT ÉPIDEMIOLOGIQUE FACE AUX EFFORTS DE DEVELOPPEMENT

Résumé

Une étude de terrain, visant à fournir des informations sur la situation des maladies cutanées dans les parcours du sud de l’Éthiopie, a été menée avec des bovins Boran élevés dans des conditions villageoises. Un questionnaire normalisé a été utilisé pour recueillir des informations de la part des pasteurs. On a eu recours à des méthodes formelles d’examen clinique et à des tests classiques de laboratoire pour confirmer les cas. Quatre-vingt-sept troupeaux, qui comptent 1.690 têtes de bovins avec des animaux ayant des lésions cutanées selon l’interview réalisée auparavant, ont servi pour l’enquête. Des lésions ont été détectées chez 308 têtes de bovins (21,8%). Les maladies cutanées identifiées comme étant un obstacle à l’élevage bovin comprenaient: la dermatophilose, la demodicose, les infestations de gale sarcoptique et psoropique et la parafilarioses.

L’étude a montré que la taille du troupeau et la saison n’avaient aucun effet sur la prévalence de la maladie, ce qui montre que d’autres déterminants du milieu sont associés à l’épidémiologie des maladies cutanées dans la zone couverte par l’étude. Les déterminants possibles étaient : les tiques, les mouches, les broussailles épineuses, l’utilisation économique des animaux et l’usage abusif des médicaments.

La présente étude révèle l’apparition des maladies cutanées chroniques chez les bovins face aux efforts de développement et essaie de sensibiliser l’opinion à la menace qu’elles constituent pour l’élevage bovin dans les parcours du sud de l’Éthiopie.

Abstract

A field study to provide information on the status of skin diseases in southern Rangeland of Ethiopia was carried out with Boran cattle kept under village condition. A standardised questionnaire was used to obtain information from the herdsman. Formal methods of clinical examination and classical laboratory tests were used to confirm the cases. Eighty-seven herds, with 1,690 head of cattle, where the presence of animal with cutaneous lesions had been reported through the previously administered interview were included in the study. Lesions were detected in 21.8% (308/1,690) head of cattle. Skin diseases which were identified as possible constraints to raising cattle included dermatophilosis, demodicosis, sarcoptic and psoroptic mange infestations and parafilariasis.

The study showed that herd size and season had no influence on the disease prevalence indicating that other environmental determinants were associated with the epidemiology of skin diseases in the study area. The possible determinants were ticks, flies, thorny bushes, economic use of the animals and indiscriminate use of drugs.

The present study revealed the emergence of chronic skin diseases in cattle in the face of development interventions, and raises awareness of the potential threat they pose for raising cattle in the Southern Rangeland.

Introduction

The Southern Rangeland is one of the three rangelands in Ethiopia occupying 13% of the country’s land surface. It covers an area of 160,000 Km² and supports over 1.7 million cattle (almost 5.6% of the national cattle population). The area experiences a bimodal equatorial rainfall, the rainfall increasing from a low 500 mm in the lower altitude areas of the south to about 700 mm in the north\(^1\). The timing, quantity and intensity of rainfall are highly variable.

People inhabiting the area are mostly Borana pastoralists. Although the Borana keep small stock and occasionally camels, the main focus of their production system is milk from their cattle. The extensive cattle management system prevailing in Borana area makes the herds prone

\(^1\) Corresponding author.
to several adverse effects, among which, disease and drought problems are the most important.

Since the late 1960s, the region has been subject to a development programme (Southern Rangeland Development Unit, SORDU), under the umbrella of the national Third Livestock Development Project (TLDP). The disease control programme of the development unit has brought most of the devastating diseases under control, leading to increase in the number of livestock in the area. The inputs provided by SORDU, like water ponds, have led to the congregation of livestock in most arable lands, which would otherwise be abandoned. These facts led to the highly aggregated cattle population within the Rangeland. With the fulminating, epizootic diseases largely under control, the more chronic and insidious diseases assume greater prominence.

The purpose of this study was to estimate the prevalence of chronic skin diseases as a consequence of development interventions. An attempt was also made to elucidate the relative importance and draw epidemiological pictures of each disease entity and, recommend appropriate corrective measures.

Materials and Methods

Study Area and Study Population

The study was conducted in three areas of Southern Rangeland, that is, the northern (Yavello), the western (Taltalle), and the central (Mega) portions, where the range potential is good and hence cattle predominate. The southern (Moyale) and eastern (Liban) portions, where the range potential is relatively poor and hence camels predominate were not included.

Water and forage constraints have led to the evolution of a system of maintaining two herds. First, the "worra"herd which consists primarily of lactating cows and a few bulls and always based near pastoral encampments and, second, the for a herd which consists of non lactating or pregnant females, some bulls and generally a high proportion of immature cattle and these are free ranging, grazing large areas thus exploiting more favourable conditions. Due to accessibility problems, the relatively permanent or sedentary "worra"herds were included in the study.

Herd Identification

Sixty-six, 53 and 42 herds were included in the study from Yavello, Mega and Taltalle areas respectively based on willingness of owners to cooperate. Prior to the start of the study, a seven page questionnaire format was prepared, pre-tested in the field and thereafter administered to all the herds. The first phase of the questionnaire was meant to establish the presence of animals with skin lesion(s). The owners (n=87) who agreed to participate in the study were recruited and were visited during morning hours for detailed inspection of the herds. This number included 31, 34 and 22 owners from Yavello, Mega and Taltalle areas, respectively. Morning visit was preferred to get in touch with every animal in the "kraal", before being let-out for grazing.

Data Collection

All animals in each "kraal" were counted individually and their number recorded. Those with gross skin lesion were also counted and recorded, thus, the rate of 'lesioned' to the whole was computed. Age and economic use of the study animals were obtained from questionnaires forwarded to the owners.

Clinical Diagnosis, Sample Collection and Laboratory Diagnosis

Visual inspection of external surfaces of all the animals in a given "kraal" was made as an initial step towards diagnosis. Animals with skin lesions such as loss of hair, crust and nodule formation, constant scratching and chuffing and persistent bleeding points were singled out for detailed investigation. Subsequently, skin scrapings from suspected or clinically diseased animals were collected using a clean scalpel blade dipped in paraffin oil. Scrapings were taken ensuring coverage of adequate depth and all peripheral angles of the lesion, and from at least two different body parts of the animal. The sample was collected into a wide mouthed glass tube, transferred onto slide with two to three drops of 10% Potassium hydroxide solution and heated
gently for about 15 minutes\textsuperscript{3,5}. It was then examined directly for the evidence of mange mites or their eggs, using the lower power objective of the microscope after the cover slip was put over, or, fixed with 70% methanol and stained with Giemsa for the demonstration of Dermatophilus organisms\textsuperscript{6,7}. Demodex organisms were detected directly under the lower power objective of the microscope, from direct smears prepared from the pus obtained by squeezing the nodules\textsuperscript{4}. Parafilaria organisms on the other hand, were detected directly from the active bleeding points\textsuperscript{5}. History, clinical manifestations and laboratory results were all used to arrive at a final diagnosis\textsuperscript{3}. Animals with lesions were then categorised according to etiological agent involved, age and economic use of the animal, area of origin and season in which the investigation was undertaken.

**Data Analysis**

A Chi-square statistic and Odds Ratio were used to test differences in prevalence and distribution of skin lesions as appropriate and a P-value of ≤ 0.05 was set for significance. In the analyses, the least affected group in a series was

### Table 1: Major types of skin diseases identified in the Southern Rangeland

<table>
<thead>
<tr>
<th>Disease type</th>
<th>Calves positive</th>
<th>Calves negative</th>
<th>Adults positive</th>
<th>Adults negative</th>
<th>Total positive</th>
<th>Total negative</th>
<th>Aetiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dermatophilosis</td>
<td>35</td>
<td>210</td>
<td>236</td>
<td>1209</td>
<td>271</td>
<td>1,419</td>
<td><em>Dermatophilus congolensis</em></td>
</tr>
<tr>
<td>Demodicosis</td>
<td>25</td>
<td>220</td>
<td>87</td>
<td>1,358</td>
<td>112</td>
<td>1,578</td>
<td><em>Demodex bovis</em></td>
</tr>
<tr>
<td>Mange mites</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>1,425</td>
<td>20</td>
<td>1,670</td>
<td><em>Sarcoptes scabei</em> &amp; <em>Psoroptes spp.</em></td>
</tr>
<tr>
<td>Parafilariaasis</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>1,433</td>
<td>12</td>
<td>1,678</td>
<td><em>Parafilaria bovicola</em></td>
</tr>
</tbody>
</table>

### Table 2: Distribution of skin diseases for 1,690 cattle examined in the Southern Rangeland

<table>
<thead>
<tr>
<th>Variable</th>
<th>Disease positive</th>
<th>Disease negative</th>
<th>%positive</th>
<th>X\textsuperscript{2} (p-value)</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Group</td>
<td></td>
<td></td>
<td></td>
<td>1.24 (&gt;0.1)</td>
<td>1.20 (0.9 – 1.71)</td>
</tr>
<tr>
<td>Calves</td>
<td>60</td>
<td>185</td>
<td>24.5</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Adults +</td>
<td>308</td>
<td>1,137</td>
<td>21.3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Seasonal Effect</td>
<td></td>
<td></td>
<td></td>
<td>2.61 (&gt;0.1)</td>
<td>1.40 (0.9 – 2.1)</td>
</tr>
<tr>
<td>Wet Season</td>
<td>65</td>
<td>186</td>
<td>25.9</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Dry Season +</td>
<td>53</td>
<td>213</td>
<td>19.9</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
<td>3.57 (&gt;0.1)</td>
<td>1.46 (1.0 – 2.2)</td>
</tr>
<tr>
<td>Mega</td>
<td>118</td>
<td>399</td>
<td>22.8</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>Tallalfe +</td>
<td>39</td>
<td>193</td>
<td>16.8</td>
<td></td>
<td>1.37 (0.9 – 2.0)</td>
</tr>
<tr>
<td>Yavello</td>
<td>151</td>
<td>545</td>
<td>21.7</td>
<td></td>
<td>52.98 (&lt;0.001)</td>
</tr>
<tr>
<td>Economic Trait</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>Milk Cows +</td>
<td>185</td>
<td>685</td>
<td>21.3</td>
<td></td>
<td>3.65 (2.6-5.3)</td>
</tr>
<tr>
<td>Ploughing Oxen</td>
<td>72</td>
<td>73</td>
<td>49.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

+ Reference group in the analysis.
Table 3: Comparison of skin diseases among different herd size categories

<table>
<thead>
<tr>
<th>Herd size</th>
<th>Average no. in a herd</th>
<th>Average no. affected</th>
<th>% affected</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (&lt;15)</td>
<td>13</td>
<td>3</td>
<td>23.1</td>
<td>1.20 (0.3-5.8)</td>
</tr>
<tr>
<td>Medium (16-50)</td>
<td>30</td>
<td>6</td>
<td>20.0</td>
<td>1</td>
</tr>
<tr>
<td>Large (&gt;50)</td>
<td>84</td>
<td>18</td>
<td>21.4</td>
<td>1.09 (0.4-3.1)</td>
</tr>
</tbody>
</table>

+ Reference group in the analysis

taken as a reference.

Results

From 1,690 animals examined 21.8% (308/1,690) were seen with different skin pathology. Dermatophilosis recorded the highest prevalence (16%) followed by demodicosis (6.6%), mange mites (1.2%) and parafilariousis (0.7%). About 2.8% of the animals exhibited mixed infections of dermatophilosis with others (Table 1).

Table 2 shows the number of individual animals tested, their age category, economic traits and the area from which they came. Altogether, 1,690 animals from extensively managed 'worra' herds were investigated. This number included 245 young stock which were kept separately in group, and 1,445 adult animals.

Age specific infection rate for dermatophilosis was 14.3 and 16.3% in calves and adult animals respectively. These rates indicated no statistically significant difference in susceptibility of the age categories ($\chi^2=0.65$, $p>0.1$). Similar study on Demodex infection revealed a prevalence of 10.4 and 6.0% in calves and adult animals, respectively. The differences in infection rates between the two groups was significant ($\chi^2=5.9$, $P<0.05$).

Oxen, which are mainly kept for ploughing purposes, had a significantly higher rate of skin lesions compared to milk cows (OR=3.7, CI=2.6–5.3). Age dependent study on the other hand revealed no significant differences between infection rates for calves and adult animals (OR=1.2, CI=0.9–1.7). Similarly, season, herd size and the geographic areas were not significantly associated with the outcome (Tables 2 & 3).

Discussion

The prevalence of skin diseases in the study area is generally high and dermatophilosis recorded the highest prevalence with no statistically significant difference in susceptibility of the age categories. This finding contradicts with previous works\(^8,9\), which held the opinion that calves are more susceptible.

A 16.3% prevalence reported in this study is much higher when compared to previous works done in Ethiopia\(^10,11\). This can be due to sampling method, but other factors do exist which can contribute to the elevated prevalence. These include abundance of ticks of *Amblyomma* species\(^12\), thorny bushes which can traumatisate the skin and inflict wounds\(^6,7,10\) and frequent acaricide wash during dry season which creates moist condition thereby compensating for the lower and insufficient moistening effect of the rain\(^2\).

Demodicetic mange was found in 10.4 and 6.0% of the calves and adult animals respectively. The difference in infection rates between the two age groups was significant and was consistent with the work of Aiello and Mays\(^8\), but varies from Blood, et al\(^6\), who, although acknowledge calves to be susceptible, reported most of the cases in adult dairy cattle.

A 6% infection rate mentioned in this study in adult animals was higher when compared to previous report of 0.84% prevalence rate in cattle of this age category\(^13\). Frequent drought condition in the Southern Rangeland may have an impact, as demodicosis is usually seen in animals under poor nutritional conditions. Koutz et. al\(^4\), reported
Demodex in 53% of normal skin, and predisposing factors, such as age, poor condition and intercurrent infections can lead to development of clinical disease\textsuperscript{14}. Among older animals, demodicosis was mainly observed in cows, those near term or lactating. The periparturient relaxation in immunity may aggravate helminth parasites\textsuperscript{5,15} and this might have an impact on the status of demodicosis.

The association between demodicosis and dermatophilosis has been noted for long and is said to be severe\textsuperscript{6,10,11}. In this study the association was seen in about 2.3% of older animals examined, or in about 41.9% of total Demodex infection observed.

The Sarcoptic/Psoroptic mange infestations of 1.2% observed on the animals was lower than other previous reports\textsuperscript{12}. The difference may be due to environmental effect (highland vs. lowland), but extensive acaricide application by Borana pastoralists with intention of controlling ticks might have contributed to the lower prevalence\textsuperscript{3}.

The association between mange mites infestation and dermatophilosis has been noted by many workers\textsuperscript{6,8,10,12,13}. It seems that continuous licking and scratching which soften the skin and further oozing of serum create an ideal environment for penetration and propagation of *Dermatophilus congolensis* organisms.

The prevalence rate of 0.7% observed for Parafilarisiasis in the animals examined was very low compared to reports from other parts of the African continent. Carmichael and Koster\textsuperscript{16} reported a 36% prevalence in the northern Transvaal\textsuperscript{16}. The low figure in this study may be due to time of inspection of the herds, which is morning hours, whereas, clinical evidence of the disease is mostly seen when animals are exposed to direct sunshine\textsuperscript{5,15}. As is the case with others, 33.3% of Parafilarisiasis cases was seen in association with dermatophilosis. Gravid females puncture the skin to lay eggs\textsuperscript{5,15} thus, disrupting integrity of the skin and causing blood to ooze thus predisposing animals to dermatophilosis. A significantly higher rate of skin diseases in oxen compared to cows is probably due to trauma inflicted by whip when threshing them to keep in line during ploughing.

Differently from what was previously reported\textsuperscript{6,8}, season had no significant contribution to the problem of skin diseases. It is probably that animals congregate near watering points during the dry season increasing the probability of contact or the low intensity of rain does not surmount a frequent acaricide wash during the dry season. The relationship between season and skin diseases in general and to dermatophilosis in particular needs further elucidation over extended period.

The present study puts into perspective the emergence of chronic skin diseases in the face of development interventions, and raises awareness of the potential threat they pose for raising cattle in the Southern Rangeland of Ethiopia.

**Acknowledgements**

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**References**


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THE EFFECT OF TRICLABENDAZOLE (FASINEX®) ON ACUTE FASCIOLOSIS IN SHEEP IN CENTRAL HIGHLAND OF ETHIOPIA

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EFFET DU TRICLABENDAZOLE (FASINEX®) SUR LA FASCILOSE AIGUE CHEZ LES MOUTONS DANS LES HAUTS-PLATEAUX DU CENTRE DE L’ETHIOPIE

Résumé

Une étude a été menée entre octobre et décembre 1999 au Centre de recherche agricole de Sheno, afin d’évaluer l’effet du Triclabendazole (Fasinex®) sur la fasciolyose chez les moutons infectés naturellement. L’étude a été réalisée grâce à des examens cliniques et fécaux, et au contrôle de l’hématocrite (H) et du poids vif (PV) avant et trois semaines après le traitement. La fasciolyose due à F. hepatica représentait 73,1% de la mortalité chez les moutons nécropsiés avant le traitement. La prévalence de la fasciolyose avant le traitement au Triclabendazole a d’aprèx l’examen fécal était de 21,8%. Les signes cliniques étaient l’abdomen ballonné avec du liquide à la moindre palpation, l’œdème submandibulaire, la conjonctivite pâle, l’émaciation, la faiblesse, la position couchée et la mort. Les valeurs moyennes de l’hématocrite variaient entre 22 et 25,6%. Un traitement au Triclabendazole a entraîné une augmentation significative de l’hématocrite (H) allant de 25,6 à 29,3% (P < 0,001), ce qui concordait avec la guérison ultérieure du troupeau de moutons traités, même si on n’a pas observé de différence remarquable de poids vif (PV) trois semaines après le traitement (P > 0,05). Il n’y avait pas de gain de H et PV chez les moutons-témoin non traités (P > 0,05). La variation de H et PV parmi les différents groupes d’âge a été constatée. Après le traitement, aucun œuf de F. hepatica n’a été détecté dans les fèces des animaux traités. En revanche, tous les animaux-témoin non traités avaient des œufs de F. hepatica avec une prévalence de 100% dans leurs fèces. Le choix des médicaments et les stratégies de lutte contre la fasciolyose sont recommandées.

Abstract

A study was conducted between October and December, 1999 at the Shero Agricultural Research Centre (ShARC) to assess the effect of Triclabendazole (Fasinex®) on fasciolosis in naturally infected sheep. This was done through clinical and faecal examinations, packed cell volume (PCV) and live weight (LWT) monitoring before and three weeks after treatment. Fasciolosis caused by F. hepatica accounted for 73.1% of the mortality in necropsied sheep before treatment. The prevalence of fasciolosis before treatment with Triclabendazole as assessed by faecal examination was 21.8%. Clinical signs were swollen abdomen with fluid upon gentle palpation, submandibular oedema, pale conjunctiva, emaciation, weakness, lateral recumbency and death. Mean PCV ranged from 22-25.6%. An intervention with Triclabendazole resulted in a dramatic increase of PCV from 25.6 to 29.3% (P<0.001). This related well with the subsequent recovery of the treatment sheep flock although no significant difference in LWT was observed three weeks after treatment (P>0.05). There was no gain in PCV or LWT in the non-treated control sheep (P>0.05). Variation in PCV and LWT among different age groups was observed. After treatment, no eggs of F. hepatica were detected in faeces of treated animals. On the contrary, all non-treated (control) animals had eggs of F. hepatica with a prevalence of 100% in their faeces. Choice of pharmaceuticals and control strategies are recommended.

Introduction

Helminthosis is of considerable significance in a wide range of agro-climatic zones in sub-Saharan Africa and constitutes one of the most important constraints to small ruminant production. Among helminth diseases, fasciolosis, caused by Fasciola hepatica and F. gigantica is one of the most important diseases in the highlands of Ethiopia resulting in high morbidity and mortality. Over 45% mortality rate ascribed to fasciolosis in adult sheep was reported at Debre Berhan, Ethiopia. In another report in the highlands, fasciolosis was the second important disease after bronchopneumonia and the most important helminth infection both on-station and on-farm. Control strategies by using pharmaceuticals (fasciolicides) and vaccines (against clostridial infections) combined with pasture management.
using epidemiological information has been recognized to effectively minimize the infection level thereby increasing productivity\textsuperscript{6,7}.

Triclabendazole (Fasinex\textsuperscript{6}), a benzimidazole fasciocide, is known to have a high efficacy against juvenile and adult flukes\textsuperscript{6}. Its spectrum of activity is very specific for *F. hepatica*, *F. gigantica*, and *Fascioloides magna* but lacks activity against nematodes, cestodes and other trematodes. Its effectiveness on juvenile flukes as young as one week and adult flukes 14 weeks of age has been well documented\textsuperscript{6}. Therefore, this study was conducted to assess the effect of Triclabendazole (Fasinex\textsuperscript{6}, Ciba-Geigy Ltd., Switzerland) on acute fasciolosis and the rate of recovery in naturally infected sheep.

**Materials and Methods**

**Study location**

Sheno Agricultural Research Centre (ShARC) is located in the central plateau of Ethiopia at an altitude of 2,800 m above the sea level, Latitude 07°10'N, Longitude 39°21'E and 70km north-east of the capital city, Addis Ababa. The grazing land size of the centre is 58 hectares. The mean annual rainfall from 1988 to 1997 was 945.4 mm with a bimodal rainfall pattern: a long rainy season that extends from June to September and a short rainy season from February to May. The area has a mean maximum temperature of 18.5°C and a mean minimum temperature of 6.1°C with a relative humidity of 68.7%. Frost occurs usually between the months of October and January. The natural pasture is dominated by *Andropogon absynicus* and *Sporobolus africanaus* with varying proportions of *Trifolium* spp. The soil type is *pellustert* or *calcic vertisol*\textsuperscript{9}.

**Sheep Management and Health Interventions**

The study was conducted between October and December, 1999. The animals at risk were 1,100 Menz and Awassi cross Menz sheep. The Menz breed has been described\textsuperscript{10}. Awassi sheep were introduced from Israel in early 1980s with the aim of increasing wool and mutton production of indigenous sheep. The natural habitat of Menz sheep is the northern part of the country within 39°-40° E Longitude, 10°N Latitude, and an altitude range of 2,500-3,000 m above the sea level.

The sheep were supplied with grass hay, mineral lick and water ad lib. Additionally, they were given a commercial concentrate at 100-400g head\textsuperscript{-1} day\textsuperscript{-1} depending on their age and physiological state.

They were dewormed with Albendazole (Vermiprazole\textsuperscript{6}, Laboratorios Hipra, S.A. Amer, Spain) in June and August and with Oxyclozanide and Levamisole HCl (Levafas\textsuperscript{6}, Norbrook Laboratories Ltd., United Kingdom) in early October, sprayed with Chlorfenvinphos (Steladone\textsuperscript{6}, Ciba-Geigy Limited, Basle, Switzerland) against ectoparasites in January and June, 1999. Vaccination has been carried out against sheep pox and anthrax annually and

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>Age range (years)</th>
<th>Total number of sheep in the group</th>
<th>Number of sheep sampled</th>
<th>Treatment\textsuperscript{1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male weaners</td>
<td>0.3-1.0</td>
<td>61</td>
<td>8</td>
<td>Treated</td>
</tr>
<tr>
<td>Female weaners</td>
<td>0.3-1.0</td>
<td>96</td>
<td>9</td>
<td>Treated</td>
</tr>
<tr>
<td>Selection ewes</td>
<td>1.3-4.0</td>
<td>295</td>
<td>15</td>
<td>Treated</td>
</tr>
<tr>
<td>Reproduction ewes</td>
<td>1.3-4.0</td>
<td>200</td>
<td>14</td>
<td>Treated</td>
</tr>
<tr>
<td>Control</td>
<td>1.2-4.0</td>
<td>27</td>
<td>9</td>
<td>Untreated</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>679</td>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{1} Triclabendazole (Fasinex\textsuperscript{6}) bolus was given at a dose rate of 10mg kg\textsuperscript{-1} body weight.
against pasteurellosis biannually using vaccines produced by the National Veterinary Institute, Ethiopia. Individual animals were examined clinically and treated for infectious diseases with different antibiotics. Mortalities were recorded as they occurred and post-mortem examinations were performed to ascertain cause of death.

**Experimental design**

A total of 55 out of the 697 sheep from different age and experimental groups were sampled randomly. The number of sheep used by age, experimental group and treatment is illustrated in Table 1. The experimental groups were those that were identified for different experiments prior to this trial and the same identification was used for easy sampling. They were two age groups (weaners and adults) and two treatment groups, treated for fasciolosis with Triclabendazole (Fasinex®, Ciba-Geigy Ltd., Switzerland) at a dose rate of 10mg kg⁻¹ body weight orally and untreated. Sheep were treated in mid-November, 1999. The untreated had not received any anthelmintic treatment prior to this trial.

Sampling was done both at pre- and post-treatment. Pre-treatment sampling was done one day before treatment whereas post-treatment sampling was three weeks after the treatment.

**Faecal examinations**

Faecal samples were taken directly from the rectum. Egg counts for strongyles were done using the modified McMaster method and expressed as eggs per gram (EPG) of faeces. The presence of eggs of Fasciola, other trematodes, nematodes and cestodes was detected by sedimentation and floatation techniques. Sedimentation was done by centrifugation at 3000 rpm for five minutes. Parasitic eggs were floated upon adding salt of zinc sulphate.

**Packed cell volume (PCV) determination and live weight (LWT) measurements**

Blood samples were collected from all animals before and three weeks after treatment by puncturing the ear vein and allowing blood to flow directly into a heparinised capillary tube. The tubes were then centrifuged in a microhaematocrit centrifuge at 12000 rpm for five minutes after which the hematocrit values were read using a PCV reader and expressed as a percentage of PCV.

Body weight (LWT) changes were monitored by weighing animals before and three weeks after treatment using a 100kg weighing scale graduated at 100g intervals fitted in a suspended weighing crate.

**Statistical analysis**

The experiment involved two treatment levels (treated and untreated), two age groups (weaners and adults) and five experimental groups (control, selection and reproduction ewes, male and female weaners). The dependent variables analysed were PCV and LWT. Data were analysed using the General Linear Model (GLM) procedure of the Statistical Analysis Systems Institute.

**Results**

An outbreak of fasciolosis occurred between the months of October and November, 1999 (Table 2) despite regular treatment with broad spectrum anthelmintics such as Albendazole and Levafas® (containing Oxyclozanide and Levamisole). Fasciolosis caused by *F. hepatica* accounted for 73.1% (Table 2 and 3) of the mortality in necropsied sheep before treatment with

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of cases</th>
<th>Percent positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasciolosis</td>
<td>68</td>
<td>73.12</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>5</td>
<td>5.38</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>5</td>
<td>5.38</td>
</tr>
<tr>
<td>Monezinosis</td>
<td>1</td>
<td>1.08</td>
</tr>
<tr>
<td>Enteritis</td>
<td>1</td>
<td>1.08</td>
</tr>
<tr>
<td>Pregnancy toxaemia</td>
<td>1</td>
<td>1.08</td>
</tr>
<tr>
<td>Unknown*</td>
<td>12</td>
<td>12.90</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>93</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

*Most of the unknown cases were those of the lambs.*
Triclabendazole. All age groups were affected. Clinical signs observed in the affected animals were swollen abdomen with fluid upon gentle palpation, submandibular oedema, pale conjunctiva, emaciation, weakness, lateral recumbency and death. Over three quarters of the sheep flock had shown most of these signs.

Except for some female weaners, the average PCV dropped below normal (22-25.6%) as a result of infection. An intervention with the benzimidazole fasciolicide, Triclabendazole (Fasinex®) resulted in a dramatic highly significant increase in mean PCV (P<0.001, Table 4). This was reflected in the subsequent recovery of the treated sheep flock although no significant difference in LWT was observed three weeks after treatment (P>0.05).

The effect of treatment on PCV among different experimental groups is given in Table 5. All treated groups had a highly significant gain in mean PCV (P<0.001) as compared to the non-treated control, sheep in which there was no significant PCV gain (P>0.05).

Weaner lambs had significantly higher PCV than adults (P<0.05). However, both groups responded to the treatment (P<0.001, Table 6). No significant increase in LWT by 0.8 kg was recorded in weaners three weeks after treatment (P>0.05) and no change wet season found in adults (Table 6).

The prevalence of fasciolosis before treatment intervention with Triclabendazole as assessed by faecal examination was 21.8% (Table 7). After treatment, no eggs of *F. hepatica* was detected in faeces of treatment animals. On the contrary, all non-treated (control) animals had eggs of *F. hepatica* (prevalence =100%) in their faeces.

### Discussion
Fasciolosis was the primary cause of sheep mortality in the ShARC during the two months (October and November, 1999): at the beginning of the dry season) causing severe damage to the liver. Serious fasciolosis has been reported earlier to occur at three critical times (in the dry, short and long rainy seasons) in a year in the highland of Ethiopia. Previous studies in similar agro-ecology in the highlands showed that transmission of *Fasciola* parasites was high towards the end of the wet season, resulting in fatalities 8-14 weeks later in the dry season. In another study made using raeer lambs at the International Livestock Research Centre (ILRI),

### Table 3: Proportion of sheep infected with *F. hepatica* in necropsied sheep between October and November, 1999

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number necropsied</th>
<th>Number positive</th>
<th>Percent positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaners†</td>
<td>37</td>
<td>25</td>
<td>67.57</td>
</tr>
<tr>
<td>Adult‡</td>
<td>56</td>
<td>43</td>
<td>76.79</td>
</tr>
<tr>
<td>Overall</td>
<td>93</td>
<td>68</td>
<td>73.12</td>
</tr>
<tr>
<td>Experimental group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>2</td>
<td>2</td>
<td>100.00</td>
</tr>
<tr>
<td>Selection ewes</td>
<td>27</td>
<td>21</td>
<td>77.78</td>
</tr>
<tr>
<td>Reproduction ewes</td>
<td>27</td>
<td>20</td>
<td>74.07</td>
</tr>
<tr>
<td>Male weaners</td>
<td>22</td>
<td>17</td>
<td>77.27</td>
</tr>
<tr>
<td>Female weaners</td>
<td>15</td>
<td>8</td>
<td>53.33</td>
</tr>
<tr>
<td>Overall</td>
<td>93</td>
<td>68</td>
<td>73.12</td>
</tr>
</tbody>
</table>

†Weaners = sheep between 4 and 12 months of age  
‡Adults = sheep whose age is above 12 months

### Table 4: Least squares means of PCV and LWT pre- and post-treatment

<table>
<thead>
<tr>
<th></th>
<th>PCV (%)</th>
<th>LWT (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>***</td>
<td>NS</td>
</tr>
<tr>
<td>Pre-</td>
<td>25.5</td>
<td>20.4</td>
</tr>
<tr>
<td>Post-</td>
<td>29.3</td>
<td>20.7</td>
</tr>
<tr>
<td>Overall mean</td>
<td>26.7</td>
<td>20.5</td>
</tr>
<tr>
<td>RSD*</td>
<td>4.3</td>
<td>4.8</td>
</tr>
</tbody>
</table>

*P<0.001; NS= not significant, P>0.05  
*RSD = Residual standard deviation
Table 5: Least squares means of PCV pre- and post-treatment in different experimental groups

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>No. of sheep</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (untreated)</td>
<td>7</td>
<td>25.5 ± 1.6 a</td>
<td>25.6 ± 1.6 a</td>
</tr>
<tr>
<td>Selection ewes</td>
<td>14</td>
<td>23.9 ± 1.2 b</td>
<td>29.9 ± 1.2 a</td>
</tr>
<tr>
<td>Reproduction ewes</td>
<td>13</td>
<td>22.0 ± 1.2 b</td>
<td>25.1 ± 1.2 a</td>
</tr>
<tr>
<td>Male weaners</td>
<td>9</td>
<td>25.6 ± 1.4 b</td>
<td>30.3 ± 1.4 a</td>
</tr>
<tr>
<td>Female weaners</td>
<td>6</td>
<td>30.7 ± 1.7 b</td>
<td>31.9 ± 1.7 a</td>
</tr>
<tr>
<td>Overall</td>
<td>49</td>
<td>25.6 ± 0.7 b</td>
<td>29.3 ± 0.7 a</td>
</tr>
</tbody>
</table>

*aRow means with different superscript differ significantly (P<0.05)

Table 6: Change in mean PCV and LWT before and after treatment as affected by age of sheep

<table>
<thead>
<tr>
<th>Age group</th>
<th>PCV(%)</th>
<th>LWT(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>Weaners</td>
<td>27.6 (6.6) b</td>
<td>30.9 (4.1) b</td>
</tr>
<tr>
<td>Adults</td>
<td>23.5 (3.7) b</td>
<td>27.1 (4.2) b</td>
</tr>
</tbody>
</table>

Numbers in parentheses are standard deviations
Row means with different superscript differ significantly (P<0.05)

Table 7: Prevalence of fasciolosis before and after treatment as assessed by faecal examination

<table>
<thead>
<tr>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number examined</td>
<td>Number positive</td>
</tr>
<tr>
<td>Control</td>
<td>9</td>
</tr>
<tr>
<td>Selection ewes</td>
<td>15</td>
</tr>
<tr>
<td>Reproduction ewes</td>
<td>14</td>
</tr>
<tr>
<td>Male weaners</td>
<td>9</td>
</tr>
<tr>
<td>Female weaners</td>
<td>8</td>
</tr>
<tr>
<td>Overall</td>
<td>55</td>
</tr>
</tbody>
</table>

*Faecal examination is not a reliable indicator of the extent of infection as the immature flukes are the ones which cause serious damage to the liver resulting in death before even the eggs are detected in the faeces.9,17*

Debre Berhan Research Station between 1992 and 1994, it was revealed that transmission of F. hepatica takes place between September and January with a peak in December.5

Low PCV (22-25.6%) was recorded in the affected sheep flock prior to treatment with Triclabendazole. The effect of fasciolosis on the blood parameters has already been studied.17 Artificial infection of sheep with viable metacercariae of F. gigantica in gelatin capsules has been reported to result in rapid reductions of PCV and RBC counts nine weeks after infection.17

Both Albendazole and Oxyclozanide were not capable of controlling fasciolosis mainly due to the lack of activity against immature flukes.8 Efficacy of Triclabendazole on immature flukes brought a dramatic change in treated animals observed by an increased PCV and subsequent
recovery of affected sheep. Between 90 and
100% efficacy of Triclabendazole against
immature and mature flukes has been well
documented.

Treatment resulted in an increase of PCV by
3.7% three weeks after treatment. Additionally,
clinical signs disappeared a week after treatment.
These indicated that the animals had responded
to treatment.

In fasciolosis endemic areas, where frequent
response-infection is most likely, it is advisable
to use drugs that are effective against both
immature and mature flukes instead of using
pharmaceuticals with questionable or nil efficacy
on immature flukes in order to minimise heavy
losses. This should be coupled with strategic
drenching and vaccination interventions against
clostridial infections.

Acknowledgements
The support of the technical staff of ShARC
without whom this investigation would have been
impossible is highly appreciated.

References

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FACTORS AFFECTING MORTALITY IN RABBITS IN CAMEROON
R.T. FOMUNYAM, B.N. NDOPING and J.M. FOTSO
Mankon Research Station, Bamenda, P.O. Box 534, North-West Province, Cameroon
LES FACTEURS AFFECTANT LA MORTALITE CHEZ LES LAPINS AU CAMEROON
Résumé
Dans la première expérience sur les deux, les lapins étaient nourris de quantité graduelle de fibre; tandis que dans la deuxième, le besoin d’espace/lapin/cage a été étudié en vue de déterminer la quantité optimale de fibre et l’espace nécessaire pour réduire la diarrhée provoquant la mortalité.

Les lapins gagnaient beaucoup plus de poids (P<0.05) si on mettait 10% et 12% de fibre (régime A) dans leurs aliments par rapport à 8% et 14% (régime B). Les taux de mortalité étaient nettement plus faibles (P<0.05) avec le régime A comparé au régime B, ce qui indique que la quantité de fibre du régime A était suffisante. L’incidence de la diarrhée chez les lapins a considérablement baissé (P<0.01) à mesure que l’on augmentait la quantité de fibre dans leurs aliments.

Les lapins sevrés à 8, 11, 14 lapins/m² ou en groupes de 3, 4 et 5 lapins par cage grandissaient beaucoup plus vite (P<0.01) que ceux mis en cage séparément (3 lapins/m²) ou en groupes de 6 (17 lapins/m²). Les mortalités étaient très élevées (P<0.05) chez les lapins mis en cage en groupes de 5 et 6 par rapport aux lapins mis en cage séparément; en revanche elles étaient réduites pour ceux mis en cage en groupes de 4. Les taux de mortalité étaient très faibles pour les lapins mis en cage séparément, suivis par ceux qui étaient à 4 par cage, ce qui montre que ce dernier système (4/cage) est le plus approprié.

Abstract
In the first two trials, graded levels of fibre were fed rabbits while in the second trial space requirements per rabbit per cage were studies in order to determine the optimum level of fibre and space requirements needed to reduce diarrhoea leading to mortality.

The rabbits gained significantly (p<0.05) more weight at the 10% and 12% fibre inclusion levels in diets than at the 8% and 14% levels. Mortality rates were significantly (P<0.05) lower at the former levels than at the latter, suggesting that fibre levels at the former levels to be adequate. The incidence of diarrhoea in rabbits significantly (p<0.01) decreased as fibre level increased in diets.

Weaned rabbits at 8, 11, 14 rabbits/m² or in groups of three, four and five rabbits per cage significantly (p<0.01) grew faster than those caged singly (three rabbits/m²) or groups of six (17 rabbits/m²). Mortalities were significantly (P<0.05) higher in rabbits caged in groups of five and six than for rabbits caged singly and best for those caged in groups of four. Percent mortality values were lowest for rabbits caged singly, followed by those housed four per cage suggesting that the latter cage system to be the most appropriate.

Introduction
Although several factors contribute to the 30 to 60% mortality levels observed in rabbits in Cameroon, feeding and management are the major causes. The use of high digestible feed for young rabbits is the cause for concern because of high losses caused by diarrhoea and dysentery. Thus some of the major causes of death are inadequate dietary fibre content and imbalances in the digestive hydrochloric acid requirements. Fibre levels of 9-12% have been shown to be adequate in temperate zones. The question arises as to what are the optimum levels in the humid tropics of Cameroon.

The manual labour-intensive husbandry techniques (feeding, breeding, cage cleaning and dung removal) imply that rabbits must be grouped to save space, time and reduce production costs. Subsequently hygiene must be observed to minimize a contaminate environment.

Scientists in the field suggested that does and bucks be housed in cages measuring 30 inches (70cm) wide by 30 inches long and 20 inches (50cm) high. Does with eight-week old rabbits should be housed in cages measuring 75 cm long by 36 inches (80 cm) wide. Another scientist observed average mortality of 17.8% for rabbits weaned in groups of 28 rabbits/m² and
finished at 16 rabbits/m² (groups of seven rabbits per cage). On the other hand, other workers showed percent mortalities to average 12 for litters of 10 and 30 for litters of 12/m². Data on the effect of cage density on rabbit growth and health in the tropics is scanty. This study attempts to evaluate the effect of fibre level in diets and caging rabbits in groups on mortality.

Materials and Methods

**Trial 1**

Forty-eight weanling Mankon local strain of rabbits were fed four test diets (Table 1) with rice straw as the main source of fibre for six weeks. Rabbits were caged singly in metallic cages measuring 60 cm wide by 60 cm long by 45 cm high. Room temperature varied from 21-28°C and relative humidity varied from 68-80%. Feed (Table 1) and water were supplied *ad libitum*. Weekly feed intake and weight gains were recorded. There were 12 rabbits per treatment. Feedstuffs were analyzed at the Mankon Nutrition Laboratory according to official methods.

**Trial 2**

Seventy-six rabbits of the local Mankon strain (medium weight), six weeks old, were randomly allocated to five treatments as shown below balancing for age and sex.

D1 : One rabbit per cage or three rabbits/m²  
D2 : Three rabbits per cage or eight rabbits/m²  
D3 : Four rabbits per cage or 11 rabbits/m²  
D4 : Five rabbits per cage or 14 rabbits/m²  
D5 : Six rabbits per cage or 17 rabbits/m²

The cages were made out of chicken wire and the bottom response-enforced with wide gauge wire. Cage size was as described in trial one. Feeders measured 60 cm long by 9cm wide and drinkers occupied a space of 157cm². Each treatment was replicated four times. The rabbits were fed the diet as shown in Table 2 for eight weeks. Feed and water were given *ad libitum.*

| Table 1: Percent composition of test diets having different fibre levels |
|-----------------------------|-------|-------|-------|-------|
| Fibre levels (%)            | 8     | 10    | 12    | 14    |
| Rice straw                  | 13.0  | 20.0  | 26.0  | 32.0  |
| Maize                       | 49.0  | 42.0  | 36.0  | 30.0  |
| Wheat bran                  | 16.0  | 16.0  | 16.0  | 16.0  |
| Soya bean meal              | 16.0  | 16.0  | 16.0  | 16.0  |
| Palm oil                    | 2.0   | 2.0   | 2.0   | 2.0   |
| Calcium carbonate           | 1.5   | 1.5   | 1.5   | 1.5   |
| Bone meal                   | 2.0   | 2.0   | 2.0   | 2.0   |
| Salt                        | 0.5   | 0.5   | 0.5   | 0.5   |
| Total                       | 100.0 | 100.0 | 100.0 | 100.0 |

**Chemical Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Energy (cal/kg DE)</th>
<th>3024.5</th>
<th>2880.0</th>
<th>2750.2</th>
<th>2635.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude fibre (%)</td>
<td>8.1</td>
<td>10.3</td>
<td>12.2</td>
<td>14.1</td>
<td></td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>18.6</td>
<td>16.3</td>
<td>18.0</td>
<td>17.9</td>
<td></td>
</tr>
<tr>
<td>Ether extract (%)</td>
<td>3.8</td>
<td>3.6</td>
<td>3.4</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
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<tr>
<td>Phosphorus (%)</td>
<td>0.9</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
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<tr>
<td>Lysine (%)</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Methionine (%)</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
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<tr>
<td>Cystine (%)</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.1</td>
<td></td>
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</table>

**Table 2: Percent composition and chemical analysis of diet**

<table>
<thead>
<tr>
<th>Feedstuffs</th>
<th>Percent levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewers dried grains</td>
<td>41.00</td>
</tr>
<tr>
<td>Maize</td>
<td>30.00</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>13.50</td>
</tr>
<tr>
<td>Cotton seed cake</td>
<td>8.00</td>
</tr>
<tr>
<td>Offal meal</td>
<td>2.00</td>
</tr>
<tr>
<td>Palm oil</td>
<td>2.50</td>
</tr>
<tr>
<td>Bone meal</td>
<td>2.50</td>
</tr>
<tr>
<td>Salt</td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Calculated analysis**

| Energy DE (Kcal/kg)   | 2716.03         |
| Crude protein (%)     | 20.01           |
| Crude fibre (%)       | 9.19            |
| Ether extract (%)     | 6.98            |
| Calcium (%)           | 0.95            |
| Phosphorus (%)        | 0.79            |
| Lysine (%)            | 0.73            |
| Methionine/cystine (%)| 0.67            |

NB: 100g of fresh Guatemala grass *Trisacum Laxum* was given daily to augment the fibre level of the ration which is actually low.
Initially and thereafter, fortnightly feed intake and weight gain values were recorded as well as mortality of rabbits. Room temperatures varied from 21-28°C and relative humidity varied from 68-80%.

Statistical Analysis

The experimental designs in both trials were completely randomized designs. Means of treatments were subjected to analysis of variance for completely randomized designs. Significant means were analyzed by Duncan's multiple range test.

Results

**Trial 1**

Daily feed intake values (Table 3) were similar for rabbits on tests. Daily weight gain values showed that rabbits fed the 10% and 12% fibre level were similar but significantly (P<0.05) higher than those of rabbits fed the 14% fibre level diet, which in turn were significantly higher (P<0.05) than weight gain values of rabbits fed the 8% fibre level diet. Feed/gain ratio showed a similar pattern as daily weight gain.

Percent mortality figures showed that significantly (P<0.05) fewer rabbits died at the 10% and 12% fibre levels in the diet than at the 8% and 14% dietary fibre levels, where 22.2% of rabbits died. Regarding the number of rabbits scouring, it was observed that the number of scouring rabbits significantly (P<0.01) decreased as the level of fibre increased in the diet.

**Trial 2**

There were no significant differences in the daily feed intake values of the various groups of rabbits (Table 4). However, rabbits in groups of three, four and five per cage significantly (p<0.01) grew faster than those placed singly or six in number per cage. There were no significant differences in the feed/gain ratio among the various groups of rabbits.

Percent mortality values showed that these were significantly (P<0.05) higher at rabbit densities of 14 rabbits/m² (20%) and 15 rabbits/m² (16.6%) than at rabbit densities of 3 rabbits/m² (0%), 8 rabbits/m² (11.1%) and 11 rabbits/m² (6.3%).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Fibre levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Daily feed intake (g/rabbit)</td>
<td>59.0</td>
</tr>
<tr>
<td>Daily weight gain (g/rabbit)</td>
<td>11.9*</td>
</tr>
<tr>
<td>Feed/gain ratio</td>
<td>5.0*</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>22.2*</td>
</tr>
<tr>
<td>Diarrhoea incidence (%)</td>
<td>55.5*</td>
</tr>
</tbody>
</table>

**Table 4: Performance of rabbits at various cage densities**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cage densities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D1</td>
</tr>
<tr>
<td>Daily feed intake (g/rabbit)</td>
<td>75.7</td>
</tr>
<tr>
<td>Daily weight gain (g/rabbit)</td>
<td>17.6*</td>
</tr>
<tr>
<td>Feed efficiency (feed/gain)</td>
<td>4.5</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>0.0*</td>
</tr>
</tbody>
</table>

**Discussion**

In the first trial, the non-significant increase in the feed intake value as fibre levels increased in the diet could be attributed to rabbits adjusting to the bulkiness and reduced energy level in the diets by eating more. These adjustments apparently enabled them to meet the nutrient needs as shown by weight gains.

Weight gain values of rabbits fed the 10% and 12% fibre levels were adequate enough to stimulate digestion and efficient feed utilization. In contrast fibre level of 8% was inadequate while that of 14% was too high to enable rabbits to grow adequately. Other scientists observed that from New Zealand White weaning rabbits, at the fibre level of 9% and more optimally 12%, rabbits
grew better when alfalfa and Bermuda grass were the fibre sources. The feed gain ratio confirmed that diets at the 10-12% fibre levels were efficiently utilized than those containing the 8% and 14% fibre levels.

Percent mortality at the 10-12% fibre levels showed that these levels were adequate to stimulate growth and reduce incidence of diarrhoea. However, the mortalities at the 8% and 14% fibre levels showed that other causes in addition to dietary sources or dietary problems predisposed rabbits to secondary infections which caused death. This was reflected in the cases of diarrhoea observed. That is scouring reduced as the level of fibre increased in the diet. Other scientists\(^2,3\) showed that high digestible or low fibre diets initiated fermentation and an imbalance in the digestive hydrochloric acid requirements, resulting in diarrhoea and secondary infections leading to deaths.

In the second trial, the non-significant differences in feed intake values showed that diets were palatable and values were comparable to those of weaning rabbits in the tropics\(^10\). However, the low daily weight gains of rabbits housed singly apparently reflected the inadequate presence of group animal behaviour. Apparently, animals in groups stimulated eating while single caged rabbits spent more time turning their food over and over. Rabbits housed five and six per cage were probably too crowded and spent more energy eating than in growth. Other scientists\(^5\) housed 18 or 28 rabbits per cage and observed feed intake values of 150g/day and average growth rates of 37.1g/day. These values were higher than values observed in this study. However, the values of 19.3g/d, 19.4g/d and 18.8g/d for weight gains for rabbits caged in groups of three, four and five were comparable to growth rates under similar conditions in the tropics\(^5,10\).

Apparently climatic and dietary types have been observed to have an effect of low feed intake and weight gains. Rabbits showed no difference in the feed/gain ratio suggesting food consumed was equally utilized.

Percent mortality increased as rabbit densities increased per unit area suggesting that hygienic conditions were less ideal and the risk of disease of transmission was greater with more rabbits per cage, particularly in hot humid tropics. Scientists in the field\(^6\) observed that average mortalities of 17% for rabbits weaned at densities of 28/m\(^2\) and 16/m\(^2\) in temperate zone and attributed to these mortalities to poor performance of the does. On the other hand, others\(^6\) have observed increased mortalities of 12-30% as litter sizes increased from 8 to 12 and suggested inadequate nutrition as the cause. The rabbits in this study were fed \textit{ad libitum} and did not show any observable signs of disease. However, dead rabbits had slightly wet anuses. This could have been the beginning of diarrhoea given that results\(^11\) have shown that rabbits diarrhoea is a complex disease involving viruses, bacteria and coccidia and transmission is by contact or is airborne. In conclusion, fibre levels above the 10% and below the 12% levels were adequate for rabbit production with reduced mortality. Also, caging four rabbits per cage or 14 rabbits/m\(^2\) appeared to be optimum cage density in the humid tropics with reduced mortalities.

References

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ECONOMIC VALUES OF TRAITS FOR BEEF PRODUCTION IN GHANA

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VALEURS ECONOMIQUES DES TRAITS DE CARACTERE POUR LA PRODUCTION DE VIANDE AU GHANA

Résumé

Les industries animales au Ghana sont en cours de restructuration et de réorganisation à travers la mise en œuvre d'un Projet des services de l'élevage, parrainé conjointement par le Gouvernement et la Banque mondiale. Un des objectifs est l'élevage de bétail trypanotolérant, en particulier le bétail plus productif que les races locales existantes. Un tel programme nécessite d'abord un déploiement d'efforts en matière de recherche locale et de planification pour identifier la production souhaitée, les systèmes de traitement et de commercialisation, et définir l'importance économique de l'élevage de bétail. L'objectif de la présente étude était de calculer les valeurs économiques des traits de caractère des bovins N'dama et Zebus comme première étape afin de définir l'objectif d'élevage pour l'industrie de bovin à viande au Ghana. La documentation a permis d'obtenir les facteurs de production et le rendement. Un modèle informatique simulant le cycle de vie de la vache reproductrice et la performance de croissance de sa progéniture, a été mis au point pour estimer les valeurs économiques des caractéristiques de survie, les traits de performance de reproduction et de croissance, et la consommation alimentaire. Les valeurs économiques étaient calculées sur la base de la différence entre le bénéfice et les frais, et avec les taux d'escompte de 0 ; 10 et 20%. Elles étaient définies comme le profit marginal/vache/an découlant de 1% du changement du niveau moyen de chaque trait de caractère, tout en maintenant constant le niveau de tous les autres traits. Le bénéfice était réparti entre les boeufs de trois ans, les génisses excédentaires et les vaches de réforme. Les frais comprenaient les aliments, l'élevage et le coût de la commercialisation, et ils étaient calculés pour tous les âges et pour toute espèce de bétail. Les traits de survie avaient la valeur économique la plus importante, suivie dans l'ordre par les performances de reproduction, le taux de croissance et la consommation alimentaire. Les valeurs économiques prévues pour les traits individuels diminuaient avec l'augmentation des taux d'escompte. L'étude a montré que le pourcentage d'animaux élevés et la performance de reproduction étaient les traits les plus importants permettant d'améliorer la rentabilité de l'industrie de bovin à viande au Ghana, tandis que le taux de croissance (ou la taille du bétail) semblait être moins important. Les répercussions des résultats sont discutées.

Mots-clés : bovins à viande, valeurs économiques, survie, reproduction, croissance, consommation alimentaire.

Abstract

The livestock industries in Ghana are undergoing restructuring and revamping through the implementation of a National Livestock Services Project that is jointly sponsored by the Government and the World Bank. One of the objectives is to breed cattle that are trypanotolerant, and especially more productive than the existing local breeds. The first requirement of such a programme that requires much research effort and planning is to identify the planned production processing and marketing system(s) and to define economic merit, which is the breeding objective for the individual livestock species. The objective of this work was to calculate the economic values of traits of economic importance in N'dama and Zebu cattle, as a first step towards defining breeding objective for the beef cattle industry in Ghana. Production inputs and outputs were obtained from the literature. A computer model simulating life cycle production of breeding cow and growth performance of her offspring was developed to estimate economic values of survival, reproduction and growth performance traits, and food intake. Economic values were calculated based on difference between income and expense (profit) and with discount rates of 0, 10 and 20%. they were defined as the marginal profit per cow per year resulting from 1% change in the average level of each trait, while holding the level of all other traits constant. Income was partitioned among three year old bullocks and surplus heifers, and cull cows. Expenses included food, husbandry and marketing cost, and were calculated for all ages and class of stock. Survival traits had the highest economic value, followed by reproduction, growth rate and food intake in that order. Predicted economic values for individual traits decreased with increasing discount rates. The study showed that survival and reproductive rates were the most important traits contributing towards improved profitability of the beef cattle industry in Ghana, whereas growth rate (or size of cattle) seems to be less important. The implications of the results were discussed.
Introduction

The livestock production potential of Ghana, especially that of ruminant livestock was recognised by the government of Ghana in the early part of this decade. As a result, a national livestock development policy has been developed, and a National Livestock Development Programme, jointly sponsored by the Government of Ghana and the World Bank, has been initiated. Emphasis is being placed on the development of the ruminant industry, because it is the least developed within the private sector and because ruminants compete less with man for feed resources, notably grain.

The objective of the project is to improve the productivity of ruminant livestock through better animal health, nutrition and water supplies, and in the long term breed improvement. Priority is accorded to the breeding of beef cattle, because their current contribution to meat supply in Ghana is larger than the combined production of sheep and goats. The main objective of the cattle breeding programme is to develop cattle that are hardy and in particular, trypanotolerant, but also have greater productive capabilities than the existing local breeds. Such a programme that is long-term requires much research effort and proper planning.

There is a well-established series of logical steps to follow in designing animal breeding improvement programmes. The first step is to identify the planned production, processing and marketing system(s). Using this information, the economic merit for various traits can be defined and subsequently breeding objectives for the individual livestock species. Choosing selection criteria and organizing logically based performance recording is difficult unless the traits that have to be improved have been identified and their relative economic importance has been established. The economic values of traits are not only important for selection within a breed, but also for choices of optimum breeding programmes.

The objective of this work was to calculate the economic values of traits of economic importance in two breeds of beef cattle in Ghana as a first step towards defining breeding objective for the beef cattle industry. The breeds evaluated were local N’dama, which is trypanotolerant and exotic Zebu, which is trypanosusceptible.

Figure 1: Generalized model flow diagram for N'dama cow and her offspring derived from average value of all traits.

<table>
<thead>
<tr>
<th>Age of Cow (month)</th>
<th>35</th>
<th>51</th>
<th>67</th>
<th>83</th>
<th>99</th>
<th>115</th>
<th>131</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parity of Cow</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

1.00 replacement heifer

5.18 calves born

4.40 calves weaned

2.09 mature heifers

2.20 heifer calves

2.20 bull calves

1.09 surplus heifers

2.09 mature

MARKET

1 old cow culled
Methodology

The method used in this study follows the sequential procedure used by\textsuperscript{10,11} and\textsuperscript{12} for sheep and beef cattle, respectively in Australia. It involves the following four procedures:

1. specification of breeding, production and marketing systems,
2. identification of the sources of income and expense
3. determination of biological traits influencing income and expense; and
4. calculation of economic value of each trait.

The objective of the present methodology is to develop models that are capable of simulating the life cycle production of a breeding cow and growth performance of her offspring in N’dama and Zebu cattle. Simulations were based on life cycle production of a breeding cow from her birth to culling, and generating heifers and bullocks for sale at different parities (Figures 1 and 2). Appendix A shows the essential equations used in the life cycle simulation model. The symbols and acronyms used in Appendix A have been explained in Appendix C and D, respectively models will apply to the situation in southern Ghana, and input variables originated from a variety of sources in southern Ghana. Cow and her offspring mortalities at pre- and postweaning stages, daily growth rates and live weight at birth, weaning and maturity, age at first breeding, calving rate, age at first calving, calving interval, length of life cycle of cows and dressing out percentage of beef carcass were provided as input variables (Table 1). Economic inputs included prices of beef, feed, marketing cost of saleable cattle and husbandry cost (Table 2). The model output included profit accruing from the sale of beef carcass from bullocks, heifers and culled cows (Appendix A).

The life cycle model was used to estimate the economic values of the following traits: calving rate, age at first calving, calving interval, survival rate of calves from birth to weaning, survival rate of calves from weaning to maturity, pre-weaning daily gain, post-weaning daily gain and food intake.

Specification of the Breeding, Production and Marketing Systems

Breeding system

It was assumed that most farmers who
Table 1: Values of Input Variables From Average Values of all Traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>Values for N'dama Cattle</th>
<th>Values for Zebu Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calving Rate (%)</td>
<td>74.0</td>
<td>76.0</td>
</tr>
<tr>
<td>Length of Life Cycle of Cow (Months)</td>
<td>131</td>
<td>139</td>
</tr>
<tr>
<td>Age at First Mating of Heifers (Months)</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>Age at First Calving (Months)</td>
<td>35</td>
<td>43</td>
</tr>
<tr>
<td>Calving Interval (Months)</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Preweaning Mortality (%)</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Postweaning Mortality (%)</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Birth Weight of Bull Calves (kg)</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Birth Weight of Heifer Calves (kg)</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>Weaning Weight of Bull Calves (kg)</td>
<td>94</td>
<td>131</td>
</tr>
<tr>
<td>Weaning Weight of Heifer Calves (kg)</td>
<td>85</td>
<td>120</td>
</tr>
<tr>
<td>Mature Weight of Bullocks (kg)</td>
<td>239</td>
<td>380</td>
</tr>
<tr>
<td>Mature Weight of Heifers (kg)</td>
<td>221</td>
<td>323</td>
</tr>
<tr>
<td>Days From Birth to Weaning</td>
<td>183</td>
<td>183</td>
</tr>
<tr>
<td>Days From Weaning to Maturity</td>
<td>915</td>
<td>915</td>
</tr>
<tr>
<td>Dressing Out Percentage of Beef Carcass</td>
<td>50</td>
<td>46</td>
</tr>
<tr>
<td>Bull Calves' Preweaning DM Intake of Pasture (kg/Day)</td>
<td>2.50</td>
<td>2.75</td>
</tr>
<tr>
<td>Heifer Calves' Preweaning DM Intake of Pasture (kg/Day)</td>
<td>2.35</td>
<td>2.60</td>
</tr>
<tr>
<td>Bullocks' Postweaning DM Intake of Pasture (kg/Day)</td>
<td>5.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Heifers' Postweaning DM Intake of Pasture (kg/Day)</td>
<td>4.70</td>
<td>5.20</td>
</tr>
<tr>
<td>Cows' DM Intake of Pasture (kg/Day)</td>
<td>6.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Days from Birth to Start of Feed Intake by Calves</td>
<td>61</td>
<td>61</td>
</tr>
</tbody>
</table>

Adapted from: 13,14,15,16,17,18,19,20,21,22,23,24,25,26,27

Table 2: Value of expenses and income (Cedis) for production system

<table>
<thead>
<tr>
<th>Expense Income</th>
<th>N'dama</th>
<th>Zebu</th>
<th>N'dama</th>
<th>Zebu</th>
<th>N'dama</th>
<th>Zebu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed (Cedis/kgDM)</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Husbandry/head/year</td>
<td>5,100</td>
<td>10,200</td>
<td>5,500</td>
<td>11,000</td>
<td>6,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Marketing/per head</td>
<td>4,500</td>
<td>6,500</td>
<td>5,000</td>
<td>7,500</td>
<td>4,000</td>
<td>6,000</td>
</tr>
<tr>
<td>Beef (Cedis/kg)</td>
<td>2,600</td>
<td>2,600</td>
<td>2,600</td>
<td>2,600</td>
<td>2,600</td>
<td>2,600</td>
</tr>
</tbody>
</table>

Source: 28, 29

produce beef may buy breeding bulls from government cattle breeding stations (nucleus herds) where these are available or from fellow farmers' cattle farm, but breed their female replacements. Under such circumstances, the government cattle breeding stations and all cattle farmers should have a common breeding objective. Purebreeding N'dama and Zebu beef production systems were considered.

Production and marketing system

The generalized model flow diagram for cows and their offspring derived from the average values of all traits are shown in Figure 1 (N'dama) and Figure 2 (Zebu). The values of the input variables used in Figure 1 and 2 are presented in
Table 1. Five classes of stock were defined in the flow diagram: calves, heifers, bullocks, cows and replacement heifers. Two growing stages were distinguished for the calves of cows: from birth to weaning at six months, and from weaning to mature age at three years. Growth rates at their respective stages of growth (birth to weaning, and weaning to mature weight at three years) were assumed to be linear. All mature male calves shall be referred to as bullocks in the rest of the text.

Heifer calves would be kept until culling takes place before mating at about 26 and 34 months, respectively, in N'dama and Zebu heifers. Surplus heifers and bullocks would be sold for slaughter at three years of age i.e. the time taken for cattle to reach maturity was assumed to be the same for the two breeds. thus, the weight of heifers and bullocks sold was taken as their expected weight for their age. Culled cows would be disposed off at 90% of the expected weight of marketed heifers, since the dressing percentage is slightly higher for finished cattle than for culled cows.

Most economic evaluations of breeding objectives have been undertaken based on the volume of product per animal (carcass weight). In the present study, carcass weight was expressed as the product of the mean weight of animals and the production per unit weight (dressing out percentage). The mean weight of mature heifers and bullocks was expressed as:

\[
\text{Mature weight} = \text{Birth weight} + (\text{Pre-weaning daily gain} \times \text{Days from birth to weaning}) + (\text{Post-weaning daily gain} \times \text{Days from weaning to maturity})
\]

Dressing out percentage for N'dama and Zebu were taken to be 50 and 46% of life weight, respectively. These were assumed to be the same for different classes of cattle of the same breed. It was also assumed that the saleable price of beef carcass of the different classes and breeds of cattle is the same on per kilogram basis (Table 2).

As pointed earlier, N'dama and Zebu heifers were assumed to be mated at 26 and 34 months of age to calve for the first time at 35 and 43 months of age, respectively. Mating was not restricted to any season of the year. A calving rate of 74% and 76% was assumed for N'dama and Zebu, respectively, (Table 1), with calving taking place throughout the year. Rebreeding occurred seven months after calving i.e., one month after weaning.

An average productive life of eight years (96 months) was assumed for both N'dama and Zebu cows in this study. When their respective age at first calving (Table 1) was added to their individual productive life, the average cow on completion of productive life would be 10.9 years or 131 months (N'dama) and 11.6 or 139 months (Zebu). Considering a calving interval of 16 months for each breed, each cow in both breeds will reach its seventh parity before being culled, when the complete replacement of the cow takes place. However, it was also assumed that a cow rears its seventh parity calf for six months (when the calf is weaned) and stays in the herd for an additional one month for reconditioning before it is sold off completely. The cow was then assumed to be replaced by one heifer.

Calf mortality up to weaning was assumed to be 15 and 25% for N'dama and Zebu, respectively (Table 1). From weaning until slaughter in heifers and bullocks, mortality was assumed to reduce to 5 to 15% in N'dama and Zebu, respectively. It was assumed that the breeding cow completed its entire before being culled.

The feeding regime assumed was that of cattle grazing unimproved natural pastures. It was assumed that feed was available throughout the year for grazing, and no supplementary feed was provided. It was also assumed that seasonal effects had no influence on quality and quantity of natural pastures. This means that seasonal effects had no influence on animal performance. Although, there is presently no cost associated with natural grazing pastures, because farmers do not cultivate or improve these pastures, food cost was assumed in this work (Table 2) because it is anticipated that in future farmers would have to cultivate pastures, and/or improve the natural grazing pastures.

Labour was provided by the Fulani herdsman, whose main duty is to graze cattle, build the kraal and assist in handling animals in case of any
veterinary interventions. Housing was not costed as kraal is built of cheap locally available materials mobilised by the Fulani herdsman. The labour cost of the Fulani herdsman was considered fixed, since it was assumed that he is paid cash, equivalent to the value of some fixed number of cattle each year, depending on the herd size, whether he works or not. Vaccination of cattle and some veterinary assistance against for example traumatic injury and minor diseases were assumed to take place. The costs associated with the marketing of cattle were also assumed to be borne by the farmer (Table 2). These include transportation, loading fees, local levies and other minor taxes.

Identification of the sources of income and expense in production system

Here, the profit (P) in the smallholder herd was expressed as a function of income (I) and cost (C):

$$ P = I - C $$

Income was derived from the sum of the products of the number of animals sold in each class of cattle (bullocks, heifers and culled cows) and the values per individual (Appendix A). Expenses were also derived from food, husbandry, and marketing costs (Table 2).

The price of beef was assumed at 2,600 Cedis per kilogramme for all classes of stock. At the time of the study, 1 US$ was equivalent to 1,200 Cedis. This information was provided by the Animal Production Department (APD), Ministry of Food and Agriculture, Ghana, and represented the average prices of beef from nine major markets in Accra, the capital city of Ghana. The Cedis is the unit of the Ghanaian currency. Food costs for all classes of cattle were assumed to be the same. These were calculated from information provided by APD, Ghana on current costs of establishing and maintaining pasture, and dry matter yields of several grasses and legume species in Ghana. Daily dry matter (DM) feed requirements were calculated for the different classes and breeds based on values obtained from. The dry matter intake of N’dama and Zebu cattle are given in Table 1. It was assumed that the feed requirements of the breeding cow covered those needed for maintenance, growth, reproduction and lactation.

The feed intake of heifers and bullocks included that occurring between birth to weaning and weaning to maturity. The feed intake values given above cover the post-weaning period, and the pre-weaning intake was assumed to be equal to half of the post-weaning food intake. Intake of the breeding cow was also assumed to include the pre-cow (from birth to first calving) intake and the active productive life intake. The pre-weaning feed intake of calves was assumed to begin actively in 61 days (two months) after birth, since very young calves consume insignificant quantities of forage as they cannot digest a greater intake. Husbandry and cost included castration, derching, de-ticking and wound treatment. Information on husbandry costs was provided by the Veterinary Services Department (VSD), Ministry of Food and Agriculture, Ghana. This information indicated that the husbandry cost of N’dama cattle is approximately twice that of the Zebu (Table 2). Marketing cost was based on mature saleable weight, assumed to be about 20 Cedis per kilogramme live weight for all breeds. Information on marketing costs was provided by APD. The pre-weaning husbandry and feed requirements assumed that animals that died did so at the end of the pre-weaning period. Similarly, animals that died at the post-weaning period were counted at the end of this period.

Determination of biological traits influencing income and expense

The biological traits assumed to have influence on profit are presented in Table 3. The meanings of the symbols used in Table 3 are given in the Appendix C. Below is the reasoning behind the choice of these traits. A balanced breeding programme demands that a cow in a herd should be in calf at a planned time each year, and producing a life calf that thrives until weaning. This provides enormous contribution to the profitability of the beef cattle industry. Calving rate and calf survival rate are therefore considered to be important traits in beef cattle, because they also contribute to higher net calf crop (number of calves weaned per cow joined). If calving and calf survival rates are low, fewer calves will be
weaned, and selection intensity would be reduced and generation length increased to maintain numbers. If a cow rear a calf each year, then, calving interval becomes important, especially in the tropics where the calving interval often exceeds one year.

In addition, survival is an important trait in the tropics because the cost of production is largely influenced by the ability of animals to cope with the prevailing environmental conditions (e.g. heat, diseases, etc.)

Baker and Rege have noted that the most appropriate option for developing breeding objectives in the tropics is to attempt both a biological and genetic understanding of adaptation and its inter-relationships with production, and so develop breeding systems that improve both adaptation and production. This approach also leads to a better understanding and exploitation of genotype by environment interactions that are commonly encountered in the tropics.

The age cattle reach a given market weight depends on the growth rate from birth to desired slaughter weight. Growth rate is therefore the trait of highest economic importance in slaughter cattle, at least in temperate regions of the world. However, Baker and Rege have contended that in the tropics, survival is much more important than growth rate. Unfortunately, for most domestic animals reared in the tropics for slaughter, the main trait under selection is growth rate because it is highly correlated with feed efficiency. Growth rate is also heritable, and within-breed selection is easy and cheap to implement. In addition, higher growth rates can lead to a decrease in the number of days required to achieve a constant slaughter weight and thus reduce the annual maintenance costs. Both pre-weaning and post-weaning growth rates were therefore included in the breeding objective in order to find out their relative magnitude to survival in the tropics.

Selection for high growth rate may produce cows that require heavier weights to achieve puberty. This can prolong the age at first calving, and compound the already existing problem of older age at first calving. The major mechanism for increasing the ability for a cattle generation to grow fast is to increase the mature size of their parental generation, since the faster growing breeds of cattle tend to be the breeds with larger mature size. Maintenance cost, which is a function of mature weight, typically account for 50-60% of the total cost in a cow calf operation. Therefore, selection decisions that increase mature size have a significant impact on feed requirements.

Calving rate, age at first calving, calving...
interval, survival rates of calves from birth to weaning, survival rates of calves from weaning to maturity, pre-weaning daily gain, post-weaning daily gain, and food intake were therefore the traits chosen to be included in the breeding objective (Table 3).

**Table 4: Economic values of traits (Cedis) at different discount rates for N'dama production system**

<table>
<thead>
<tr>
<th>Trait</th>
<th>0 %</th>
<th>10 %</th>
<th>20 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>1,089.24</td>
<td>747.59</td>
<td>530.19</td>
</tr>
<tr>
<td>AFC</td>
<td>233.27</td>
<td>170.31</td>
<td>132.30</td>
</tr>
<tr>
<td>CI</td>
<td>697.87</td>
<td>478.97</td>
<td>339.69</td>
</tr>
<tr>
<td>SBW</td>
<td>979.57</td>
<td>672.26</td>
<td>476.73</td>
</tr>
<tr>
<td>SWM</td>
<td>1,126.59</td>
<td>773.15</td>
<td>545.14</td>
</tr>
<tr>
<td>bPRDG</td>
<td>184.48</td>
<td>126.60</td>
<td>86.44</td>
</tr>
<tr>
<td>hPRDG</td>
<td>304.42</td>
<td>159.23</td>
<td>96.81</td>
</tr>
<tr>
<td>bPODG</td>
<td>677.11</td>
<td>464.69</td>
<td>326.39</td>
</tr>
<tr>
<td>hPODG</td>
<td>575.55</td>
<td>301.04</td>
<td>183.03</td>
</tr>
<tr>
<td>bPRIFI</td>
<td>-7.56</td>
<td>-5.16</td>
<td>-3.64</td>
</tr>
<tr>
<td>hPRIFI</td>
<td>-9.84</td>
<td>-7.23</td>
<td>-5.51</td>
</tr>
<tr>
<td>bPOFI</td>
<td>-96.34</td>
<td>-66.12</td>
<td>-46.89</td>
</tr>
<tr>
<td>hPOFI</td>
<td>-130.32</td>
<td>-96.62</td>
<td>-74.32</td>
</tr>
<tr>
<td>CFI</td>
<td>-189.31</td>
<td>-126.26</td>
<td>-87.23</td>
</tr>
</tbody>
</table>

**Table 5: Economic values of traits (Cedis) at different discount rates for Zebu production system**

<table>
<thead>
<tr>
<th>Trait</th>
<th>0 %</th>
<th>10 %</th>
<th>20 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
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<td>732.68</td>
<td>499.06</td>
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<tr>
<td>AFC</td>
<td>297.69</td>
<td>215.29</td>
<td>161.79</td>
</tr>
<tr>
<td>CI</td>
<td>733.90</td>
<td>482.11</td>
<td>328.39</td>
</tr>
<tr>
<td>SBW</td>
<td>1,181.90</td>
<td>777.75</td>
<td>530.64</td>
</tr>
<tr>
<td>SWM</td>
<td>1,352.00</td>
<td>879.41</td>
<td>617.30</td>
</tr>
<tr>
<td>bPRDG</td>
<td>33.48</td>
<td>22.22</td>
<td>15.29</td>
</tr>
<tr>
<td>hPRDG</td>
<td>136.05</td>
<td>60.56</td>
<td>32.61</td>
</tr>
<tr>
<td>bPODG</td>
<td>86.53</td>
<td>57.43</td>
<td>39.51</td>
</tr>
<tr>
<td>hPODG</td>
<td>44.36</td>
<td>19.75</td>
<td>10.63</td>
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<tr>
<td>bPRIFI</td>
<td>-8.05</td>
<td>-5.50</td>
<td>-3.88</td>
</tr>
<tr>
<td>hPRIFI</td>
<td>-10.47</td>
<td>-7.62</td>
<td>-5.75</td>
</tr>
<tr>
<td>bPOFI</td>
<td>-90.52</td>
<td>-61.83</td>
<td>-43.66</td>
</tr>
<tr>
<td>hPOFI</td>
<td>-138.50</td>
<td>-103.24</td>
<td>-79.73</td>
</tr>
<tr>
<td>CFI</td>
<td>-201.11</td>
<td>-127.88</td>
<td>-84.59</td>
</tr>
</tbody>
</table>

**Derivation of the economic value for each trait**

A method of deriving economic values is to utilise profit equations. It involves combining income and expense as a function of profit, where profit is derived from the difference between income and expense. The economic value of a trait is the extra profit per cow per year from a unit increase in a trait, under the condition that performance levels of all other traits are held constant, at their mean values. This is known as the partial budgeting approach. It is done in a budgeting framework by considering only those parts or items of the budget that change. The budgeting process involves identifying and costing all activities carried out on each class of animal from birth to sale. When the increment in the trait is small, the partial budgeting gives the same result as the partial derivative approach.

Profit (P in Cedis) was expressed as a function of m traits in the breeding objective as follows:

\[
P = \sum_{i=1}^{m} n_i (V_i - C_i) X_i - K
\]

Where, \( n_i, V_i \) and \( C_i \) are the number of expressions, the value (Cedis) per unit and cost (Cedis) per unit, respectively, for the \( X_i \) trait. \( K \) represents fixed costs. The value of a trait determines the final returns from an animal in Cedis. For example, in Appendix A.1., the returns from a bullock is affected by CR, AFC, CI, SBW, SWM, bPRDG and bPODG (see also Table 3). It is these traits \( (X_i) \) which would determine the final value of an animal in monetary units (Cedis). The profit equation was expressed by grouping terms by classes of cattle. The profits from the individual classes were combined to give a total enterprise profit as follows:

\[
P = (P_{bullocks} + P_{heifers} + P_{cow}) - \text{Fixed cost}
\]

Where \( P_{bullocks}, P_{heifers} \) and \( P_{cow} \) are the profits from bullocks, heifers and cow, respectively in the complete life cycle of the breeding cow. Fixed costs were ignored, since income and expense were combined as a difference, and do not include the items of the budget that change. It should be noted that when income and expense are combined as a ratio (e.g.
of cows. In this study, the change was greater the greater the discount rate applied.

Among the reproductive traits, calving rate was the most important trait. This was followed by calving interval, with age at first calving ranking the least important. It was surprising to note that age at first calving ranked the least important amongst the reproductive traits, although the ages at first calving of these breeds are quite late.

Survival from weaning to maturity was more important than survival from birth to weaning. Mortality from birth to weaning was higher than that from weaning to maturity in the assumptions made earlier in this study (Table 1). This means that calves are more vulnerable than their adult counterparts. It was therefore expected that survival at the pre-weaning stage would have been more important than survival at the post-weaning stage. This result is difficult to explain, although a simple reason that could possibly account for this is that the pre-weaning stage of growth is short, compared to post-weaning stage. End points are always determined by passage of time.

In both N’dama and Zebu cattle, the economic value of hPRDG was higher than that of bPRDG, whereas the reverse occurred at the post-weaning stage of growth. In the former, the heifer stage of the breeding cow contributed to heifer returns, and hence economic values of offspring heifers. Whereas in the latter, returns from heifers relative to that of bullocks was reduced because a heifer was used to replace the culled cow in each production system (Figures 1 and 2). Hence, returns and therefore economic values of heifers reduced. In general, the economic values for growth from birth to weaning were small compared with those for later growth, except in the case of the Zebu, where the value of hPRDG was higher than hPODG. This effect was observed by MacNeil et al.43. This is because growth early in life is short compared to growth at the post-weaning stage. The cost associated with the pre-weaning stage is therefore low. Rapid growth early in life does not increase the amount of product produced, as slow growth later in life would do, because endpoints are completely determined by passage of time.

Results

The economic values of traits resulting from 1% increase or decrease (in the case of AFC and CI) in the average value of each trait are presented in Table 4 (N’dama) and Table 5 (Zebu). The economic values for individual traits regressed towards zero for non-discounted marginal returns compared to discounted marginal returns. The regression increased as the discount rate increased. The regression of economic values towards zero was more pronounced in hPRDG and hPODG than in other traits, because these traits affected the returns from the culled cow (Table 3 and Appendix A.3), and are expressed later in life than all the other traits. This observation has been made by other workers. For example, Ponzoni and Newman12 observed that relative to taking all income and expenses per year, discounting increased the importance of traits expressed early in the life of animals, e.g. carcass weight of calves, whereas the opposite was true for traits expressed late in life, e.g. carcass weight...
The economic values of food intake had negative values because increasing food intake had the effect of increasing cost and decreasing marginal profit. CFF had the highest negative economic value relative to the values of heifers and bullocks for food intake. This effect was reported by Ponzoni et al.\textsuperscript{12}. They observed that the cow's food intake made the greatest negative contribution to total gain in terms of economic units. Since more feed is required to maintain the breeding cow, increasing food cost of the cow has a pronounced effect of decreasing marginal returns in the cow, compared to the same effects in bullocks and heifers.

The economic values of food intake of heifers had larger negative values than that of bullocks at both the pre- and post-weaning stages because the food intake of the cow's heifer stage contributed to the economic value of heifer's food intake. The economic values of food intake of both heifers and bullocks at the pre-weaning stage had lower negative values than that of the same class of stock at the post-weaning stage. A similar explanation given earlier indicates that growth is a function of number of days in the pre- and post-weaning stages, and end points are always determined by passage of time.

Combining pre- and post-weaning characters for either a heifer or a bullock, survival appeared to be the most important trait in both breeds. This was followed by reproduction, with growth rate ranking the least important (Figure 3). It is important to note that while the economic values of survival traits in Zebu cattle were slightly higher than their values in N'dama cattle, the economic values of growth rates were much lower in the Zebu cattle, compared to the N'dama. This probably suggests that survival is more important in the Zebu than the N'dama, because the latter is being adapted to its environment than the former. Additionally, growth rate is more important in N'dama cattle than the Zebu, because the latter has good growth rates and is larger than the former. These suggest that the emphasis on traits in the breeding objective for two breeds in the same environment may be different.

\textbf{Figure 3: Economic Values of Reproduction, Survival and Growth in N'dama and Zebu Cattle}
Discussion

Although the findings of the present study are, of course, dependent on the assumptions made during the development of the model, it may be worthwhile speculating about some of the main results. Under most circumstances, combined data from a bullock or a heifer indicated that survival was the most important trait that made the greatest positive contribution to profit, in terms of economic units (Figure 3). This was followed by reproductive traits, with growth rate making the lowest positive contribution. Breeding of cattle in the tropics has always focused attention in the improvements of growth traits. Surprisingly, this work has demonstrated that growth rate per se is not important, compared to survival and reproductive traits.

Recently, Baker and Rege pointed out that in many subsistence tropical farming systems, survival in the face of multiple stresses (heat, diseases, etc.) is one of the most important economic traits, while increasing growth rate is of less economic value. This statement traces back to the work of Upton which evaluated the returns from small ruminant (sheep and goats) production in south west Nigeria. The results of that work are quite similar to the present study. Analysis done by Upton suggested that the most critical area, where improvements were most needed, was that of reducing mortality i.e., increasing survival. Variation in growth rate had only a relatively small impact. The second most influential factor on overall economic performance was reproduction rate (litter size and parturition interval). This is supported by work done recently in South Africa to determine biological efficiency of meat and wool production of seven sheep genotypes. The result of this latter work also emphasizes the importance of high reproductive and survival rates to increased efficiency of lamb production in the tropics.

Conflicting results to the present study were obtained in Canada. MacNeil et al. observed that the economic values for male fertility, female fertility and calf survival were small compared to the economic values of growth rates. In their studies, post-weaning growth rate was the trait with the highest economic value. This emphasizes the important point that breeding objectives in temperate regions may be very different from those in the tropics, and that European animal husbandry models should be adopted by developing countries with extreme caution.

Conclusion

The present study shows that survival and reproductive rates are the most important traits contributing towards improved profitability of the beef cattle industry in southern Ghana, whereas growth rate seems to be less important. The most important single factor contributing to the survival of the breeds of cattle evaluated in this work is trypanosomiasis. Fortunately, the local breeds of cattle in Ghana are trypanotolerant. Since it is not easy to improve survival in tropical cattle net of all cost, it is suggested in this work that consideration should be given to the use of trypanotolerant cattle breeds in Ghana.

References

29. Veterinary Services Department (VSD), Annual Reports (1990-95). Ministry of Food and Agriculture, Accra, Ghana.
A..3. Cow costs and returns

\[
\text{MarkCow} = \text{cM}
\]

\[
\text{FoodHeiC} = \left( (\text{hPRF}^{*} \text{DBW}) - \text{DBF1}) + \text{hPOF}^{*} (\text{AFD}^{*} \text{DOM}^{*} - \text{DBW}) \right)^{*} F
\]

\[
\text{FoodCow} = \left( (\text{LP}^{*} \text{AFD}) + \text{MLCC}^{*} \text{DOM}^{*} \text{CFT}^{*} \right)
\]

\[
\text{HusHeiC} = \left( \text{AFD/12} \right)^{*} H
\]

\[
\text{HusCow} = \left( (\text{LP}^{*} \text{AFD}) + \text{MLCC/12} \right)^{*} H
\]

\[
\text{RetCow} = \left( \text{hBWT} + (\text{hPRDG}^{*} \text{DBW}^{*} + \text{hPODG}^{*} \text{DWM}) \right)^{*} 0.9^{*} \text{DOP}^{*} \text{Pcwt}
\]

\[
\text{ProfitCow} = \text{RetCow} - \text{MarkCow} - \text{FoodHeiC} - \text{FoodCow} - \text{HusHeiC} - \text{HusCow}
\]

Appendix B:

Calculations of Marginal, and Discounted Costs and Returns

\[
\text{ProfitTotal} = \text{ProfitBull} + \text{ProfitHei} + \text{ProfitCow}
\]

\[
\text{ProfitTotal}^{*} = \text{ProfitBull} + \text{ProfitHei} + \text{ProfitCow}
\]

\[
\text{ProfitCowYr} = \text{ProfitTotal}^{*} / (\text{LP} + \text{MLCC}/12)
\]

\[
\text{ProfitCowYr}^{*} = \text{ProfitTotal}^{*} / (\text{LP} + \text{MLCC}/12)
\]

\[
\text{ProfitMCow}^{*} = \text{ProfitCow} - \text{Yr}^{*} - \text{ProfitCowYr}
\]

\[
\text{Discount Rate} = 1 / (1 + DF) \text{(Applied to all costs and returns)}
\]

Appendix C:

Lists of Symbols Used in the Models

- \text{CR} = \text{Calving rate}
- \text{LP} = \text{Length of life cycle of cow (months)}
- \text{AFC} = \text{Age at first calving (months)}
- \text{CI} = \text{Calving interval (months)}
- \text{SBW} = \text{Survival rate from birth to weaning}
- \text{SWM} = \text{Survival rate from weaning to maturity}
- \text{bBWT} = \text{Birth weight of bull calves (kg)}
- \text{hBWT} = \text{Birth weight of heifer calves (kg)}
- \text{bWWT} = \text{Weaning weight of bull calves (kg)}
- \text{hWWT} = \text{Weaning weight of heifer calves (kg)}
- \text{bMWT} = \text{Mature weight of bull calves (kg)}
- \text{hMWT} = \text{Mature weight of heifers (kg)}
- \text{DBW} = \text{Days from birth to weaning}
- \text{DWM} = \text{Days from weaning to maturity}
- \text{bPRDG} = \text{Pre-weaning daily gain of bull calves (kg/day)}
- \text{hPRDG} = \text{Pre-weaning daily gain of heifer calves (kg/day)}
- \text{bPODG} = \text{Post-weaning daily gain of bull calves (kg/day)}
- \text{hPODG} = \text{Post-weaning daily gain of heifers (kg/day)}
- \text{MH} = \text{Number of matured heifers}
- \text{RH} = \text{Number of replacement heifers}
- \text{DOP} = \text{Dressing out percentage of beef carcass}
Appendix D: List of Acronyms Used in Essential Equations

MarkBull = Marketing cost of bullocks
MarkHeif = Marketing cost of heifers
MarkCow = Marketing cost of cow
FoodBullPRW = Pre-weaning food cost of bullocks
FoodHeifPRW = Pre-weaning food cost of heifers
FoodHeifC = Pre-cow (from birth to first calving) food cost of cow
FoodBullPOW = Post-weaning food cost of bullocks
FoodHeifPOW = Post-weaning food cost of heifers
FoodCow = Food cost of cow from first calving to culling
HusBullPRW = Pre-weaning husbandry cost of bullocks
HusHeifPRW = Pre-weaning husbandry cost of heifers
HusHeifC = Pre-cow (from birth to first calving) husbandry cost of cow
HusBullPOW = Post-weaning husbandry cost of bullocks
HusHeifPOW = Post-weaning husbandry cost of heifers
HusCow = Husbandry cost of cow from first calving to culling
RetBull = Returns from bullocks
RetHeif = Returns from heifers
RetCow = Returns from culled cow
ProfitBull = Profit from bullocks
ProfitHeif = Profit from heifers
ProfitCow = Profit from cow
ProfitTotal = Total profit from the entire life of cow due to average values of all traits
ProfitTotalT* = Total profit from the entire life of cow due to 1% change in the level of trait
ProfitCow Yr = Profit per cow per year due to average levels of all traits
ProfitCow YrT* = Profit per cow per year due to 1% change in the level of trait
ProfitMCowT* = Marginal profit per cow per year due to change in the level of trait
T* = Any of the traits in the breeding objective.

Received for publication on 16th June, 2000
A retrospective study on the occurrence of dog rabies in three major towns in Nigeria (1993-98), was carried out to determine factors associated with the disease in affected dogs. This study was carried out in Lagos, Abeokuta and Ibadan areas of south west Nigeria.

Overall, a total of 21 cases of dog rabies were reported in the three participating towns while a total of 6,796 dogs were vaccinated against the disease. Ibadan reported a total of ten cases (47.6%), Lagos reported six cases (28.6%) while Abeokuta reported five cases (23.8%). Clinically, more cases (13.21, 61.9%) of the dumb paralytic form of rabies were reported while the rest were the furious form. More male dogs (14/21, 66.7%) were diagnosed as rabid, and 16/21 (76.2%) were restricted to households. Twelve (57.1%) of the rabid dogs were reported to roam freely in the streets without any form of restraint.

There is need for public enlightenment on rabies as zoonosis in Nigeria and proper legislation on dog control and vaccination.

Rabies is an acute neurotropic disease of man and other warm blooded animals particularly carnivores, felidae and some bats. Dogs are the major reservoirs of rabies in Nigeria1,2,3. The disease is invariably fatal in clinically affected animals. In humans, early post-exposure vaccination is associated with a high survival rate4,5. In some parts of the world where there is intensive vaccination of dogs and control of stray dogs, the disease is minimal in human populations.

In Nigeria, previous reports have shown that dog rabies is highly prevalent1,2,3 and campaigns to control the disease have not received adequate support from individuals and the government (Adeyemi, G.A. personal communication). Also there are indications that the disease is on the increase2.

This paper presents various clinical and epidemiological findings in 21 cases of dog rabies presented at veterinary clinics in three major towns in South-West Nigeria between 1993 and 1998.

A questionnaire survey of dog rabies was carried out in three towns in South-West Nigeria, namely, Lagos, Abeokuta and Ibadan over a five-year period (1993-98). The information was collected from 12 veterinary clinics located in these three towns in a retrospective study.

The questionnaire was structured in two sections. Section A dealt with general information such as routine preventive measures against rabies and actions taken on suspecting rabies cases. Section B dealt with specific information on dog rabies cases, including breed, sex and age of rabid cases, major clinical, laboratory and epidemiological findings, vaccination record and actions taken by the Clinician-in-Charge. Cases lost to follow-up (ten cases) were excluded from the study.

The data collected were analysed using percentages. Suspected cases of rabies were confirmed by the veterinary clinics. Diagnosis was based on clinical signs of rabies in affected dogs, death of the suspected case within ten days after showing clinical signs and the presence of Negri bodies in brain smears at post mortem or through animal inoculation.

Based on the above criteria, 21 dogs were confirmed rabid during the survey period (1993-98) in the three towns. In all, more male dogs, 14/21 (66.7%) were diagnosed as rabid. Using clinical signs at presentation, thirteen (61.9%) were classified as dumb/paralytic form of rabies. Twelve (57.1%) of the dogs were reported to roam freely and 16/21 (76.2%) were household pets. Majority of the rabid dogs 13/21 (61.9%) were more than one year in age (Table 1). Only one case of the cases reported to have been vaccinated against rabies in the previous twelve-
month period. All but one of the dogs was of the local mixed breed of mongrel dog. A total of 6,796 dogs were reported to have been vaccinated against rabies in the three towns (Lagos, 2,148; Abeokuta, 1,139 dogs, Ibadan, 2,509 dogs).

There is clinical evidence of rabies in the population of dogs surveyed with 21 cases confirmed as rabid. This finding is similar to those previously reported\(^2,3\) which indicates that dog rabies predominates in Nigeria. In countries with intensive rabies vaccination and stray dog control, dog transmitted rabies has been reduced to the barest minimum\(^4,6\). The reasons why more cases of rabies (ten) were reported in Ibadan is unclear but it may have been because it is the only town with a Veterinary School and diagnostic facilities for rabies among the three towns surveyed and so there is improved diagnosis.

Although natural resistance to rabies is uncommon in dogs\(^7\), a large proportion of the rabid dogs in this study were over one year in age. This is consistent with the epidemiology of the infection, since maternally derived immunity would have been on the wane by this time. Similarly, some workers\(^3\) have reported more cases of rabies in dogs six months and above, stressing the need to vaccinate dogs early so as to prevent rabies. The 21 cases reported from this study may be an underestimation since some cases were lost to follow-up.

In this study, a high proportion of the dogs were reported to roam freely without being confined thereby becoming a source of infection to other animals. Generally, dogs in low income areas in Nigeria roam freely and absence of enabling laws in Nigeria may be a contributing factor to the endemcity of rabies in Nigeria.

Predominantly more male dogs were reported rabid in this study. This might be related to their roaming, mating behaviour or frequent fights with other dogs\(^7,8\). Rabies is traditionally transmitted by contact with infective saliva\(^7,9\) although recently there have been reports of human rabies without a bite exposure\(^4\). The use of many of the dogs as household pets may pose a human health risk to rabies.

The higher number of paralytic form of rabies may reflect the terminal stage of the illness\(^7\). Also dogs in the furious form of rabies tend to roam\(^7\) and may get lost if they move far away from home. Most Nigerians recognize the furious form of rabies as reflected in local languages\(^3\).

There is urgent need for an enabling legislative enforcement of dog control laws and campaigns on dog vaccination as dogs are the natural hosts of rabies in Nigeria and most developing countries\(^9\).

**Acknowledgements**

We are grateful to the participating Veterinarians and dog owners for their co-operation.

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**Table 1:** Characteristics of dog rabies cases in three towns in South-West Nigeria

<table>
<thead>
<tr>
<th>Town</th>
<th>Age (years)</th>
<th>Use</th>
<th>Method of keeping</th>
<th><strong>Types of Rabies</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;1</td>
<td>&gt;1</td>
<td>Pet Guard</td>
<td>Confined</td>
</tr>
<tr>
<td>Lagos</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Abeokuta</td>
<td>-</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ibadan</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Total (%)</td>
<td>8 (38.1)</td>
<td>16 (76.2)</td>
<td>13 (61.9)</td>
<td>5 (23.8)</td>
</tr>
</tbody>
</table>

*Semi-stray dogs that move around without restraint
**Based on Clinical signs.
References


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SHORT COMMUNICATION

ISOLATION OF AFRICAN HORSE SICKNESS VIRUS FROM SUSPECTED CLINICAL CASES FROM SEVEN AREAS IN EAST-CENTRAL ZIMBABWE

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African Horse Sickness virus is a non-contagious arbovirus transmitted by Culicoides imicola. The disease is manifested by pyrexia, inappetance and clinical signs and lesions compatible with impairment of the function of the cardiovascular system and haemorrhages of the serosal surfaces1. Clinically, veterinarians are known to misdiagnose this disease as they confuse the clinical signs of African Horse Sickness (AHS) with those of others such as equine encephalosis. The aim of this work was to present results of viral isolation attempts from clinical cases as well as determine the seasonality of the occurrence of these clinical cases.

Suspected cases of AHS were collected during the ‘informally accepted’ AHS season in Zimbabwe during the period from November, 1998 to September, 1999. Where possible both whole blood and spleen samples were collected from suspected clinical cases by private veterinarians. Samples of individual horse spleens (1cm³) were cut into small pieces using sterile scissors. The cut samples were homogenised with 5ml of Phosphate buffered saline with Tween 20 (PBST) to give a 20% suspension using sterile pestle and mortar with sterile sand. The resulting solution was centrifuged at 1500 rpm for five minutes. Supernatant (0.4ml) was added to 3.6ml of Eagles minimum essential medium (Eagles MEM) (1:10 dilution) which was centrifuged and then filtered using biological filters (pore size=0.2μm). The resulting solution was inoculated onto Baby Hamster Cells (BHK-21) using standard methods2. Whole blood samples were collected into heparinized tubes and stored at 4°C. At the laboratory, the initial volume of the blood was marked and the blood centrifuged at 2000 rpm for ten minutes. The supernatant was discarded leaving a red blood cell (RBC) pellet, to which was added PBS to reconstitute the initial volume of the sample and the sample was centrifuged again as above. The initial volume of the sample was made up again with PBS and the red blood cells in the sample lysed by sonication. To one aliquot of the sample was added equal volume of orthophenoglucuronate (OPG). The resulting solution was used for inoculation onto BHK-21 cell cultures using standard methods2. The viruses grown in cell culture were confirmed as to whether they are AHS by the use of a sandwich ELISA for the detection of AHS antigen3. Details of the seasonality of outbreaks as well as information about the percentage positive for AHS virus from samples in the seven areas is presented in Figure 1 and Table 1 respectively.

In total 51 spleen and blood samples from seven

<table>
<thead>
<tr>
<th>Location</th>
<th>Harare</th>
<th>Marondera</th>
<th>Mvurwi</th>
<th>Mount Hampden</th>
<th>Inkom</th>
<th>Raffingora</th>
<th>Chinoyi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>17/28</td>
<td>2/2</td>
<td>4/4</td>
<td>1/3</td>
<td>1/2</td>
<td>1/2</td>
<td>5/8</td>
</tr>
<tr>
<td>Positive</td>
<td>60.7%</td>
<td>100%</td>
<td>100%</td>
<td>33.3%</td>
<td>50%</td>
<td>50%</td>
<td>62.5%</td>
</tr>
</tbody>
</table>
areas in east-central Zimbabwe were analysed for AHSV and 32/51 were positive for AHS virus. Currently we are working on serotyping these isolates. For cases where both whole blood and spleen samples were submitted, it was seen repeatedly that the virus was recovered from spleen samples using less passages as compared to whole blood samples.

In a previous study in Zimbabwe AHS virus was identified in 44.2% of the samples submitted\(^4\). We noted a similar trend to that reported by earlier workers that virtually all cases of AHS were diagnosed in late summer and autumn (February to May), with most cases recorded at the end of the rains in March and April which is also within the time period of the year when *C. imicola* (known vector of AHS) numbers are highest in Zimbabwe\(^4\).

**Acknowledgements**

We would like to recognise the assistance of Prof. P.S. Mellor and Mr. Chris Hamblin of the Institute for Animal Health, Pirbright, UK for their assistance. This work was funded by the Wellcome Trust through a grant entitled 'Development Research capacity in Zimbabwe for investigations of arboviral infections.'

**References**


Bluetongue (BT) is a *Culicoides* transmitted arboviral infection of ruminants which is characterized by congestion of the buccal and nasal mucosa, the coronary tissue of the hooves, stiffness due to muscle degeneration and oedema of the head and neck. Congenital abnormalities may occur in the foetuses of animals infected during pregnancy. It is probable that most or all ruminant species are susceptible to infection with the virus that causes BT but severe clinical disease and mortality are more pronounced in sheep breeds from traditionally BT free areas. Numerous large outbreaks in which thousands of sheep have been infected and died have occurred in Portugal, Spain, sub-Saharan Africa, the Near East and the Middle East through to Asia. The occurrence of BT virus in Zimbabwe is well documented. However, detailed information on its distribution in the country is not available.

Serum samples from Zimbabwean cattle, sheep and goats were collected from abattoirs between September, 1997 and January, 1998. In Zimbabwe, abattoirs have strictly defined catchment areas, therefore sera collected at a particular slaughter house will be known to have originated from animals kept locally. The cattle sera were collected mainly from the abattoirs in Chinhoyi and Bulawayo, whilst sheep and goats sera originated from 33 locations in Zimbabwe. These sera were also supplemented with additional cattle, sheep and goat sera (11 holdings in Zimbabwe). A competitive ELISA for the detection of BT antibodies developed by Anderson was used to assay the samples.

Tables 1 & 2 show the proportions of samples from cattle, sheep and goat species positive for BTV specific antibodies, and the range of positivity as detected by the ELISA. Origins of samples were defined as high altitude (1,800+), middle altitude (500-1,799m) and low altitude (0-499m). Using the chi-square test the serological results indicate that there is a significant association between BTV seroprevalence in cattle found at the middle and high altitude ranges compared to those found at low altitude range (χ² = 10.1; P=0.007). The 2 x 2 contingency table consisted of number of positive for BTV antibodies at the combined altitude range combined and the low altitude range. The range of positive cattle samples for BTV as 1/15 to 1/240+ whilst in sheep and goats the range for positive sera was 1/7.5 to 1/240+.

BTV antibodies in goat samples ranged from 100% in Mvurwi and 87% in Kwekwe to 16% in Gwanda. Jorgensen et al. reported a seroprevalence of 71% to BTV in goats using an unspecified ELISA. Their study was limited only to indigenous goats whereas this study did not focus specifically on any group of goats. It is interesting to note, however, that Jorgensen found no clear correlation of percentage positive animals with certain types of altitude ranges. The focus of this paper is to show that antibodies to BT virus are widely distributed in domesticated animals in Zimbabwe. Our future research will focus on increasing the numbers of samples analysed in each category in order to enhance the statistically significance of the various results for the areas sampled.
Table 1: Results of BTV virus specific antibodies of cattle samples from 23 locations in Zimbabwe

<table>
<thead>
<tr>
<th>Location</th>
<th>BTV +ve Total</th>
<th>BTV +ve range of seropositivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beatrice</td>
<td>6/16</td>
<td>1/15-1/120+</td>
</tr>
<tr>
<td>Bulawayo</td>
<td>18/18</td>
<td>1/30-1/240</td>
</tr>
<tr>
<td>Bulimaramwe</td>
<td>16/16</td>
<td>1/30-1/160+</td>
</tr>
<tr>
<td>Chinamhora</td>
<td>13/19</td>
<td>1/15-1/30</td>
</tr>
<tr>
<td>Chirau</td>
<td>7/16</td>
<td>1/15-1/120+</td>
</tr>
<tr>
<td>Chisumbanje</td>
<td>13/16</td>
<td>1/15-1/120+</td>
</tr>
<tr>
<td>Enterprise</td>
<td>8/16</td>
<td>1/15</td>
</tr>
<tr>
<td>Hwedza</td>
<td>16/16</td>
<td>1/15-1/160</td>
</tr>
<tr>
<td>Juru</td>
<td>8/11</td>
<td>1/15-1/240+</td>
</tr>
<tr>
<td>Karoi</td>
<td>8/16</td>
<td>1/15-1/160</td>
</tr>
<tr>
<td>Mberengwa</td>
<td>4/9</td>
<td>1/30-1/160+</td>
</tr>
<tr>
<td>Mount Selinda</td>
<td>16/16</td>
<td>1/60-1/1120</td>
</tr>
<tr>
<td>Mount Hampden</td>
<td>16/16</td>
<td>1/15-1/120</td>
</tr>
<tr>
<td>Mvurwi</td>
<td>6/16</td>
<td>1/120-1/160</td>
</tr>
<tr>
<td>Nkayi</td>
<td>6/6</td>
<td>1/60-1/240+</td>
</tr>
<tr>
<td>Nyamandlovu</td>
<td>11/11</td>
<td>1/60-1/240+</td>
</tr>
<tr>
<td>Rafingora</td>
<td>1/16</td>
<td>1/60-1/120</td>
</tr>
<tr>
<td>Rekomitje</td>
<td>3/16</td>
<td>1/60-1/160+</td>
</tr>
<tr>
<td>Rusape</td>
<td>4/16</td>
<td>1/60-1/160</td>
</tr>
<tr>
<td>Seke</td>
<td>14/16</td>
<td>1/60-1/160</td>
</tr>
<tr>
<td>Shamva</td>
<td>5/16</td>
<td>1/60-1/160</td>
</tr>
<tr>
<td>Somabhula</td>
<td>16/16</td>
<td>1/60-1/120+</td>
</tr>
<tr>
<td>Tsholotscho</td>
<td>16/16</td>
<td>1/60-1/160-1/120+</td>
</tr>
</tbody>
</table>

Table 2: Results of BTV specific antibodies in sheep and goat samples collected from ten locations in Zimbabwe

<table>
<thead>
<tr>
<th>Location</th>
<th>BTV+ve/Total</th>
<th>BTV+ve range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gwanda (g)</td>
<td>3/16</td>
<td>1/15-1/60</td>
</tr>
<tr>
<td>Kwekwe (g)</td>
<td>20/23</td>
<td>1/15-1/240</td>
</tr>
<tr>
<td>Banket (s)</td>
<td>9/9</td>
<td>1/60-1/240+</td>
</tr>
<tr>
<td>Centenary (s)</td>
<td>18/32</td>
<td>1/15-1/60</td>
</tr>
<tr>
<td>Harare (s)</td>
<td>0/9</td>
<td>0</td>
</tr>
<tr>
<td>Concession (s)</td>
<td>12/24</td>
<td>1/7.5-120</td>
</tr>
<tr>
<td>Chakari (s)</td>
<td>5/12</td>
<td>1/7-1/240+</td>
</tr>
<tr>
<td>Chinhoyi (s)</td>
<td>6/9</td>
<td>1/7.5-1/240+</td>
</tr>
<tr>
<td>Mvurwi</td>
<td>9/9</td>
<td>1/120-1/240+</td>
</tr>
<tr>
<td>Karoi (s)</td>
<td>0/5</td>
<td>0</td>
</tr>
</tbody>
</table>

Key: g = goat samples; s = sheep samples

In Zimbabwe, the significance of BTV antibodies in sheep is more difficult to assess because of unclear information on the vaccination histories of these animals that are brought to abattoirs. This is not the case with cattle and goats which are not vaccinated as these rarely suffer clinical BT disease.

BT is not considered by the farmers as a major constraint to livestock agriculture as compared to other diseases such as foot and mouth and tick-borne diseases leading to poor record keeping of BTV vaccination by farmers.

Although BT is a notifiable disease no useful records on mortalities and cases caused by the same are kept making it impossible to accurately predict the economic losses caused by this disease to the sheep industry.

Acknowledgement

We would like to recognise the assistance of Prof. P.S. Mellor and Mr. Chris Hamblin of the Institute for Animal Health, Pirbright, UK. This work was funded by the Wellcome Trust and the European Union through a research grant entitled 'Development of Research Capacity in Zimbabwe for Investigations of Arboviral Infections' and 'Arboviral Disease in southern-Africa - identification of the vectors and development of a climate driven risk assessment model,' Contract No. IC18-CT95-0010.

References


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The limited research that has been carried out on the gastrointestinal - intestinal parasitic diseases of the domestic chickens in Ethiopia has been confined to Bahir Dar\(^1\), Soddo\(^2\) and Debre Zeit\(^3\). These studies were undertaken only on relatively few birds and for relatively short duration. Except for a few\(^4\), there is no any other study undertaken on arthropod parasites of chickens so far.

From September, 1998 to June, 1999 a total of 227 local chickens kept under the traditional management system from three districts of South Wollo Zone and one district of West Gojam Zone of the Amhara Regional State were subjected to detailed examination for parasitic mange mites of the air sac and skin. The main objective of the work was to get an indication on the presence as well as the prevalence of these parasites on chickens in the area.

The chickens of both sexes of various age groups were bought from markets in the area and included sick-looking and apparently healthy ones.

The overall prevalence of mange mites in the area was found to be 46.70%. The highest infestation was with *Cnemidocoptes mutans* that accounted to 19.82% followed by *Cyttodites nudus* with 11.89% and *Epidermoptes bilobatus* having 9.25% (Table 1).

*Cyttodites nudus* and *Epidermoptes bilobatus* are being reported for the first time as mange mites of chicken in Ethiopia. Although not considered pathogenic, it has been stated that heavy infestations by *Cyttodites nudus* may predispose to pulmonary disorders\(^5\). On the other hand, it was registered that cyttoditis has got an enzootic character whereby in affected flocks the mites could be isolated from more than 50% of the chicken and around 50% of the parasitized chickens may die\(^6\). Being a problem of poorly managed farms, increased morbidity and mortality of chickens were observed in summer and autumn in temperate areas\(^6\). It was reported in Victoria, Australia as a cause of respiratory disease in five flocks of free range chickens\(^7\). Hence, further study is needed in Ethiopia.

The scaly leg mite *Cnemidocoptes mutans* causes inflammation with exudates that hardens after piercing the skin underneath the scales\(^8\). This mite was most commonly observed in older chickens. In 5.73% of the chickens, it was found in combination with the scaly skin mite, *Epidermoptes bilobatus*. The scaly skin mite in large numbers, are known to cause ill-health in domestic fowls\(^8\).

This preliminary work indicates the need for further systematic study of these and other arthropod parasites in most parts of the country in order to know their prevalence, economic significance and prescribe simple methods of control.

**Table 1**: The prevalence of mange mite parasites in 227 chickens in four districts of Amhara Regional State, Ethiopia

<table>
<thead>
<tr>
<th>Common name</th>
<th>Parasite species</th>
<th>Number of chickens infested</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaly skin mite</td>
<td><em>Epidermoptes bilobatus</em></td>
<td>21/227</td>
<td>9.25</td>
</tr>
<tr>
<td>Scaly leg mite</td>
<td><em>Cnemidocoptes mutans</em></td>
<td>45/227</td>
<td>19.82</td>
</tr>
<tr>
<td>Air sac mite</td>
<td><em>Cyttodites nudus</em></td>
<td>27/227</td>
<td>11.89</td>
</tr>
<tr>
<td>Mixed 1 &amp; 2</td>
<td><em>E. bilobatus &amp; C. mutans</em></td>
<td>13/227</td>
<td>5.73</td>
</tr>
</tbody>
</table>

\(^*\) reported for the first time in Ethiopia.

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*Corresponding author*
References


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SHORT COMMUNICATION

GASTRIC ACID SECRETION IN THE ANAESTHETISED CAPTIVE GUINEA FOWL
(NUMIDA MELEAGRIS) FROM ZIMBABWE

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In the presence of light the chicken will eat almost continuously¹. It would appear that the secretory activity of the digestive system of chicken is adapted to this continual digestive process. In birds, unlike mammals, the oxynticpeptic cells produce hydrochloric acid and pepsinogen from one and the same cell². The basal secretory rate of the chicken is 18-32% of that observed after maximal stimulation and is much higher than in other species of animals per kilogram body weight³. Even after 24 hours of starvation, there is a considerably high rate of acid secretion in the fowl⁴.

Although the Guinea fowl is traditionally a wild bird in Zimbabwe, many are beginning to utilise it in commercial production systems. For Guinea fowls, diets and feeding strategies are based on the requirements of chickens. A literature survey revealed that the digestive physiology of the Guinea fowl has been poorly studied. It is important to fully understand the digestive physiology of the Guinea fowl as it may aid in the development of appropriate diets, feeding strategies and interventions when disease situations arise. The aim of this study was to determine the basal and histamine-stimulated acid output of the anaesthetised Guinea fowl.

Ten adult Guinea fowls weighing 1.2-1.5 kg were used in the study. After a 12-hour starvation, they were anaesthetised with urethane (50% W/V solution at 3.0ml/kg body weight) via the deep ulnar vein. A tracheotomy was performed to permit a patent airway. A skin incision was made in the left inguinal region caudally from the ventral aspect of the last rib. The abdominal muscles were bluntly dissected and the post-hepatic septum was incised to expose the gizzard. The intermediate zone of the proventriculus was exteriorised, and a longitudinal incision was made proximal to the gizzard. A cannula for collection of gastric juice was inserted and secured in place by a purse string suture. The proximal gizzard was ligated to prevent reflux of gizzard contents into the thoraco-abdominal cavity. The oesophageal portion just before the crop was incised and a cannula passed beyond the crop into the proventriculus. The upper part of the cannula was then connected to a Harvard infusion pump and the proventriculus perfused with normal saline warmed to the birds body temperature at a flow rate set at 1 ± 0.1 ml/minute. The effluent was collected at ten-minute intervals and titrated with 0.01 N Sodium hydroxide (NaOH) with phenolphthalein as an indicator. Basal acid was collected for one hour. Secretions were then stimulated with single doses of histamine (75ug/kg and 75ug/kg and 1500ug/kg) injected subcutaneously in random order, on the right sternal region (secretions were allowed to return to basal levels before the next dose). Effluents were collected at ten-minute intervals for an hour. The total titratable acid in the effluents was expressed in Meq/10 minutes. The Guinea fowls were hydrated with 0.9% saline at the rate of 5ml/hr. through an infusion set with a 23G needle placed subcutaneously in the upper right inguinal region.

The mean basal total acid output was 2.9 ± 1.2mEq/kg/hr. Injection of histamine resulted in an increase in acid output that increased with incremental doses (Figure 1). A low dose of histamine (75ug/kg) resulted in a peak secretion within twenty minutes whereas for higher doses it was in forty minutes (Figure 2).

In unanaesthetised chickens a mean basal acid output of 1.2mEq/hr² and a basal secretion of 1.36±1.2 Meq/kg/hr has been recorded. Although anaesthetics generally affect gastric
acid secretion, in the chicken\textsuperscript{5}, urethane does not significantly depress secretion. In the chicken, peak acid output of 4.9mEq/hr was recorded at an infusion rate of 600ug/kg/hr histamine\textsuperscript{3}. This represented a four-fold increase and, higher doses of up to 1,200ug did not further increase the acid output. However, for single subcutaneous injections of histamine, higher doses were required (at least 800ug/kg) in the chicken to produce maximal acid output\textsuperscript{6}, which still resulted in a four-fold increase. In the Guinea fowl, 75ug/kg histamine increased the acid output more than five-fold. At a dose of 1,500ug/kg histamine, there was still a large increase in acid output at 37.4±5.1 Meq/kg/hr (Figure 1). This indicates a massive reserve for the acid output of almost twelve-fold in the anaesthetised Guinea fowl. In the chicken, after a single dose of subcutaneous administration of histamine the maximal acid output was attained within 40 minutes of injection\textsuperscript{6}, which is comparable to our study.

The lengths and weights of the different segments of the gastrointestinal tract of the domestic fowl (\textit{Gallus domesticus}) are significantly longer and heavier than those of the Guinea fowl\textsuperscript{7}. Thus, the difference in acid output is not due to the difference in weights of the proventriculus but perhaps due to the relative numbers of secretory cells and/or different mechanisms of secretion.

The acid secretin mechanisms of the domestic fowl appears to be adapted to continuous feeding\textsuperscript{9} whereas in the wild, the Guinea fowl is a daylight feeder and sleeps at night. We suggest that the Guinea fowl's acid secretory pattern (low basal acid secretion with a very high stimulated reserve capacity) is adjusted to this diurnal feeding behaviour. In conclusion, mean basal acid secretion in the urethane-anaesthetised Guinea

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image1.png}
\caption{Dose secretion relationship for total acid output (n=10)}
\end{figure}
fowl is significantly higher than that in the unanaesthetised chicken and the Guinea fowl has a significantly higher response to histamine than the chicken. There is need for further study on the effects anaesthetics and other drugs and hormones that are known to affect and regulate secretion in chickens so as to fully understand acid secretion in the Guinea fowl and thus feed appropriately.

Acknowledgements
The technical input of Mr. F. Jim, Mr. F. Chimudzi and Mr. W. Saunyama in the Preclinical Department of Veterinary Medicine and funding by the University of Zimbabwe research board is acknowledged.

References

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CORNUA ABNORMALITY IN SHEEP – A CASE REPORT

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A ram about 12 months old was presented at Animal Research Institute’s Veterinary Clinic at Achimota, Ghana for clinical attention. The ram was from a flock of eleven sheep of mixed ages and sexes kept semi-intensively at a backyard. The parents of the flock were bought from unidentified sources.

The flock is routinely left to scavenge during certain periods of the day. Breeding is, therefore, uncontrolled. The ram appeared to be a mixture of breeds with the predominant characteristics of the West African Dwarf Sheep.

The owner’s complaint to the clinic was a lump about 4 cm in diameter on the left flank of the ram.

Routine general examination of the ram gave the rectal temperature as 38.9°C and a respiratory rate of 20 per minute. The lump on the flank was palpated and found to be hard and felt to be like a golf ball buried subcutaneously. No fluid was obtained on aspiration. Otherwise, the ram was in a generally healthy condition. The ram was suspected to have a benign neoplasia (tumor). Surgery was therefore prescribed.

In the course of body examination the ram was observed to have three processus cornuus. The left cornus measured 20.8 cm from the root to the tip while the right one was 20.5 cm. The two normal cornua grew pointing postero-ventral, gently twisted and almost straight (Fig. 1).

The third processus cornuus grew pointing posterior on the left and then curved antero-ventrally with the tip only 1.7 cm from the posterior border of the orbital cavity close to the supraorbital process. This processus cornuus appeared more recent (newer) than the normal two cornua.

The benign tumor was surgically removed. The ram was given 6mg intramuscular acepromazine maleate (Neurotonin® Alfasan). After ten minutes the site was prepared aseptically for surgery 1. The site was infiltrated with 2% Zyllocaine and Adrenalin (Alfacaine® Alfasan).

About 4 cm incision was made on the tumor and blunt dissection method used to remove the tumor. The incision was sutured and dressed. The animal was then given 2 mg Dexamethasone (Farvet) and 2 ml benzy/penicillin – dihydrostreptomycin (Coophavet®) for five days. The supernumary horn was not removed.

Developmental abnormalities ordinarily originate before birth most definitely in embryonic life 2,3. Often the etiology is unknown 4. However, numerous factors have been incriminated in the formation of different types of anomalies. Among the common factors that contribute to malformations are certain compounds of plant.
and chemical origin, heredity, some disease causing organisms, and radioactive materials.

Some alkaloids which are widely distributed in the plant kingdom including *Veratrum californicum* are known to cause between 1 - 25% malformations when fed to ewes during early pregnancy. These malformations are often found to be confined to the head region\(^\text{5,6,3}\). Toxicity of benzimidazole compounds (anthelmintics) given orally to pregnant ewes have also been recorded to cause various forms of congenital malformations\(^7\).

Hereditary studies in a sheep flock showed that the incidence rate of congenital abnormalities were higher among certain breeds such as the Suffolk than others\(^8\). In the industrialised countries, radioactive contaminations are also known to increase skeletal abnormalities commonly found in the cranium, spine limbs and the anal region in sheep\(^9,10\).

Certain viral infections especially the *Main Drain* when they infect ewes during early pregnancy lead to congenital brain and musculoskeletal malformations\(^11\).

It is suspected that the incidence of congenital malformations could be high in all farm animals in Ghana as most cases are not reported. Malformed animals often do not survive after birth when vital organs are affected. Most of them are destroyed by the farmers or owners as a traditional means of suppressing perpetuation of such abnormalities as is justified through superstition.

The cause of this malformation is not apparent but could be attributed to certain toxic compounds of plant and chemical origin. These compounds could have been ingested by the animal as a result of the free-range or scavenging husbandry system practised in Ghana coupled with indiscriminate waste disposal especially in the urban areas.

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References


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Le Bulletin de la Santé et de la Production animales en Afrique contient des articles de recherches originales traitant d'activités en matière de santé et de production animales visant à assurer le développement de l'industrie animale et une meilleure utilisation des ressources du bétail en Afrique. Le Bulletin est un périodique trimestriel.

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Deux exemplaires des articles doivent être adressés à Monsieur le Rédacteur en Chef, Bulletin de la Santé et de la Production Animales en Afrique, Organisation de l'Unité Africaine/Bureau interafricain des Ressources animales, P.O. Box 30786, Nairobi, Kenya.
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