SOUTHERN AFRICAN

SOCIETY FOR VETERINARY EPIDEMIOLOGY

AND PREVENTIVE MEDICINE

Proceedings of a meeting held at the Onderstepoort Veterinary Institute, Onderstepoort, Gauteng, South Africa on the 10th and 11th May 2001

2 nd Edition

Edited by B. Gummow and P.N. Thompson

The views expressed in these proceedings are not necessarily those of the Editors or the Executive Committee of the Society

ACKNOWLEDGEMENTS

The following bodies provided support for the conference:

The Onderstepoort Veterinary Institute

Geographical Information Management Systems

The National Directorate of Veterinary Services, South Africa

The Department of Production Animal Studies, University of Pretoria

Daleen Anderson provided secretarial assistance.

Bruce Gummow, Peter Thompson, Rick Mapham and Richard Emslie provided the continuing education programme

CONTENTS

Acknowledgements ..... **iii**

PAPERS 1

EPIDEMIOLOGICAL INFORMATION SYSTEM FOR COMMUNAL AREAS: THE NAMIBIAN EXPERIENCE - L. LARBODIERE, F. GOUTARD, N.S. AMUTHENU , C. BAMHARE AND P. HENDRIKX 2

THE USE OF DECISION TREES FOR VETERINARY DECISION MAKING - P.H. MAPHAM 11

AN ALTERNATIVE APPROACH FOR MONITORING AND IMPROVING BEEF ENTERPRISE EFFIECENCY - W.A. SCHULTHEISS 19

THE MONITORING OF INDIVIDUAL COW SOMATIC CELL COUNTS IN A DAIRY HERD HEALTH PROGRAMME - G.V.S. TURNER 25

GEOGRAPHIC DISRIBUTION OF SAT-2 TYPE FOOT-AND-MOUTH DISEASE VIRUS GENOTYPES IN AFRICA - A.D.S. BASTOS 27

AN OVERVIEW OF THE ERADICATION OF *BRUCELLA MELITENSIS* FROM KWAZULU-NATAL - F.R. EMSLIE AND J.R. NEL 34

AN EPIDEMIOLOGICAL STUDY OF AN OUTBREAK OF LEPTOSPIROSIS IN CATTLE IN A MIXED FARMING UNIT - P.N. THOMPSON AND B. GUMMOW 40

MOLECULAR CHARACTERIZATION OF AFRICAN SWINE FEVER VIRUS FIELD ISOLATES: NEW EPIDEMIOLOGICAL INSIGHTS - A.D.S. BASTOS, B.I. PHOLOGANE, J.L.EDRICH, C.I. BOSHOFF AND M.L. PENRITH 46

CONSTRAINTS INVOLVED IN INVESTIGATING THE EPIDEMIOLOGY OF AFRICAN SWINE FEVER IN MANKWE/BAFOKENG DISTRICT OF NORTH WEST PROVINCE - C.M. MCCRINDLE AND E.J. MANENEZHE 47

EAST COAST FEVER IN NORTHERN MALAWI: AN ATTEMPT TO EXPLAIN AN UNEXPECTED SEASONAL PATTERN OF DISEASE INCIDENCE - K. LORENZ 52

POSTERS 61

A STOCHASTIC DECISION TREE MODEL TO ASSESS THE IMPACT OF GROUNDWATER POLLUTION ON LIVESTOCK - B. GUMMOW 62

GENETIC RELATIONSHIPS OF SAT2 TYPE FOOT-AND-MOUTH DISEASE VIRUS ISOLATES FROM OUTBREAKS IN WEST AFRICA, 1974-1991 - O. SANGARE, A.D.S. BASTOS, W. VOSLOO AND E.H. VENTER 63

TUBERCULOSIS – A TIME BOMB IN SOUTH AFRICA'S KRUGER NATIONAL PARK? - A.L. MICHEL, D.F. KEET, R. BENGIS AND V. DE VOS 64

PAPERS

EPIDEMIOLOGICAL INFORMATION SYSTEM FOR COMMUNAL AREAS: THE NAMIBIAN EXPERIENCE

L. LARBODIERE[1], F. GOUTARD[1], N.S. AMUTHENU[1], C. BAMHARE[2] & P. HENDRIKX[3]

SUMMARY

Export of livestock and animal product is a major economic activity in Namibia. The country's main trading partners only accept to import according to strict sanitary guarantees. Some of the main functions of the Directorate of Veterinary Services are diseases surveillance, control and reporting aiming at fulfilling the strict import requirements and maintaining a disease-free status in commercial areas. Therefore, an effective Epidemiological Information System (EIS) has been put in place in commercial areas since 1984 (Biggs, 1984).

This EIS has however not been as efficient in the Northern Communal Areas (NCA), where major diseases such as CBPP still occur. To complement the regular vaccination campaigns and the veterinary cordon fence, an effective EIS is essential to monitor the progress made in disease control and detection in emergent conditions.
There is also a strong political desire to improve the animal health status in the NCA to increase the access of communal farmers to lucrative export markets. In order to obtain a disease free status, it is necessary to stop the vaccination, follow the OIE pathway and an efficient EIS is required for early detection and control of diseases.

To fulfill this need, a Franco-Namibian project was set-up to design and test a local adaptation of the national EIS, for use in communal areas. A pilot system was developed in the North-Central Division in close collaboration between the Namibian Veterinary Services and the French Technical Assistance. The system has been tested over a period of 4 months and proposals have been made for further improvements.

INTRODUCTION

- During the year 2000, Namibia has exported 10 000 tons of beef to the European Union; 10 000 tons of beef and 11 000 tons of goat meat to South Africa; 69 000 heads of cattle and 644 000 heads of small ruminants to South Africa. This represents 16 % of the exportations and contributes to 80% of the Agricultural GDP and 9% of the national GDP. To ensure this, appropriate sanitary requirements from trading partners had to be complied with and appropriate guarantee given to keep the foreign markets opened. By setting-up a national Epidemiological Information System (EIS) since the mid eighties (Hare & Biggs, 1985), Namibian authorities have early understood the strategic role it would play in building the confidence of importing countries.

- The national EIS mainly collects three types of data:

1. Data from veterinarians and submitted on a Disease Report Form (DRF) for all diseases investigated or reported. The DRF is sent to the Epidemiology unit and to the Laboratory

[1] Directorate of Veterinary Services, P.O. Box 224, Ondangwa, Namibia
[2] Directorate of Veterinary Services, Epidemiology Unit, Private Bag 12022, Windhoek, Namibia
[3] CIRAD-EMVT, Campus International de Bailarguet, 34398 Montpellier Cedex 5, France

when specimens have been submitted. This serves an early warning, and early reaction (EW-ER) system, and provides georeferenced maps of diseases outbreaks. State veterinarians are given the opportunity to validate their data.

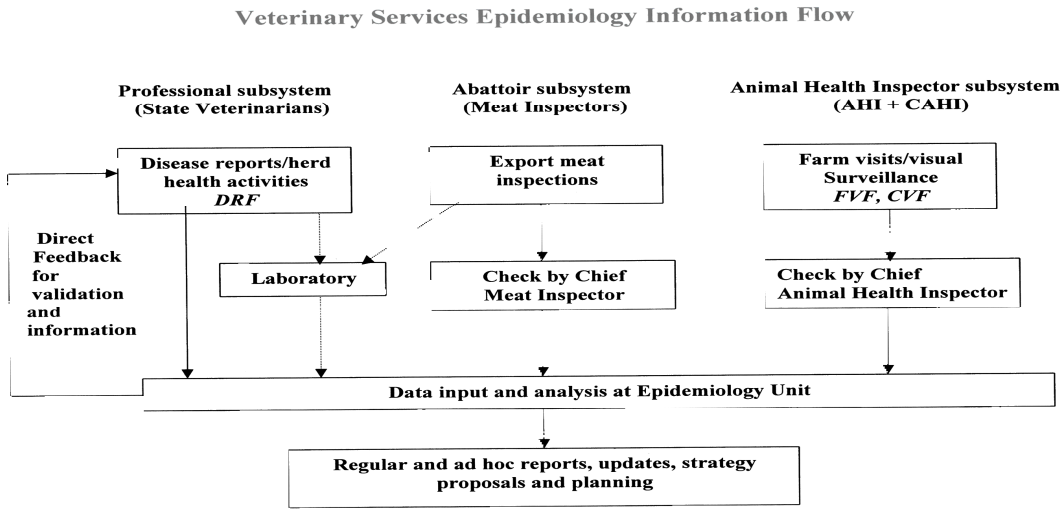
2. The Animal Health Inspectors (AHI) also actively collecting data during their pre-programmed visits to farmers (Farm Visit Form: FVF). This form is meant to draw on a regular basis a general picture of the farming conditions: diseases observed, toxic plants, body scores, watering and grazing condition. In communal areas, the same kinds of data were previously collected by the AHI during the vaccination campaign (Crushpen visit Form).
3. Data are also collected during meat inspection in export abattoirs.

Regular reports are produced from the system as feedback to State Veterinarians, AHI and other stakeholders. The reports include an Epidemiology update, AHI update, disease listing, national summary reports, quarterly and annual reports…). This system has proven to give a good picture of the animal health status in the commercial farms. The confidence and the regular contacts between commercial farmers and veterinary services allows a fast and reliable declaration of suspicious cases.

- This EIS was not as efficient in the Northern Communal Areas (NCA), where major infectious diseases such as CBPP still occur. Great dependence was placed on the veterinary cordon fence and on the regular vaccination campaigns against CBPP and FMD. More recently, an increasing interest has raised for disease surveillance in NCA for the following reasons:
  1. It is necessary to monitor closely the efficiency of the costly vaccination strategy,
  2. There is an increasing political desire to provide communal farmers with an access to lucrative export markets. This would entail following the OIE pathway up to the disease free status recognition. To enable a move from vaccination to eradication strategy, when the disease incidence has fallen low enough, a reliable EIS is required to enable DVS to detect and quickly control any outbreak of contagious diseases.

- To support this evolution, a Franco-Namibian project has been set-up to design and test an adaptation of the national EIS in communal areas. A pilot system has been developed in the North-Central Division (NCD) in close collaboration between the Namibian Veterinary Services and the French Technical Assistance. The system has been tested over a 4 months period.

- This paper tries to give an accounts of the steps and methods used to develop and implement an Epidemiological Information System in a communal area where accurate reporting is made difficult by a semi-transhumant farming system.



MATERIAL AND METHODS

The methodology to improve the EIS in NCA has followed successive steps:

1) Identification of the weaknesses of the existing Epidemiological Information System (EIS) with the special reference to communal areas.
2) Design specific adaptations of the existing EIS to fit to NCA.
3) Implementation of these adaptations.
4) Assessment of results during a test period.

RESULTS

Weakness of the existing EIS in NCD

After a review of the existing information system, following issues were observed:

- Limited coverage of the area of the early warning early reaction system. The system relies on only 3 State veterinarians and most of the DRF are filled for diseases suspected in the immediate vicinity of the State veterinarian offices.
- There is no uniform procedure for the following up of cases
- The geographical location of the suspicious cases with a GIS is made difficult because of the inaccuracy of the available static file for villages in NCD.
- Active surveillance is only performed during the 5 months of vaccination campaign. Contacts at other times are limited to farmers coming to DVS field offices for consultation.
- Some of the crushpen visit forms went missing or were wrongly filled.
- The quality of data collected is questionable as most data was provided by herd boys and not by the owner.
- The feedback of information received from the national Epidemiology Unit is mainly targeted to the State veterinarians, and rarely reaches the field staff.

Problems peculiar to communal areas.

- A very high number of farms (110 000 homesteads) are scattered over the region (few hundreds for the same surface in commercial areas), with difficult access.
- Only 3 State Veterinarians are in charge to cover the region.

- Farmers are often unaware of the existence of veterinary services, of the location of DVS offices and of the necessity to report diseases.
- Veterinary services are under-equipped (8 cars available for field staff, few telephones, 1 fax…)
- Veterinary field staff has got a poor level of education.
- No specific training has been organized on disease surveillance.

a) <u>Necessary adaptation of the national EIS:</u>

The following objectives have been targeted:

1- Improve the precision of data collected
2- Improve the geographical coverage of the network
3- Initiate a local coordination of the EIS
4- Improve the feedback of information to the field workers involved in the EIS

1- <u>Improve the precision of data collected</u>

- *The surveillance is focused on some **priority diseases,*** which have been selected by State Veterinarians and the Chiefs AHI according to their knowledge of the field and taking into consideration 6 criteria: mortality rate, contagious power, zoonotic nature, socio-economical consequences, possibility to control, international regulations. The priority diseases selected for the NCD are the following:
  - Rabies
  - CBPP
  - Foot and mouth disease
  - Botulism
  - Mange for small stocks
  - Internal Parasites

This list is flexible, and can be revised to take into account any epidemiological change.

- *For every priority disease, a **specific surveillance protocol** has been designed.* This protocol includes: the actors involved, the places where surveillance takes place, the procedures to follow, the symptoms leading to a suspicion, the specimens to take, the timing for transmission of specimens, forms and results, the immediate actions to take to inform the farmers and control the disease.
- *The **Static file** (location of villages) has been completed* with other available databases. A permanent updating system has been put in place in order to enable the location of diseases suspicions / outbreaks.

2- <u>Improve the coverage of the early warning – early reaction (EW-ER) network</u>

- ***A new form has been designed, the*** **Suspicion Form (SF)**. It is similar to the DRF, but is filled by EIS field workers (see below) when they suspect a priority disease. This form is then forwarded in emergency to the State Veterinarian, who translates it into a DRF, and takes appropriate action.
- ***New actors are involved in the EW-ER surveillance system***:

  - DVS field staff: 18 Stock Inspection Assistant (SIA) and 8 Animal Health Inspectors (AHI) have been trained to identify priority diseases, take sample and report (SF) them to the State veterinarians. Sampling kits and cool boxes have been provided;
  - 40 Community based Animal Health Agents (CAHA) have been trained to identify priority diseases and report (SF) them to the DVS staff, who is charged to take samples;

- 15 Agricultural Extension Technicians (AET) have been trained to identify and report orally to DVS the suspicions of any priority disease;
- 11 butchers have been trained to report to DVS the suspicious lesions on carcasses (Butcher form).

➢ *EW-ER procedures are implemented* ***during vaccination campaign****:*

DVS staff has been trained to identify and report priority diseases (SF + samples) during the vaccination campaign (focused on highly priority diseases: FMD, Rabies and CBPP).

3. Develop the active surveillance:

➢ After the vaccination campaign*, regular* ***meetings with communities*** are organized by the staff focusing on the priority diseases and the importance of their early reporting to DVS offices. Joined community visits are also conducted with AET, who are more traditionally crop oriented. Specific extension messages have been designed for them to inform farmers about the EIS and the reporting system.

➢ *Permanent surveillance is developed* ***on markets*** (along the Angolan border) through the traditional authorities,

➢ DVS staff, in order to collect SF and maintain their dedication, organizes *regular* ***visits to trained butchers and CAHAs*** *in their area.*

4. Initiate a local coordination of the EIS

➢ ***One State veterinarian is responsible for following EIS activities in order to keep*** the dedication of field workers (training, meetings, newsletter) and to monitor the quality of the network (forms filling, quality of samples, data flow…).

➢ ***Performance indicators are set-up*** to monitor the operation of the network (number of SF, number of samples, number of meetings to communities, timing…).

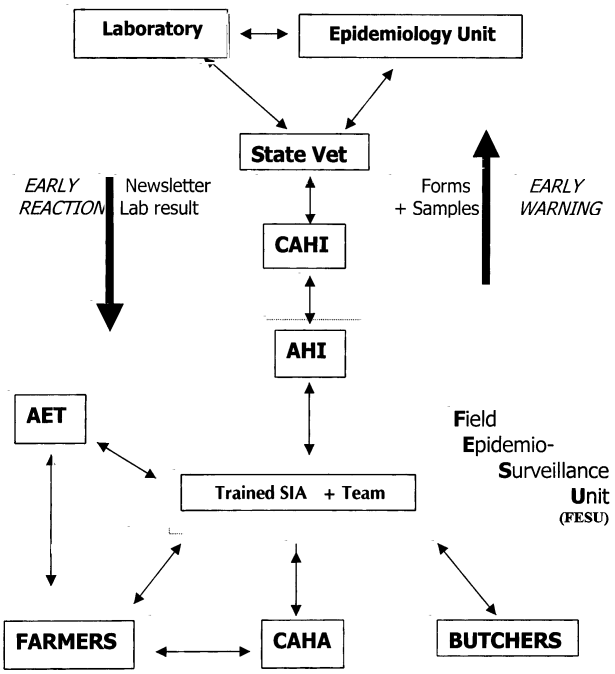
5. Improve the feedback of information to the field workers involved in the EIS

➢ ***Monthly meeting are organized between the supervisors and their EIS teams***

➢ ***A user-friendly bi-annual newsletter about the EIS is edited*** in English and Oshivambo (EIS results, interviews, technical focus on one specific disease…).

➢ ***A general workshop is organized twice a year*** with EIS teams to discuss the results and the problems faced on the field, and to give targeted refresher lectures.

SCHEME OF THE EIS



Organization of the new EIS in the North-Central Division

b) : Implementation of the adaptations:

❖ Initial training and refresher course for EIS field workers

Every actor of the EIS has received a training adapted to his role inside the EIS (§ 2.2).

❖ Tools for change:

- **Monthly meeting with the EIS teams:**

EIS agents have to fulfill a monthly program for surveillance activities (community visits, visit of butchers, visit of CAHAs, visits of markets…). During the monthly meeting, every EIS staff gives a feedback about the past month activities, builds his program for the following months and discusses problems with his supervisors.

- **Meeting with the management of the State Veterinarian office:**

Every 2 weeks, a local management meeting is organized by the coordinator, with State veterinarians and Chief AHI, to assess the EIS activities, propose improvements, monitor the progress made and organize training.

- **Technical committee:**

Every 4 months, a meeting is organized with DVS and laboratory specialists to monitor the technical development of the EIS. Once a year, a steering committee with the top management discusses the results and gives appropriate guidelines for future activities.

- **EIS newsletter:**

Published every 6 months and widely spread, the newsletter contributes to the dedication of the EIS actors and is a good communication tool toward the Ministry and the stakeholders.

❖ **Implementation of the strategy:**

Most of the strategy has already been put in place except:

- The surveillance on markets, still to be finalised;
- The first epidemiological newsletter, about to be released (June 2001);
- The performance indicators, still to be been designed.

❖ **Some of the EIS results:**

These are some of the main results of the EIS activities between November 2000 and February 2001 (4 months):

Results of the EIS

SUSPICION FORMS	**61Suspicions done by DVS staff**
	9 of Botulism
	14 of Internal Parasites
	8 of Mange
	14 of CBPP: only 2 suspicions with samples
	2 of rabies: 1 suspicion with sample
	14 suspicions of no Priority diseases
	Samples
	9 suspicions with samples
	22 Suspicions done by CAHAs
	2 of botulism
	3 of Internal parasites
	6 of Mange
	4 of CBPP
	5 of Rabies

CVF	**36 Communities visited**
	770 farmers involved
	271 dogs vaccinated
	36 cats vaccinated

DISCUSSION

The first results show that the system is already operational. The coverage of the surveillance has been increased, and is now performed by 3 State Veterinarians, 20 AHI, 40 CAHAs, 15 AET and 11 butchers. Within 4 months, the field actors have made more than eighty suspicions all over the region, which represents 1/3 of the total number of suspicions during the period (2/3 of DRF directly filled by State veterinarians). Nearly 40 community meetings have been organized gathering nearly 800 farmers.

These results, although still insufficient (160 communities were supposed to be visited if according to the objectives), represent a revolution for most of the field staff, previously focused on their vaccination campaign duties only. This evolution has been welcome very positively by most of them, who are proud of their new responsibilities. The close supervision of the teams, which is allowed by the monthly EIS meeting with EIS teams is a very strong asset for the EIS. The contact with farmers has also considerably improved, and all the office registers have shown a clear increase in the number of farmers coming to the DVS offices. The collaboration initiated with the Agricultural Extension Services, with common visits to

communities planed with AETs, gives a more coherent image of the Ministry to the farmers. This evolution is reinforced by the improvement of the veterinary drug distribution (implementation of a veterinary revolving fund in the region, also supported by the French Cooperation, with a privatization process going on): more drugs available urging more farmers to come into the offices and more data to be collected.

Some aspects of the EIS are still not running smoothly:

- The surveillance based on butchers has been relatively inefficient, mainly due to the poor following up. The surveillance should probably be more focused on CBPP, with a closer linkage with Veterinary Services. The possibility to give butchers the responsibly for samples taking should be studied.
- Many suspicions still reach the State veterinarian without samples, which deprives DVS of the data validation.
- Overloaded with their clinical activities, state veterinarians do not have enough time to follow all the suspicions made, especially when no sample was taken and further investigations is required. There is a risk to discourage the reporting and to disappoint the farmers. Efforts should be made to increase the immediate sample by field staff.
- The visits to communities have to be increased to reach a significant number of farmers, covering remote places (a lot of the communities visited are in the immediate vicinity of the field offices).

A very good asset of the EIS is the full involvement of the local and the national management, with good prospects for the sustainability of the system. The performance indicators will provide regional and national management a very useful tool to monitor and supervise the EIS. The connection with the other partners (especially butchers and CAHAs) is more fragile, and will have to be maintained regularly (refresher courses, meeting, newsletter…).

A lot of EIS activities (especially training) have still to be transferred to the government budget.

CONCLUSION

The Namibian Veterinary Services have managed to develop original adaptations to the EIS in order to accommodate valuable data from both commercial and communal farming systems.

The Namibian experience, although still under assessment, has proven to improve data collection from communal areas, to the extent that French Cooperation has been requested to support its extension to the remaining regions in the North (Kaokoland, Kavango and Caprivi).

This system might also to interest other countries in Southern Africa where both communal and commercial farming system are found.

REFERENCES

K.M. Hare, H.C. Biggs (1996). Design and evaluation of a veterinary information System for Namibia. *Review of Preventive Veterinary Medicine*, 26: 239-251.

Dufour B. (1999). Méthode d'évaluation technico-économique de la qualité du fonctionnement des réseaux de surveillance épidémiologique des maladies infectieuses animales en vue de leur amélioration, *Epidemiol. et Santé anim*., 35 : 11-20.

Hendrikx P., Bidjeh K., Ganda K., Ouagal M., Haggar A. I., Saboun M., Maho A. (1997). Le réseau d'épidémiosurveillance des maladies animals au Tchad. *Rev. Sci. tech. Off. Int. épiz.*, 16 : 759-769.

Hueston W.D. (1993). Assessment of the national systems for the surveillance and monitoring of animal health. *Rev. sci. tech. off. int. épiz,* 12: 1187-1196.

THE USE OF DECISION TREES FOR VETERINARY DECISION MAKING

P. H. MAPHAM[1]

SUMMARY

This article briefly covers the integration of events over which veterinary decision makers have control with the probability of the occurrence of chance events and the value of the consequences in decision analysis, and applies them to a practical situation using an example of choosing between two different respiratory treatments in an intensive livestock production unit.

INTRODUCTION

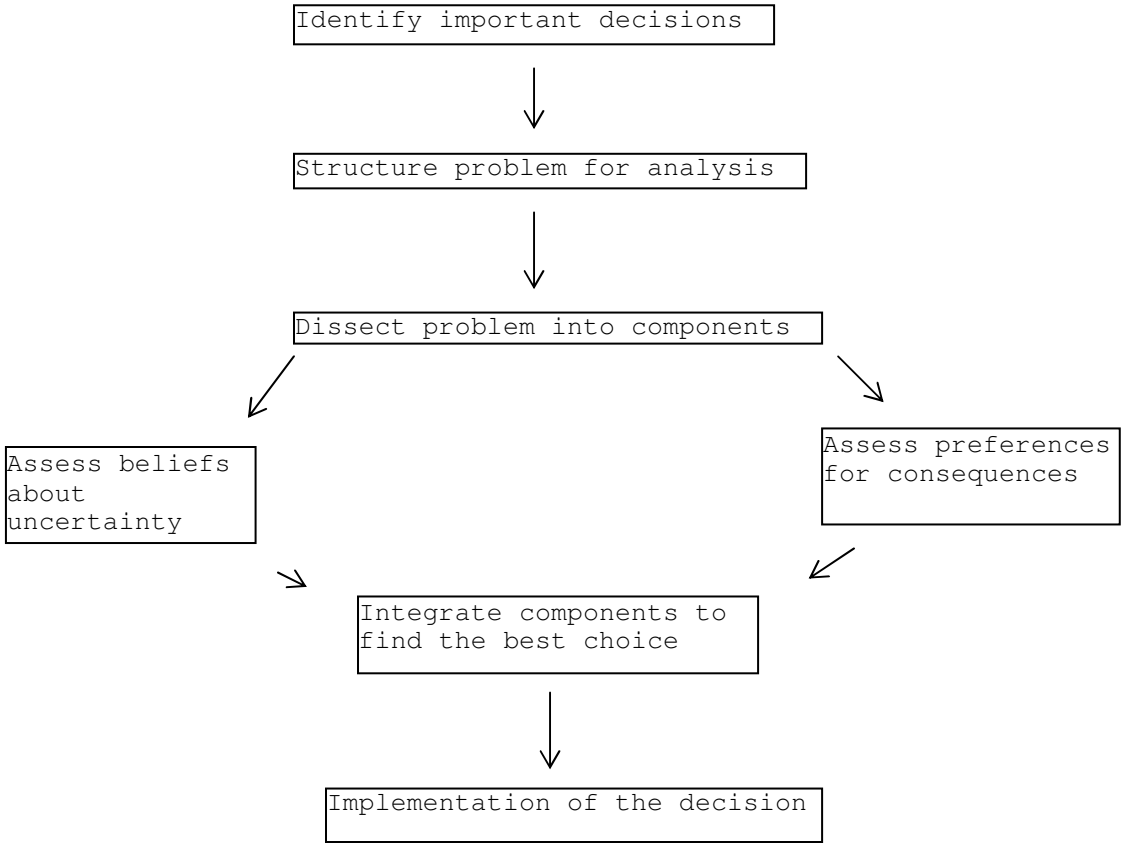
Veterinarians by nature of their profession make many decisions on a daily basis. These decisions frequently have to be made in the absence of complete information and the consequences thereof may vary significantly. Decisions made by veterinarians carry considerable weight in the eyes of veterinary clients who put their faith in the profession, and consequently should be given serious consideration.

DECISION MAKING

Decision making is the process of choosing which of a number of alternatives is “best” or “most appropriate” to meet identified goals or objectives according to some defined criteria. Decision analysis is the name given to the family of methods that have been developed, and are still being developed, to try to rationalise choice in an uncertain world. Using mathematical programming or dynamic simulation is outside the scope of most veterinary practitioners and a relatively simple method to break decisions down into separate judgments about the nature of the uncertainties is required. A basic approach to the application of decision analysis is described and illustrated by using a simple example of a veterinary decision. This example will illustrate how to make a decision taking into account treatment response and economic factors.

[1]P O Box 13373, Cascades, 3202

Fig 1. An outline of decision analysis:



DECISION ANALYSIS

The major elements considered in decision analysis include:

I. The events over which the decision maker has control (alternatives)
II. The probability of the occurrence of chance events
III. The value of various consequences

A SIMPLE PROBLEM

To illustrate a decision making process, the question of whether to recommend drug A or drug B for the treatment of bovine respiratory disease in a feedlot situation is used. Both drug A and drug B are antibiotics registered for use in bovine respiratory disease. Respiratory disease in the feedlot involves both bacteria and viruses, and antimicrobial therapy of the bovine respiratory disease complex is the subject of many publications (Apley & Fajt, 1998).

Which drug to use is an important decision (decision maker controlled) because respiratory disease causes significant losses in the feedlot industry, and improvements in the treatment protocols are continuously being investigated. In order to analyse the question it is necessary to separate or dissect the possible consequences (chance events) of using any particular

treatment protocol, and structure these in a manner which makes it possible to compare any number of protocols by the same measure. In this case some suggested possible consequences are listed in Table 1. These consequences should be listed in consultation with the client for whom the decisions are to be made in order to integrate their personal beliefs into the process.

Table 1. Possible consequences of using a particular treatment protocol

Health consequences

Die	after one or more treatments
Marketed:	**after recovery after a single treatment**
	After recovery after more than one treatment
Cull	after one or more treatments

Carcass consequences

Carcass and organs normal	
Carcass and organs abnormal:	Lungs condemned
	Lungs and pleura condemned (pleuritis and pneumonia)
	Carcass partially condemned
	Carcass condemned

Performance consequences

Daily gain normal or abnormal
Daily intake normal or abnormal
Days on feed normal or abnormal

The expected preferences for the outcome of the treatment are shown in Table 1 in bold print.

Beliefs about the probability of each consequence could be evaluated using various methods including expert opinion, research data, literature, anecdotal evidence or subjective probability judgments, amongst others. A combination of the above factors may also be used and it is important to realise that the quality of the probability data used has a direct bearing on the reliability of the final result.

For the purposes of this article it will be assumed that the only data available is an article from a reputable peer reviewed journal giving the information in Table 2.

Table 2. Information on treatment outcome obtained from the literature

No of animals treated	Drug A 250 head	Drug B 252 head
Recovered after 1 treatment	166	136
Recovered after 2 treatments	31	66
Recovered after 3 treatments	15	25
Died	21	16
Chronic	17	9

In addition the article reports that animals treated with drug A gained 1.2 kg per day to slaughter while drug B animals gained 1.1 kg per day. Neither comparative slaughter data nor daily intakes or feed conversion data were given. Point estimates of the probabilities (number in category/total number) of each consequence or chance event can be calculated from this data (Table 3).

Table 3. Probability of each outcome

	Drug A	Probability (p)	Drug B	Probability (p)
Number treated	250	1	252	1
Recovered after 1 treatment	166	0.664	136	0.540
Recovered after 2 treatments	31	0.124	66	0.262
Recovered after 3 treatments	15	0.060	25	0.099
Died	21	0.084	16	0.063
Culled chronic	17	0.068	9	0.036

The values of the various outcomes are estimated as follows:
Recovered animals are valued, in the absence of specific performance data, at average market value less the cost of the number of treatments received. Culls are valued at a rate provided by a feedlot manager, less the cost of treatments. The cost of treatment can be calculated from IVS or from specific cost data supplied by the relevant companies, although in this case the drug values used are for example only. The estimates used in this example are shown in Table 4.

Table 4. Estimates for parameters used in calculating values of outcomes

Drug costs per treatment drug A =R25.00
Drug costs per treatment drug B = R50.00
Average marketed carcass mass = 206 kg
Average live mass of culls = 220 kg
Average marketed carcass selling price = R8.31 per kg
Average "on the hoof" price per cull = R 4.00 per kg
Average days from treatment to market = 70 days
Value of deaths = nil

Market value: Average carcass mass kg * average realisation c/kg - cost of treatments
= 206 * 8.31= R1711.86 - cost of treatments (A)
= 199*8.31=1653.69 - cost of treatments (B)*

Culled value: Average weight at cull kg *Average realisation c/kg - cost of 3 treatments
= 220 * 4.00=R880 - cost of 3 treatments

Death value: Nil - cost of 2 treatments

*In order to integrate the reported difference in daily gain after treatment into the calculations the average days from treatment to marketing is multiplied by the difference in the average daily gain i.e. 0.100 kg/day and deducted from the market mass of animals recovered after drug B. The average carcass mass attributed to drug B recovered animals is therefore reduced by 7 kg (70*0.100) from 206 to 199 kg.

The probability data are now integrated into a table or spreadsheet known as a "payoff matrix". Multiplying the value of an outcome by the probability (p) of it occurring yields the expected value (p*value) of the outcome. The sum of the expected values of the drug-value combinations for a particular drug is the expected value of that particular protocol. This is illustrated in Table 5.

Table 5. Payoff matrix comparing total expected values of two treatment protocols

	P (A)	Value (A)	p*value (A)	p (B)	value (B)	p*value (B)
Treat 1	0.664	1686.86	1120.08	0.540	1603.69	865.48
Treat 2	0.124	1661.86	206.07	0.262	1553.69	406.92
Treat 3	0.060	1636.86	98.21	0.099	1503.69	149.18
Died	0.084	- 50.00	- 4.20	0.063	-100.00	-6.30
Cull	0.068	805.00	54.74	0.036	730.00	26.07
	Total expected value		1474.90	Total expected value		1441.30

Finally, the consequences can be evaluated and a decision made. In this example the treatment with the highest total expected value is drug A, and if the decision to be made is based on maximising expected monetary value then it should be recommended that drug A be used.

DISCUSSION

There are a number of fundamental factors to be considered in decision analysis. Firstly, although in time the consequences of any decision made become apparent, it is rarely possible to know the consequences of an option that was rejected. A "good" decision can be defined as one that is consistent with what the decision maker believes about the uncertainty surrounding that decision, and his or her relative preferences for the possible alternative consequences.

Secondly, the approach described above is based on some assumptions of how a rational person would wish to act in making decisions carrying significant consequences. Thirdly, not everyone will want to address decision making in this way and may prefer more conservative methods, but these have their own limitations. Lastly, there is inevitably a certain amount of subjectivity in decision analysis that may be "unacceptable" or disturbing to people with scientific approaches, but in reality it is seldom, if ever, possible to delay a decision until all subjectivity is eliminated.

The consequences listed in Table 1 regarding carcass and performance data are often not available or limited, particularly when applied to specific treatment groups. Health data is often available from feedlot managers and, if properly controlled, field trial data may also be used or compared. Abattoir management may be able to supply information regarding the rate of "pleuritis and pneumonia" and the rate of lung condemnations, but this information would not differentiate between treatments unless data for individually identified animals is specifically recorded. The use of slaughter data is briefly considered below. Performance data is usually unavailable from field situations, because animals are grouped together and individual feed intake data is usually not recorded. The preferences highlighted (Table 1) are the obvious choices for this example but may not be so clear in other situations.

The values used (Table 4) are arbitrary estimates for use in this example and could be modified to any drug price and animal cost schedule.
The number of treatments costed for the death value is subjectively set at two, as this is the assumed midpoint of the number of treatments reported in the trial. It would be possible to repeat the exercise in Table 5 with either one or three treatments allocated to the deaths.
In this example the decision to recommend drug A is supported by the greater total expected value achieved in the drug A protocol. In an alternative method the "count data" shown in Table 2 (excluding the first row) could be used in a chi-squared test for statistical significance. A χ^2 value calculated using EpiInfo6 software is 21.24 and for 4 degrees of freedom p=0.000284 which indicates a statistically significant difference at a confidence level of 99%. If one ignored the expected monetary value, a decision to use drug B could be justified on the basis of the significantly reduced death and chronic (cull) rates and increase recovery (marketed) rates, and this may find some acceptance amongst decision makers whose risk preference is towards minimizing losses.

Drug B would have achieved a higher total expected value if the limited performance data available were not used in adjusting the market values. The manner in which this was done may not suit all decision makers, but since the information is from the same reference and feed costs (or days on feed/feed conversions) are a significant factor in intensive animal husbandry, some adjustment is considered justifiable. Alternative methods to adjust for the weight gain difference would be to include feed costs estimated to achieve the same market weight in the amount deducted from the estimated value. This introduces more variables in terms of feed intakes, cost of feeds, etc. and consequently introduces more uncertainty to the calculations.

The decision to recommend drug A is not necessarily correct or incorrect, and can only be considered good if it truly reflects the beliefs of the veterinarian and his client about the inherent uncertainties, if the data complies with minimum epidemiological standards and if the methods used are statistically valid. The advantage to this type of decision analysis is that it is transparent, the numbers may be changed to reflect the attitudes of the people affected by the decision to the probabilities and consequences, and new information can be integrated into the payoff matrix.

The decision making process illustrated above is a very simple example of a "decision tree" type of approach and can be expanded by building in carcass consequences as shown in Fig 2.

In a study (P H Mapham; unpublished data) of 846 animals marketed during the winter of 1993 the overall incidence of "pleuritis and pneumonia" was 7.3% (62/846) and the rate was 12.9% (21/162) in animals that had been treated and 5.9 % (41/684) in animals that had not been treated. Unfortunately, no differentiation was made between animals treated more than once. This information can be integrated into the "decision tree" as shown in Fig. 1 with the assumption that the lungs of animals showing pleuritis and pneumonia would be condemned and result in a reduced expected monetary value, which can be calculated using the expected mass of the lungs multiplied by the market value of this type of offal. The weight of lungs is given as 1.35% of carcass mass (Abakor personal communication) i.e. 206*0.0135=2.78kg and the value is given as R2.80 per kg (Samic personal communication) and so the loss of value can be estimated at R7.78 per carcass where lungs are condemned on account of pleuritis and pneumonia. The expected value for animals treated once [value (A)] in Table 5

can be adjusted according to the method shown for the expected value of animals recovering after 1 treatment as in Table 6.

Table 6. Revised value (A) using carcass chance events for animals recovered after 1 treatment

P	value	expected value
0.129	1711.86-7.78-25 = 1679.16	1679.96*0.129 = 216.66
0.871	1711.86-25 = 1686.86	1686.86*0.871 = 1469.25
	Total expected value	1685.91

This process of calculating values from right to left on the decision tree is known as "folding back" and further refines the decision process. The values for treated animals for drug A and B can be revised and the payoff matrix in Table 6 recalculated to take into account the hypothetical carcass data. In this example it would reduce the total expected value for both drugs by about R0.90 and makes a negligible difference to the decision.

This was not used in the above example because it introduces an unacceptable amount of uncertainty due to the unavailability of information to support the notion that the incidence of lesions is the same for the different drugs used, and is shown here only to illustrate the method.

CONCLUSION

Decisions relating to significant consequences made in this and other ways where accountability can be justified, are necessary in a world where financial consequences are becoming more and more critical to the survival of many livestock enterprises. This is a relatively new field in which veterinary practitioners need to become proficient.

REFERENCES

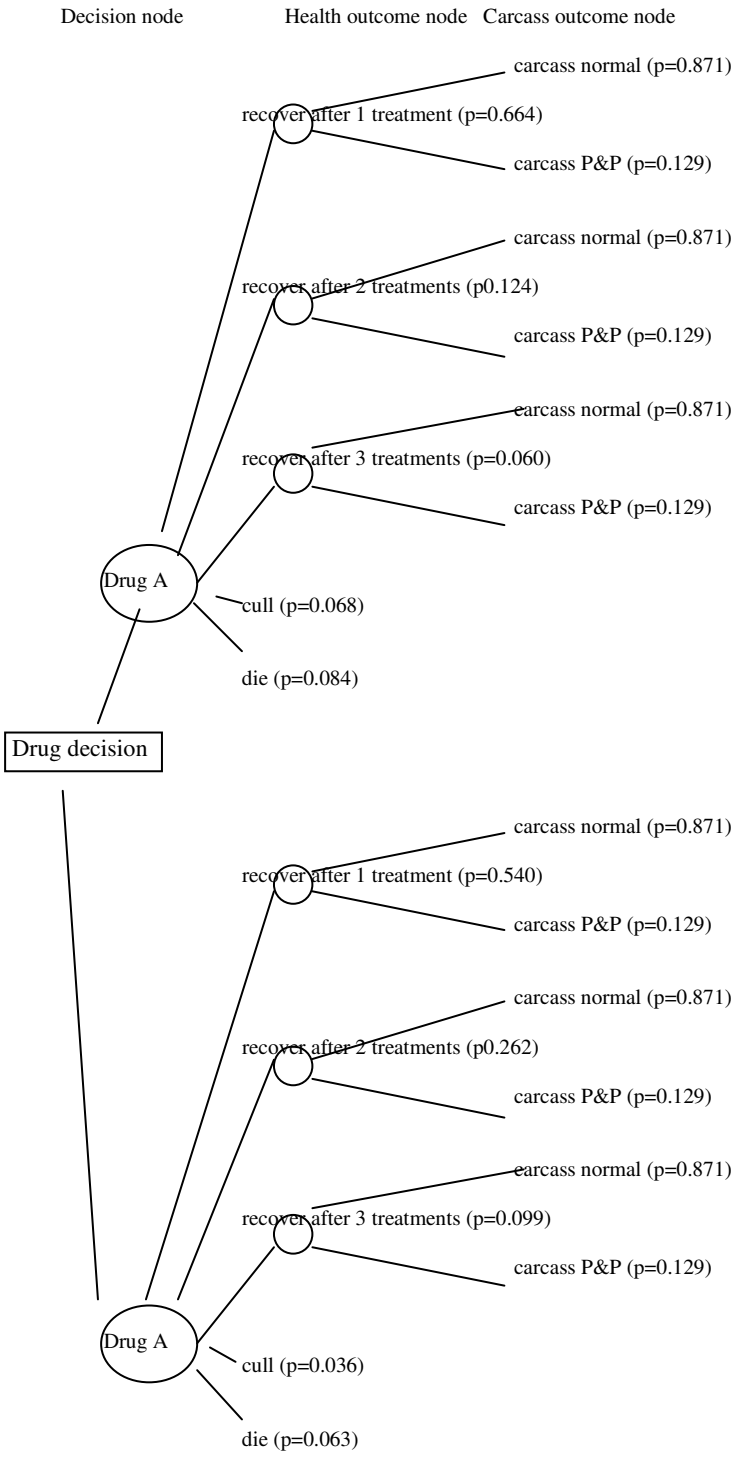
Apley M.D. & Fajt V.R. (1998). *Veterinary Clinics of North America: Food Animal Practice*, vol 14, no. 2, 219-297

Gummow, B. *et al*. (1998). *Animal Health Decision Making*: Practical Solutions to Real Problems. Course notes

Hardaker, J. B. *et al.* (1997). *Coping with Risk in Agriculture*. Cab International.

Woolridge, M. & Kelly, L. (2000). *Risk Assessment and Risk Management for the Livestock Sector*. Course notes.

Fig. 2. Example of a decision tree



AN ALTERNATIVE APPROACH FOR MONITORING AND IMPROVING BEEF ENTERPRISE EFFICIENCY

W.A. SCHULTHEISS[1]

INTRODUCTION

"If you do not measure, you cannot manage" is a saying that is often heard during discussions on the evaluation of farm enterprises. Most production aspects on a beef farm can be measured, yet it is what the producer measures and how that raw data is transformed into workable information that will have the greatest impact on enterprise management through pro-active decision making.

Veterinarians have traditionally focussed their skills on the individual animal, but over the past decades the emphasis has shifted towards the population. The role of environmental influences on animal welfare, health and production have also been recognised and are now well documented.

In controlled, intensive production environments it is not too difficult to determine which parameters to measure and how to measure them. It is when one is confronted with an extensive system that data capture from the environment becomes difficult. It is therefore understandable that performance evaluation of an extensive beef enterprise mainly involves parameters that measure animal health and production. However, sustainable beef production dictates that holistic farm resource management is required which is not possible without data capture at critical points of the production chain.

Despite substantial research on the matter, the utilisation of a routine pasture evaluation data capture system has not been widely accepted by beef cattle producers for reasons that will not be discussed here (but that are nevertheless important to consider).

This paper will focus on the most neglected, if not generally ignored, routine data capture method in the chain of events that can enable the producer to make informed decisions on the health of the extensive environment that has to sustain the enterprise.

BEEF PRODUCTION: A CHAIN OF EVENTS

A chain of events determines the sustainability of an extensive beef cattle farm. These events can be categorised into three links. The enterprise will be as healthy as the weakest link. The 3 three links are:

- Link 1: Transforming sunlight, air, water and soil elements into grass; which is measured as kilograms (kg) grass per hectare (ha): seldom recorded or reported,
- Link 2: Transforming grass into beef; measured as kg beef per ha: reported as part of the Production Analysis, and
- Link 3: Transforming beef into money; measured as income per ha: reported as part of the Financial Analysis.

Ultimately, the only true, accurate measure of beef enterprise health is profit per ha. Most beef farmers can provide you with this figure on an annual basis, but all the factors that

[1] Department of Production Animal Studies, Faculty of Veterinary Science, P/Bag X04, Onderstepoort, 0110. Tel: 5298219; Fax: 5298315; E-mail: wschult@op.up.ac.za

impact on this figure are not necessarily always monitored on a regular basis. This makes it difficult to identify and quantify circumstances that erode this parameter and it becomes virtually impossible to make focussed management decisions to counter inefficiency.

In an economic climate where profits are gradually decreasing, advisors have sought to stem this declining trend by improving beef production through measuring individual bovine performance and applying the results as direct selection tools to achieve increased calf weaning weights and growth rate, ultimately selecting for replacement females which are capable of higher milk yields. Veterinarians have considered maximum annual weaning percentage as the ultimate target to pursue. These efforts can be categorised under the second link of the chain.

Furthermore, beef cattle producers have realized the importance of financial management decision aids to optimise the profitability of their operations. To survive they must manage the farm as a business and use available financial tools to maximise profits. These actions fall under the third link of the chain.

Efforts to strengthen the first link are, however, sadly lacking. It is also astonishing that financial lenders most often base their approval decisions on only part of one of the three links, namely the repayment record, adequacy of collateral margins (cash flow as an element of repayment ability), financial statements and key ratios – omitting enterprise analysis in terms of management of grass yield (the first link). There is a reason for this: records in this regard seldom exist.

MEASURING THE EFFICIENCY OF PHOTOSYNTHESIS THROUGH ANIMAL DAYS PER HECTARE

Photosynthesis is summarised by the following reaction:

$$6CO_2 + 6H_2O + \text{sunlight} \rightarrow \text{glucose} + 6O_2$$

This forms the basis of beef production from grass. Any factor that negatively impacts on the production of glucose would interfere with the beef yield of a pasture. Each pasture or camp should be evaluated separately as an income generating entity.

The determination of annual grass yield (kg) per ha is the parameter that measures the photosynthesis efficiency on a particular pasture or camp. When this figure becomes known, the producer can make better-informed management decisions. Contrary to popular belief, it is possible to calculate the grass yield per unit pasture area. The concept of Animal Unit-Days per ha (ADH) is used for this purpose.

ANIMAL-UNIT-DAYS PER HECTARE (ADH)

AU = $(M^{0.75} / 450^{0.75})$ x CF;

Where the correction factor (CF) = 1.25 for lactating cows and 1.00 for all other cattle.
AU expresses metabolic mass ($M^{0.75}$) as a fraction of a 450kg bovine, which is more closely correlated with the skin surface area (size) and ultimately its nutrient requirement for maintenance.

ADH of a camp = (AU x days grazed) ÷ camp or pasture size

For a producer to be able to calculate ADH, only 3 easily measurable parameters are required:

- Total bovine mass on pasture per grazing opportunity
- Days on pasture
- Size of camp/ pasture

From the total annual ADH for a camp, the annual grass yield of that camp can be determined with relative accuracy. Consider a camp of 120 ha that was grazed on 4 occasions in one year, as follows:

- by 84 AU for 3 days = 2.1 ADH
- by 72 AU for 5 days = 3 ADH
- by 60 AU for 4 days = 2 ADH
- by 80 AU for 4 days.= 2.7 ADH

From this data it is evident that the camp yielded a total of 9.8 ADH. This figure will differ for different camps on a farm. Pasture evaluation in terms of plant species composition, cover density, grass vitality and soil parameters alone have a lesser predictive value if one does not know what the previous year(s) grazing intensity was, which is measured by ADH.

Given the fact that one AU would consume approximately 10 kg of pasture dry matter (DM) per day, if no significant factors that limit dry matter intake (DMI) exist, the above camp would have yielded about 98 kg of DM per ha during the year under question. The annual yield for the entire camp was therefore 11.7 tons of herbage.

With the ADH and grass yield known, producers will be able, in conjunction with climatic conditions that prevailed during the period, to adapt the stocking density of a camp in order to achieve the maximum beef production per ha. Table 1 demonstrates the suggested layout for a camp card.

ADH is therefore a parameter to measure the amount of grass harvested by cattle. ADH will also give an indication of animal impact on pasture; it can be used to compare the camps' ability to sustain cattle, to plan the grazing strategy and to budget for grazing reserves during the dormant season.

From Table 1 the annual supplement cost per camp can be calculated and camp occupation per season can be planned. For example: the annual winter nitrogen lick consumption in Camp A is significantly higher than for Camp B. This implies that winter roughage in Camp B most likely has a higher digestibility and that the allocation of Camp A for grazing during the dormant season need to be reconsidered. Also, with the incubation period of insect borne diseases known, any insect related disease could be traced back to the camp of origin. Pro-active ectoparasites control measures could be applied for certain 'problem' camps.

Table 1. Suggested Pasture Data Capture Sheet

Grazing Opportunity & Class of Stock		**Date in**	**Date out**	**AU in**	**ADH**	**Approximate grass-(DM) production**	**Type of supplement & cost/ ton**		**Average daily supplement intake**	**Total cost of supplement consumed**	**Comments (ticks, diseases, losses etc.)**
1								R			
2								R			
3								R			
4								R			
5								R			
6								R			
7								R			
8								R			
10								R			
TOTALS:			**days**			**kg**			**kg**	**R c**	
Notes											
Date(s) & results of pasture evaluation(s):											
Rainfall data (dates & mm): **TOTAL:.....mm**											
Other information e.g. date of fire, water point, fire breaks maintenance costs:											

Camp ID:…….. Camp size:.....ha Year:.....

ADH, ANIMAL IMPACT AND RECOVERY PERIOD

Like all production parameters, ADH should never be viewed in isolation. The following example illustrates this point:

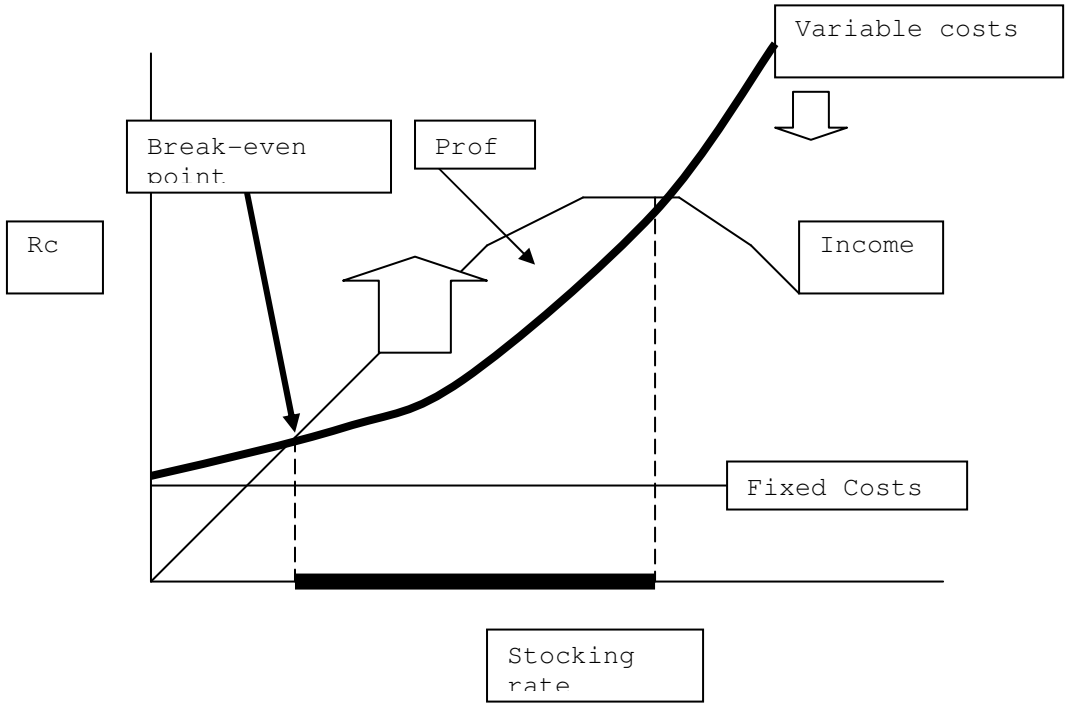
Consider one cow (body mass = 450kg) grazing on an 8 ha camp for 365 days, yielding an ADH of 45,62. In another event 365 cows, with an average body mass of 450 kg graze on an 8 ha camp for 1 day only. This yields a similar ADH value of 45,62. Despite the equal ADH values, there are important differences between the 2 scenarios:

- In the first case there is no recovery period (RP), whereas in the second example the RP equals 364 days,
- The rate of urine and faeces deposition is higher in the second case, effectively fertilizing the soil (with nitrogen, phosphorous and potassium which are needed for root, leaf and seed production of grasses),
- Soil compaction, poor water penetration and limited microbial break down of unutilised organic matter, resulting in an increased risk of soil erosion, is likely to be the result in the first case; whereas in the second case the effect of many hooves breaking the soil crust and trampling down less palatable, unutilised material will speed up decomposition of organic material through microbial action in a better aerated soil. This improves the water and mineral cycle which is advantageous for energy production in grass through photosynthesis,
- In the second case grass yield per annum and hence potential ADH will be higher,
- Consumption of expensive nutritional supplements will be lower in the second case since grass consumed at subsequent grazing opportunities will have an improved

nutritional value in terms of palatability, nutrient (nitrogen, phosphorous, carbohydrates) concentration and digestibility.

Knowing the annual grass yield per ha by implementing a simple ADH pasture monitoring system, better informed management decisions can be put into place to maximise grass yield, and ultimately profit per ha. Through this data capture system the optimum stocking density, where maximum profits realize for a particular beef enterprise environment, will become evident. Figure 1 illustrates this concept. The goal is to establish the stocking density where the window of opportunity for profit is greatest.

Figure 1. Schematic illustration of the relationship between stocking rate and profitability



Where the first link has been strengthened and grass yield is increasing, higher than generally accepted stocking densities will become necessary to efficiently utilize pasture DM. The popular belief is that more cattle will lead to overgrazing and deterioration of pasture. Overgrazing is not a function of animal numbers but rather the result of a too short recovery time for palatable grass species.

Grazing period (GP) per camp should be based on the desired recovery period (RP), which varies between seasons and ecosystems, and not *vice versa*. In any pasture management plan, continuously planning the desired RP is of critical importance. For any number of camps or herds, the GP to achieve the required RP is given by the following formula:

$$GP = RP \div [(\text{no. of camps} \div \text{no. of herds}) - 1]$$

Each day that cattle are kept longer in any one camp, adds another day of recovery to the remaining camps.

CONCLUSION

This paper attempts to illustrate the need for veterinarians to consider the impact that a natural pasture performance-recording scheme will have on the financial health of extensive beef enterprises. No novel, quick solution for drastic improvement of beef production is given.

Because of the breadth and depth of knowledge needed to advise beef producers, veterinarians, nutritionists, pasture scientists and economists need to provide an input on an effective, but user-friendly data capture system to monitor beef enterprise efficiency. However, many beef cattle producers rarely use any of these consultants on a regular, routine basis other than the veterinarian, who should serve as coordinator and facilitator for decision analysis and implementation of a Farm Plan, where data capture from pastures is of paramount importance. Table 2 summarises the paradigm shift that is required in data capture for beef herds on pasture:

Table 2. Data capture & health management in beef herds grazing natural pasture

A Paradigm Shift in Beef Herd Health Data Capture	
Old approach	**New approach**
Management of the individual or herd	Management of the pasture
Primary focus is to improve weaning percentage, feed conversion rate (FCR) and average daily gain (ADG)	Primary focus to improve grass yield as part of total enterprise efficiency
The bovine as the source of income	The pasture as the source of income
Monitor cow or herd efficiency	Monitor total enterprise efficiency
At best: a 10% improvement	At best: a 50%++ improvement

REFERENCES

Bingham, S. & Savory, A. (1990). *Holistic Resource Management Workbook*. Island Press, Washington DC.

Danckwerts, J.E. & Teague, W.R. (1989). *Veld Management in the eastern Cape*. Dept. Agriculture & Water Supply.

Kothmann, M.M. & Hinnant, R.T. (1999). *Nutritional Management of Livestock Grazing Range and Pasture Lands.* In: Current Veterinary Therapy – Food Animal Practice. W.B. Saunders Co.

Larson, R.L. & Pierce, V.L. (1999). Agricultural Economics for Veterinarians: Partial Budgets for Beef Cow Herds. *The Compendium of Continuing Education for the Practising Veterinarian*. Vol 21 No. 9.

Tainton, N. (editor) (1999). *Veld Management in South Africa*. University of Natal Press, Pietermaritzburg.

Toombs, R.E. *et. al.* (1993). Methods to Evaluate a beef Cattle Ranch's Financial Status and Identify Unprofitable Management Practices. *The Compendium of Continuing Education – Food Animal Practice*. January 1993.

Toombs, R.E. *et. al.* (1993). Formulating, Implementing, and Monitoring the Ranch Plan. *The Compendium of Continuing Education – Food Animal Practice*. February 1993.

THE MONITORING OF INDIVIDUAL COW SOMATIC CELL COUNTS IN A DAIRY HERD HEALTH PROGRAMME

G.V.S. TURNER[1]

INTRODUCTION

The various facets of epidemiology provide essential background knowledge and a format for strategies of intervention in veterinary preventive medicine. There are three levels of application of preventive measures in relation to the natural history of any disease process, namely primary, secondary and tertiary prevention. Secondary prevention is based on the early diagnosis or detection of a problem in a population and the instigation of prompt remedial actions. Methods used to achieve the early detection of a problem in a population include selective examinations, screening surveys, disease surveillance and investigation of disease outbreaks.

Disease surveillance is an important component of secondary prevention measures in any animal health programme. Surveillance is a continuous and systematic process requiring the continued vigil over the occurrence and distribution of a disease or condition in a population. The collation of disease surveillance data into meaningful arrangements and the correct interpretation thereof is essential for determining the extent of a disease in a population.

Mastitis is one of the most important health problems encountered in dairy cows, with sub-clinical mastitis being regarded as the most economically significant erosive disease complex found in dairy herds. The measurement of the somatic cell count (SCC) in milk is the main parameter used to determine the presence of sub-clinical mastitis in individual cows and in bulk herd milk samples. It is generally accepted that a stable udder health situation exists in a dairy herd when the SCC of the bulk milk supply is continuously in the region of 250 000 cells/ml.

Traditionally many dairy herd health practitioners have relied heavily on this parameter for assessing the udder health status of a herd. It is felt that this is not sufficient and that the udder health status of individual cows and the predominant mastitis causing bacteria occurring in the herd should be monitored on a routine basis. As a guideline a stable situation exists when less than 10% of the cows in milk have a SCC of above 500 000 cells/ml and less than 20% have a SCC above 250 000 cells/ml. This tends to correlate well with a bulk milk tank reading of 250 000 cells/ml or less.

Various methods can be employed to screen individual cows for the SCC of their milk. In the Republic of South Africa dairy farmers belonging to the Official Milk Recording Scheme have composite milk samples from individual cows tested every 5 weeks for various milk quality parameters including the SCC. The data generated is then reported back to the farmer. Unfortunately, the interpretation of the SCC data is often left up to the farmer and this is not always adequately done or understood.

[1] P O Box 11513, Silver Lakes, 0054. Tel: (012) 346 2826, Fax: (012) 460 3089

INDIVIDUAL COW SCC IN A DAIRY HERD

A well-managed dairy farm, milking 240 cows, had been obtaining the SCC for individual cows every five weeks for many years. After each testing period cows with a high cell count had quarter milk samples tested with a band-held device that measured the electrical conductivity of the milk. Cows that showed a positive reading were then treated orally with a herbal preparation. No specific correlations were made regarding the occurrence or distribution of high SCC in individual cows over a period of time. Milk samples were also not tested to determine whether any mastitis causing bacteria were involved with the increase in the SCC. Historically the herd's bulk milk SCC had been in the region of 300 000 cells/ml and then over a period of four years the SCC gradually increased to a level of 600 000 cells/ml.

An analysis was performed on the SCC of individual cows as supplied by the Milk Recording Scheme for the months of February and March 2001. In both months it was found that 25.0% of the cows had SCC above 500 000 cells/ml and 40.0% above 250 000 cells/ml.

Twenty-four cows which had a SCC above 500 000 cells/ml in February and March were randomly selected for quarter milk sampling. The quarter samples were tested bacteriologically and cytologically in the laboratory for sub-clinical mastitis. Seventeen (70.8%) of the 24 cows tested were diagnosed as having chronic sub-clinical mastitis and 13 of the 17 cows' infections were due to *Staphylococcus aureus*.

DISCUSSION

These findings show the typical trend of how *S. aureus* infections develop in a herd. The bacteria are transmitted between cows. As more and more cows develop chronic sub-clinical mastitis and serve as the main reservoir of the organism in the herd, the transmission cycle between cows increase and a snowball effect ensues. The bulk milk SCC increases proportionately at the same time.

If the SCC data of the individual cows had been collated and interpreted correctly then the first few cows showing persistent high SCC would have been detected timeously. Follow-up bacteriological tests would have shown that contagious bacteria were causing the problem. Cows chronically infected with *S. aureus* could then have been identified and dealt with accordingly so as to prevent the infection escalating to unacceptable proportions in the herd.

The monitoring of individual cow SCC is a useful tool in the overall disease surveillance component of a diary herd health programme. However, the importance of the correct collation and interpretation of the SCC data cannot be overemphasised.

GEOGRAPHIC DISRIBUTION OF SAT-2 TYPE FOOT-AND-MOUTH DISEASE VIRUS GENOTYPES IN AFRICA

A.D.S. BASTOS [1,2] & O. SANGARE [2,3]

SUMMARY

Of the three South African Territories (SAT) type foot-and-mouth disease (FMD) serotypes endemic to sub-Saharan Africa, SAT-2 is most often associated with outbreaks of the disease in livestock in southern Africa and is the only SAT-type to have been recorded outside the African continent in the last decade. The epidemiology in Africa is complicated by the presence of wildlife. In particular, the role of the African buffalo (*Syncerus caffer*) in virus maintenance and transmission is well recognized.

In order to accurately assess the role of wildlife and the level of genetic complexity of this virus type on the continent, genetic characterization of field strains from diverse African countries and species was performed in order to determine viral relationships. The phylogenetically informative VP1 gene encoding the major immunogenic region of the virus capsid was targeted for molecular epidemiological studies. The complete gene region was amplified by means of the polymerase chain reaction (PCR) and the nucleotide sequences were determined following agarose gel electrophoresis and purification. A 648 nucleotide (nt) region was ultimately characterized in this manner for 42 viruses from southern, central, eastern and western Africa, and from Saudi Arabia. In addition, three viruses obtained from published sources were used as reference strains. Phylogenetic resolution of the genetic relationships of 45 SAT-2 type viruses on the continent indicates that 10 independent virus lineages occur in Africa. Five of these lineages fall within the southern African region, one in West Africa and the remaining four in central and east Africa. These independently evolving virus lineages occur in discrete geographical regions in accordance with the FMD virus topotype concept. The results further indicate that the SAT-2 virus introduced into Saudi Arabia in 2000 is most closely related to a 1998 virus from Eritrea, indicating that this region of Africa was the most likely source of the infection. This study emphasizes the value of molecular characterization of diverse FMD field strains, as a means of clarifying the epidemiology of the disease in Africa.

INTRODUCTION

Foot-and-mouth disease (FMD) is an economically devastating disease affecting domestic and wild cloven-hoofed species. The causative agent is a single stranded positive sense RNA virus of the aphthovirus genus within the picornavirus family. Seven immunologically distinct FMD serotypes occur, of which three, the South African Territories (SAT) types 1-3 are

[1] Department of Zoology & Entomology, University of Pretoria, 0002, South Africa.
Tel 012 420-4612. Fax: 012 362-5242.
E-mail: ADBastos@zoology.up.ac.za
[2] ARC-Onderstepoort Veterinary Institute, Exotic Diseases Division, Private Bag X5, Onderstepoort, 0110, South Africa
[3] Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria

endemic to sub-Saharan Africa. The three SAT serotypes differ from each other with respect to distribution, outbreak incidence in domestic livestock and infection rates in wildlife in southern Africa (Brooksby 1972; Thomson 1994). SAT-2 is of particular importance due to its extensive distribution throughout Africa and its recent incursion into the Middle East. In Africa, the epidemiology of this virus type has received some attention in southern Africa, where the role of wildlife is well-recognized (Thomson 1994). In particular, the maintenance (Condy *et al.* 1985) and transmission of SAT-2 type virus from African buffalo (*Syncerus caffer*) to cattle under experimental conditions has been demonstrated (Dawe *et al.* 1994; Vosloo *et al.* 1996), as has natural transmission of virus between buffalo and impala (*Aepyceros melampus*) in South Africa (Bastos *et al.* 2000). Genetic characterization of SAT-2 viruses from maintenance host populations throughout southern Africa has not, however, been adequately addressed, nor has an attempt been made to determine genetic variability on a continental scale. Establishment of a southern African SAT-2 buffalo virus database is critical for accurately tracing the origin of outbreaks in this region (Bastos *et al.* 2001), whilst continental genetic variability provides a measure of the complexity of disease control through vaccination (Esterhuysen 1994; Hunter 1998). It is with these objectives in mind that SAT-2 type viruses from different regions, species and sampling dates have been selected for genetic characterization.

MATERIALS & METHODS

Genetic characterization of SAT-2 viruses

The 45 SAT-2 type isolates selected for this study are summarized in Table 1. Viral RNA extraction, cDNA synthesis and genomic amplification were performed as previously described (Bastos 1998), using primers targeting the entire VP1 gene. Nucleotide sequences were obtained using both manual and automated sequencing approaches, and all data have been submitted to the Genbank database under the accession numbers provided in Table 1.

Table 1. Summary of SAT-2 type FMD viruses used in this study

Virus name	Country of origin	Year of sampling	Species of origin	Reference	Genbank accession No
RHO/1/48	Zambia	1948	Bovine	Knowles et al., 2001	AJ251475
KEN/3/57	Kenya	1957	Bovine	Knowles et al., 2001	AJ251473
MAL/3/75	Malawi	1975	NK	This study	AF367099
NIG/2/75	Nigeria	1975	NK	This study	AF367139
SEN/5/75	Senegal	1975	NK	This study	AF367140
MOZ/1/79	Mozambique	1979	NK	This study	AF367137
ZAI/1/82	DRC	1982	Bovine	This study	AF367100
MOZ/4/83	Mozambique	1983	Bovine	This study	AF367101
PAL/5/83	South Africa	1983	Bovine	This study	AF367102
ZIM/7/83	Zimbabwe	1983	Bovine	van Rensburg & Nel 1999	AF136607
KNP/7/88	South Africa	1988	Buffalo	This study	AF367103
KNP/16/88	South Africa	1988	Impala	This study	AF367104
KNP/17/88	South Africa	1988	Impala	This study	AF367105
KNP/18/88	South Africa	1988	Impala	This study	AF367138

Virus name	Country of origin	Year of sampling	Species of origin	Reference	Genbank accession No
KNP/19/88	South Africa	1988	Impala	This study	AF367106
KNP/20/88	South Africa	1988	Impala	This study	AF367107
ZIM/1/88	Zimbabwe	1988	Buffalo	This study	AF367108
KNP/2/89	South Africa	1989	Impala	This study	AF367109
KNP/19/89	South Africa	1989	Buffalo	This study	AF367110
BUN/1/91	Burundi	1991	Bovine	This study	AF367111
KNP/183/91	South Africa	1991	Buffalo	This study	AF367112
ZIM/Gn10/91	Zimbabwe	1991	Buffalo	This study	AF367113
KNP/1/92	South Africa	1992	Impala	This study	AF367114
KNP/32/92	South Africa	1992	Buffalo	This study	AF367115
ZAM/9/93	Zambia	1993	Buffalo	This study	AF367116
ZAM/10/93	Zambia	1993	Buffalo	This study	AF367117
KNP/18/95	South Africa	1995	Buffalo	This study	AF367118
KNP/31/95	South Africa	1995	Buffalo	This study	AF367119
ZAM/7/96	Zambia	1996	Buffalo	This study	AF367120
ZAM/10/96	Zambia	1996	Buffalo	This study	AF367121
BOT/1/98	Botswana	1998	Buffalo	This study	AF367122
BOT/18/98	Botswana	1998	Buffalo	This study	AF367123
BOT/29/98	Botswana	1998	Buffalo	This study	AF367124
BOT/31/98	Botswana	1998	Buffalo	This study	AF367125
ERI/12/98	Eritrea	1998	Bovine	This study	AF367126
NAM/286/98	Namibia	1998	Buffalo	This study	AF367127
NAM/292/98	Namibia	1998	Buffalo	This study	AF367128
NAM/304/98	Namibia	1998	Buffalo	This study	AF367129
ZIM/267/98	Zimbabwe	1998	Buffalo	This study	AF367130
KEN/5/99	Kenya	1999	Bovine	This study	AF367131
KEN/7/99	Kenya	1999	Bovine	This study	AF367132
KEN/9/99	Kenya	1999	Bovine	This study	AF367133
RWA/1/00	Rwanda	2000	Buffalo	This study	AF367134
SAU/6/00	Saudi Arabia	2000	Bovine	This study	AF367135
ZIM/1/00	Zimbabwe	2000	Buffalo	This study	AF367136

GR: Game reserve, NK: Not known; NP: National Park; SA: Safari Area

Phylogenetic analysis

An homologous region of 648 nt was ultimately used for phylogenetic analysis. Data analyses were performed using MEGA (Kumar *et al.* 1993) with different correction methods and algorithms being applied. Trees with identical topology were obtained, irrespective of the method used, indicating that the gene tree was reliable (Kim 1993).

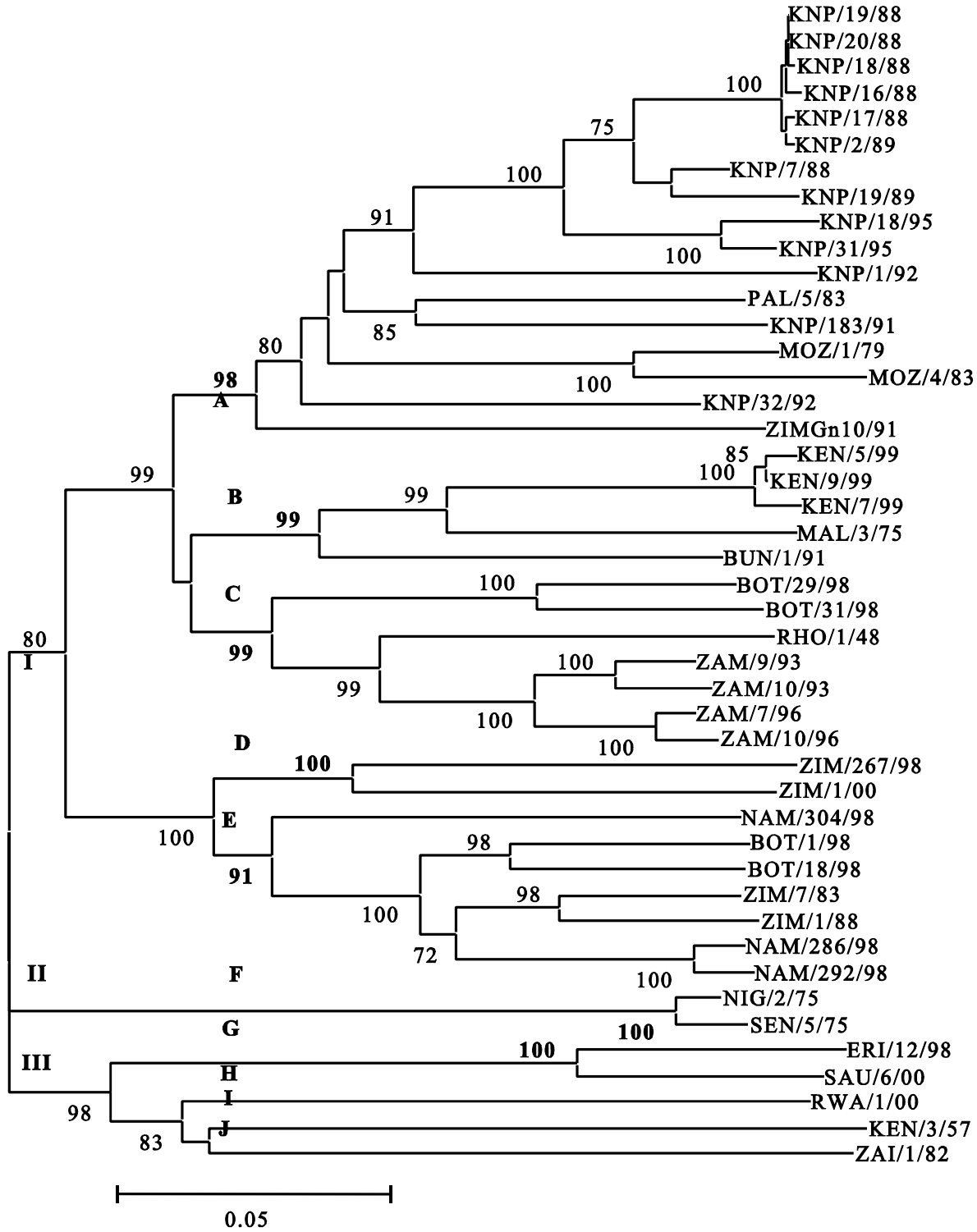


Fig. 1 Neighbour-joining tree depicting VP1 gene relationships of SAT-2 type foot-and-mouth disease viruses in Africa and the Middle East (1948-2000). The southern African cluster (I) comprises 5 genetically independent lineages (A-E), the West African cluster (II) comprises one lineage (F), whilst the east-central African group is made up of four independent lineages (G-H). Bootstrap values greater that 70 %, based on 1000 replications are indicated.

RESULTS & DISCUSSION

Phylogenetic resolution of VP1 gene sequences reveals the presence of three geographically discrete regions, labelled I-III in Fig. 1. These regions correspond to southern, western and east-central Africa respectively. Evolutionary distinct viral lineages (labelled A-J) can be discerned within each of the regional virus clusters found in Africa. Viruses from different regional clusters (I-III) are defined as those that differ from each other by more than 30 % on nucleotide sequence level, whilst viruses from independent lineages (A-J) differ from each other by more than 20 %. The geographical distribution of SAT-2 virus lineages is summarized in Table 2.

TABLE 2 Geographic distribution of SAT-2 virus lineages in Africa

Virus cluster	**Virus lineage**	**Country of origin**
I	A	South Africa, Mozambique & southern Zimbabwe
I	B	Kenya, Malawi & Burundi
I	C	Botswana & Zambia
I	D	northern Zimbabwe
I	E	Namibia, Botswana & western Zimbabwe
II	F	Nigeria & Senegal
III	G	Eritrea & Saudi Arabia
III	H	Rwanda
III	I	Kenya
III	J	Democratic Republic of the Congo

Three of the five virus lineages occurring in southern Africa (virus cluster I) correspond geographically with evolutionary discrete lineages previously identified for the SAT-1 serotype (Bastos *et al.* 2001). The remaining two lineages (B & C) comprise countries that are represented in more than one lineage, i.e. Botswana and Kenya. The overlap in lineage distribution for these countries is most likely due to trans-boundary movement and introductions from neighbouring countries, as the remaining eight lineages cluster strictly according to sampling locality.

Virus cluster II, which is represented by a single genotype (F) corresponds to West Africa. Further genetic characterization of viruses from this region reveal that there are additional virus lineages occurring within these regions of Africa (Sangare *et al* 2001, unpublished).

The east-central African virus cluster is made up of four independently evolving viral lineages (G-J), which are for the most part represented by a single virus. The 100 % bootstrap support for a 1998 virus from Eritrea and the virus isolated from the Saudi Arabian outbreak in 2000, together with the high level of sequence identity (> 90 %) indicates that the northeastern African region was the most likely source of the infection for the recent outbreak in the Middle East.

This study has been instrumental in identifying the major virus lineages and has demonstrated that SAT-2 viruses evolve independently in different geographical regions in Africa. Previous antigenic characterization studies have shown that viruses that are genetically unrelated (different evolutionary lineages) also tend to be antigenically unrelated (Esterhuysen 1994) and stresses the importance of custom-made vaccines for effective control of the disease on the African continent.

REFERENCES

Bastos, A.D.S. (1998). Detection and characterization of foot-and-mouth disease virus in sub-Saharan Africa. *Onderstepoort Journal of Veterinary Research*, 65:37-47.

Bastos, A.D.S, Boshoff, C.I., Keet, D.F., Bengis, R.G. & Thomson, G.R. (2000). Natural transmission of foot-and-mouth disease virus between African buffalo (*Syncerus caffer*) and impala (*Aepyceros melampus*) in the Kruger National Park, South Africa. *Epidemiology and Infection*, 124: 591-598.

Bastos, A.D.S, Haydon, D.T., Forsberg, R., Knowles, N.J., Anderson, E.C., Bengis, R.G., Nel, L.H. & Thomson, G.R. (2001). Genetic heterogeneity of SAT-1 type foot-and-mouth disease viruses in southern Africa. *Archives of Virology* (In press)

Brooksby, J.B. 1972. Epizootiology of foot-and-mouth disease in developing countries. *World Animal Review*, 3:10-13.

Condy, J.B., Hedger, R.S., Hamblin, C. & Barnett, I.T.R. (1985). The duration of the foot-and-mouth disease carrier state in African buffalo (i) In the individual animal and (ii) in a free-living herd. *Comparative Immunology Microbiology and Infectious Diseases*, 8: 259-265.

Dawe, P.S., Sorensen, K., Ferris, N.P., Barnett, I.T.R., Armstrong, R.M. & Knowles, N.J. (1994). Experimental transmission of foot-and-mouth disease virus from carrier African buffalo (*Syncerus caffer*) to cattle in Zimbabwe. *Veterinary Record*, 134:211-215.

Esterhuysen, J.J. (1994). The antigenic variation of foot-and-mouth disease viruses and its significance in the epidemiology of the disease in southern Africa. MSc dissertation. University of Pretoria.

Hunter, P. (1998). Vaccination as a means of control of foot-and-mouth disease in sub-Saharan Africa. *Vaccine*, 16:261-264

Kim, J. (1993). Improving the accuracy of phylogenetic estimation by combining different methods. *Systematic Biology*, 42:331-340.

Kumar, S., Tamura, K., & Nei, M. (1993). *MEGA. Molecular Evolutionary Genetics Analysis*, version 1.0. Pennsylvania State University.

Thomson, G.R. (1994). *Foot-and-mouth disease, In: Infectious Diseases of livestock with special reference to southern Africa*, edited by J.A.W. Coetzer, G.R. Thomson & R.C. Tustin. Cape Town, London, New York: Oxford University Press: 825-952.

Van Rensburg, H.G. & Nel, L.H. (1999). Characterization of the structural-protein-coding region of SAT2 type foot-and-mouth disease virus. *Virus Genes*, 19: 229-233.

Vosloo, W., Bastos, A.D, Kirkbride, E., Esterhuysen, J.J., Janse van Rensburg, D., Bengis, R.G., Keet, D.F. & Thomson, G.R. (1996). Persistent infection of African buffalo (*Syncerus caffer*) with SAT-type foot-and-mouth disease viruses: rate of fixation of mutations, antigenic change and interspecies transmission. *Journal of General Virology*, 77: 1457-1467.

AN OVERVIEW OF THE ERADICATION OF *BRUCELLA MELITENSIS* FROM KWAZULU-NATAL

F.R.EMSLIE[1] & J.R.NEL[2]

ABSTRACT

Brucella melitensis is a Gram-negative bacterium whose primary hosts are sheep and goats. This is the least host-specific *Brucella,* pathogenic to a variety of other mammal species including man, and is rated as one of the most important zoonotic diseases. Three outbreaks have been recorded in South Africa; the first outbreak occurred in 1965 in the old Transvaal province, the second occurred in 1989 near Pretoria, and the third and current outbreak was diagnosed in northern KwaZulu-Natal in September 1994. Following the initial diagnosis of *Brucella melitensis* in northeastern KwaZulu-Natal, a survey was conducted in order to establish where foci of infection existed. six positive foci were identified.

In March 1996 a test and slaughter eradication campaign was initiated in these areas. Initial test results revealed a prevalence of between 1.23% and 4.02%. All positive animals were identified and slaughtered. Eradication programmes were repeated in the populations at risk and the incidence of new cases varied between 0/1000 and 14.5/1000 per annum.

INTRODUCTION

One of the most serious zoonoses in the world, *Brucella melitensis* is highly pathogenic to man and is readily transmitted from a reservoir of infection in goats and sheep which are its primary hosts. This is the least species-specific *Brucella* and is able to infect numerous other species through inhalation or ingestion of infective organisms, or via mucous membranes (conjunctiva) or abrasions. An initial bacteraemia is followed by localization in various organs, especially the uterus, udder, and various lymph nodes. Invasion of the pregnant uterus often results in abortion, with large numbers of the bacteria being shed in discharges and foetal tissues. *Brucella melitensis* organisms are shed in the milk for prolonged periods post-partum, which presents the greatest risk of human infection (Alton 1990a).

Only three outbreaks have been documented in South Africa; the first occurred during 1965 in the old Transvaal province (Van Drimmelen 1965), the second occurred in a herd of Boer goats near Pretoria in 1989 (Ribiero, Herr, Chaparro & Van der Vyver 1990), while the third and current outbreak was diagnosed in northeastern KwaZulu-Natal in 1994 (Reichel, Nel, Emslie & Bishop 1996).

In September 1994 an investigation was launched, to investigate the disease status of a herd of goats adjacent to Makhathini Research Station, after the owner of the goats was diagnosed as having 'Malta Fever' by a medical specialist in Empangeni. Twelve out of 14 goats tested positive using the Rose Bengal and Complement Fixation Tests. The entire herd was slaughtered and *B. melitensis* biovar 1 was cultured from milk and tissue samples (Reichel *et al* 1996).

A province wide survey was then initiated to identify foci of infection, and between October 1994 and April 1995 six foci of infection were identified in the districts of Ubombo,

[1] State Veterinarian, P/Bag X004, Jozini, 3969 South Africa
[2] Vryheid Veterinary Laboratory, P.O .Box 96, Vryheid, 3100 South Africa

Ingwavuma and Pongola. The survey sample comprised approximately 10% of the adult female goats and sheep on farms, and presented by rural farmers. Thirty one out of 2684 (1.2%) animals tested positive. Two of the positive foci consisted of herds belonging to speculators. Both the herd in which the outbreak had first been diagnosed and the second herd in Pongola were slaughtered out, and the owners were compensated financially for their losses. The four other foci of infection were identified in goats belonging to rural subsistence farmers who practice communal grazing. These rural subsistence-farming communities are served by communal dipping tanks, which were constructed by the Government in the early 1900's in order to eradicate East Coast Fever and Corridor Disease. Each dip tank serves a community with a radius of ±7km, and it was decided to identify all goats and sheep from a dip tank as a single herd. Four dip tank areas were identified as being positive foci; however, due to frequent movement between them, two of these areas were combined.

In March 1996 a test and slaughter eradication initiative was launched in the three positive dip tank areas (viz. Machobeni, Nondabula, and Ntenga/ Mamfene areas). In the Ntenga/Mamfene area 31/2684 (1.2%) animals tested positive, in the Machobeni area 15/373 (4.02%), and in the Nondabula area 44/1817 (2.42%). All positive animals were slaughtered and the owners received financial compensation.

Test and slaughter exercises were repeated in the three populations at risk, and the cumulative incidence of new cases occurring between tests was used as a measure of success/impact of the eradication programme. In the Ntenga/Mamfene area incidence rates varied between 0/1000 and 4.4/1000 new cases per annum, in the Machobeni area incidence was 0/1000 cases, while in the Nondabula area the incidence varied between 0/1000 and 14.5/1000 cases per annum.

MATERIALS AND METHODS

Survey:

Approximately 10% of all mature nanny goats/ewes were sampled on each farm, or from the animals presented at a prearranged rendezvous in each dip tank area. Sera were collected from these animals and were screened using the Rose Bengal Test (RBT), The Complement Fixation Test (CFT), and the Serum Agglutination Test (SAT). Three different laboratories screened initial sera, each subjecting the sera to all three of the tests mentioned above. A high proportion of agreement was reached between the laboratories, and between the screening tests. This, together with the fact that no *B. melitensis* Rev1 vaccination had been carried out in the area previously, resulted in the RBT being utilized as the sole screening test in the subsequent eradication campaign (Alton 1990b). No identification of animals occurred during the survey, however positive animals could be traced back to dip tank area and owner by means of consecutive sample numbering and recording of owner information on data record sheets. Sample dates and times were prearranged through meetings with farmers, or tribal authorities in dip tank areas. These tribal authorities played a key role in soliciting the support of the local communities.

A stratified sample was taken, as only mature ewes and nanny goats were tested. This was also a biased sample as only approximately 10% of said animals were sampled based on their being able to be caught and bled. A single 10ml ‘Vacutainer’ sterile serum sample collection tube of blood was collected from the jugular vein of each goat selected for testing. The samples were stored and transported on ice to Makhathini Research Station where the sera were decanted into cryogenic vials and frozen. The frozen sera were then forwarded to

Allerton Provincial Veterinary Laboratory (Allerton P.V.L.), Vryheid Veterinary Laboratory, Ermelo Laboratory, and the Onderstepoort Veterinary Institute for testing.

Eradication:

Test and slaughter initiatives were preceded by lengthy extension and information transfer opportunities with stockowners and representatives of the various dip tank communities. The tribal authorities were also approached for their authorization and support of the disease eradication programme. Following the education of the affected communities with respect to the nature of the zoonosis and the need to eradicate it in order to promote and protect human health, test opportunities were planned as follows:

Day 1
- collect serum sample from every goat and sheep presented
- identify each animal with a unique number (orange spray paint)
- identify each sample with the animal's number
- test sera in mobile laboratory
- identify positive sera/ animals

Day 2
- trace all positive animals tested on day 1
- identify positive animals with ear tags (indelible ink)
- negotiate compensation with owner
- pay compensation
- remove positive animals to quarantine facility

Day 3 & 4
- repeat day 1 & 2

These initiatives were planned to test an entire dip tank area's animals in one continuous session, usually lasting between 4 and 6 weeks. At the end of each initiative the positive animals were transported directly from the quarantine facility at Makhathini Research Station, to Cato Ridge abattoir, where the animals were slaughtered under appropriate quarantine conditions. Tissue samples were collected and in a number of cases *B. melitensis* biotype 1 was cultured from these samples at Allerton P.V.L. All samples were screened using the RBT, which allowed for rapid screening of samples under field conditions.

RESULTS

From October 1994 to April 1995, 2684 goats and sheep were tested. Thirty one out of 2684 tested positive, giving an overall prevalence of 1.2%. The positive animals were identified as having come from six foci of infection: a speculator's herd in Pongola, a speculator's herd adjacent to Makhathini Research Station (Ubombo), Ntenga & Mamfene dip tank area (Ubombo), Machobeni dip tank area (Ingwavuma), and Nondabula dip tank area (Ingwavuma). The herds of both speculators were culled out in their entirety, leaving the four dip tank areas for the subsequent test and slaughter campaign. In excess of 10000 survey animals were tested through the rest of the province, with no further positive foci being identified.

Eradication:

The eradication campaign was initiated in March 1996 with the following results:

Table 1. Ntenga/Mamfene dip tank

Test	Test Date	No. Pos./ No. Tested	Test Interval	Cases/1000 p.a.
01	March 1996	30/2442	-	*1.23%* (prev.)
02	July 1996	1/1500	4m	2
03	October 1998	2/2020	27m	0.4
04	February 1999	5/2948	4m	5.1
05	February 2000	0/523	12m	0
06	June 2000	1/687	4m	4.4
		39/10120		

Table 2. Machobeni dip tank

Test	Test Date	No. Pos./ No. Tested	Test Interval	Cases/1000 p.a.
01	February 1997	15/373	-	*4.02%* (prev.)
02	February 1999	0/302	24m	0
		15/675		

Table 3. Nondabula dip tank

Test	Test Date	No. Pos./ No. Tested	Test Interval	Cases/1000 p.a.
01	July 1997	44/1817	-	*2.42%* (prev.)
02	March 1998	17/1757	8m	14.5
03	March 1999	0/50	12m	0
		61/3624		

DISCUSSION

Survey:

As is often the case, insufficient planning resulted in a rushed and biased sampling of the population at risk. More care could have been taken to ensure that a representative sampling strategy was employed which would have given greater credibility to the results obtained. Financial and time constraints, as well as personnel inexperience, were responsible for this poor planning. In order to verify the accuracy of the initial survey results it will be necessary to resample all the dip tank areas which were previously classified as being disease free, and confirm the absence of disease there.

Eradication:

With repeated test and slaughter exercises, the number of animals presented for testing on successive samplings decreased. This can be attributed to stockowner disillusionment with compensation measures and the effort required to drive a herd of goats up to 7km in order to have the animals tested. This resulted in animals belonging to the responsible owners being presented repeatedly, while those belonging to owners less concerned about the disease were presented once or twice and were then absent. All positive animals were removed from the population at risk after diagnosis. Based on this the assumption was made that the same population was at risk between consecutive tests, and a cumulative incidence of new cases was calculated for the intervals between testing (Tables 1-3).

No evidence could be found that *B. melitensis* Rev.1 vaccine had been used in either the goat or sheep populations in the affected area. This, together with the high proportion of

agreement between the RBT, CFT, and SAT tests used to screen sera during the survey, supported the decision to utilize the RBT as the sole screening test during the eradication campaign. The use of this test facilitated rapid in field screening of samples, which allowed for recovery of positive animals. Cultures from tissues of a number of the slaughtered goats confirmed the presence of *B. melitensis* biotype1; however, it is likely that a number of false positives were slaughtered. The serious nature of this zoonosis and the policy of the Directorate of Veterinary Services to eradicate the disease, support the use of a test with a high sensitivity. Alton *et al* (1990b) and Herr (1994) confirmed that the RBT was one of the best screening tests provided that no Rev1 vaccination had occurred in the test population.

Compensation of stockowners proved to play a key role in the success of the eradication campaign. Initially owners were compensated financially at above market-related prices, with up to R600,00 being paid for a wether. However, stockowners became suspicious of the motives behind the campaign and became reluctant to accept financial compensation in lieu of positive animals. This situation was solved by the purchase of disease free animals by the Directorate from disease free areas, which were then exchanged for positive goats during eradication campaigns. This proved to be an extremely effective means of compensation which was acceptable to the stockowner community.

Despite their being susceptible hosts and their being grazed communally in the presence of infected goat herds, all sheep tested during the campaign were *B .melitensis* free. Alton *et al* (1990) reported similar situations in the Mediterranean and Middle East. The conclusion reached is that the local Nguni sheep breed is resistant to *B. melitensis* infection.

The apparent slow rate of spread experienced in KwaZulu-Natal is in contrast to all other documentation of the disease from the Mediterranean, the Near and Middle East, the Americas and Africa. This is difficult to explain, since the susceptible goat population is grazed communally by day and confined in traditional kraal facilities by night. Contamination of dust must occur in these kraals, which should result in aerosol infection of uninfected animals.

Human infections may be confused with other fever causing diseases, specifically malaria, which have a high incidence in the area. However the communities in the affected areas do not appear to utilize goat milk for human consumption (Reichel *et al* 1996), which is the primary route of infection for humans. The disease was diagnosed by Bruce (1887), who isolated the organism from the spleens of soldiers who had died of ‘Malta or Mediterranean Fever’ on the island of Malta. The soldiers had contracted the disease through the ingestion of contaminated goats’ milk. Milk and dairy products, especially cheese, still comprise the primary source of human infection (Alton 1990b).

The histories of positive goats were obtained from their owners in order to try and trace the source of infection. A number of the positive goats had been purchased in Swaziland and illegally imported into South Africa. The stockowners concerned alleged that goats were cheaper in Swaziland than in South Africa and that they purchased and imported these goats in order to speculate, celebrate important cultural events, and pay ‘lobola’ (a payment made to one’s future wife’s family). The route of this illegal entry of animals into South Africa is in close proximity to Machobeni dip tank, which lies less than 10km from the southeastern Swaziland border. Following the diagnosis of *B. melitensis* in South Africa, Swaziland veterinary officials conducted a survey in their goat populations. Samples were forwarded to Allerton P.V.L. and the presence of the disease was confirmed in several dip tank areas, with

high prevalences being reported in the southeastern region (Dr P. Danso, personal communication, 1996). A control programme was initiated in Swaziland in 1998. In order for the South African eradication programme to be successful, it will probably be necessary to coordinate the Swaziland and South African eradication initiatives in a regional control programme.

At face value the results indicate that the eradication programme has been extremely successful in reducing the disease prevalence. The low incidences may be the result of false positive RBT reactors, and *B. melitensis* incidence is probably even lower than reported levels. Future testing efforts will involve screening with the RBT, and positive sera will be tested with the CFT, which has a higher specificity than the RBT. Two consecutive negative CFT tests six months apart would confirm the absence of *B.melitensis* from the population being tested (Herr, Bishop, Bolton, T.F.W. & Van der Merwe 1979).

REFERENCES

Bruce, D. (1887). Note on the discovery of a microorganism in Malta fever. *Practitioner*, 39:161

Alton, G.G. (1990a). *Brucella melitensis*, in *Animal Brucellosis*, edited by Klaus Nielsen & J. Robert Duncan. Boston: CRC Press, 16:383-409

Alton, G.G. (1990b). *Brucella melitensis* 1887 to 1987, in *Animal Brucellosis*, edited by Klaus Nielsen & J. Robert Duncan. Boston: CRC Press, 16:379-382

Van Drimmelen,G.C. (1965). The presence of *Brucella melitensis* infection in sheep in the Transvaal. *Bulletin de l' Office International des Épizooties*, 64:745-756.

Ribeiro, L.M.M., Herr, S., Chaparro, F. & Van der Vyver, F.H. (1990). The isolation and serology of *Brucella melitensis* in a herd of goats in central RSA. *Onderstepoort Journal of Veterinary Research*, 57:143-145.

Herr, S. (1994). *Brucella melitensis* infection, in *Infectious diseases of livestock*, edited by J.A.W.Coetzer, G.R.Thomson & R.C.Tustin, Oxford University Press, 2:1073-1075.

Reichel, R., Nel, J.R., Emslie, R. & Bishop, G.C. (1996). *Brucella melitensis* biotype 1 outbreak in goats in northern KwaZulu-Natal. *Onderstepoort Journal of Veterinary Research*, 63:183-185.

AN EPIDEMIOLOGICAL STUDY OF AN OUTBREAK OF LEPTOSPIROSIS IN CATTLE IN A MIXED FARMING UNIT

P.N. THOMPSON[1] & B. GUMMOW[1]

SUMMARY

A disease outbreak involving *Leptospira interrogans* serovar *pomona* in a Jersey herd within a mixed farming system (cattle and pigs) is discussed. Abortions and haemolytic disease with high mortality occurred in adult cows on this farm. A large proportion of cows showed titres to various serovars including *pomona*. *Leptospira pomona* was also isolated from bovine urine, an aborted bovine foetus and kidneys from slaughtered pigs. This outbreak is regarded as clinically atypical in that adult Jersey cattle died of acute leptospirosis in a semi-arid region of South Africa. The poor management of pig effluent played a pivotal role in the transmission of the disease. Failure to vaccinate animals against leptospirosis and poor record keeping within the pig unit were also contributing factors to the spread of leptospirosis.

INTRODUCTION

Leptospirosis is an important zoonotic disease affecting many mammal species throughout the world. Because of its multi-host nature, the epidemiology of leptospirosis is complex. However, in order to implement effective prevention and control measures, a better understanding of the epidemiology of leptospirosis in a region is essential.

Leptospira interrogans serovar *pomona* (*L. pomona*) is a pathogen of worldwide importance in pigs, which are considered to be the maintenance host (Faine, 1994). It usually causes chronic, asymptomatic disease that may lead to abortion, infertility, and the birth of premature or weak piglets (Christianson, 1992; Ellis, McParland, Bryson, Thiermann & Montgomery, 1986; Faine, 1994; Hunter & Herr, 1994; Kingscote, 1986; Mercy, 1979; Thiermann, 1987). Infection by *L. pomona* in a piggery is usually first recognised when lesions are found in abattoir material (Hunter, Van der Vyfer, Selmor-Olsen, Henton, Herr & De Lange, 1987). Outbreaks of acute disease caused by *L. pomona* are uncommon, but may have severe economic consequences for the affected farm (Bolt & Marchall, 1995, Christianson, 1992; De Lange, Gummow, Turner & Redman, 1987; Hunter *et. al.*, 1987; Kingscote, 1986). The bacterium has also been associated with disease in other species, including cattle (Faine, 1994; Heath & Johnson, 1994; Hunter *et. al.* 1987; Herr, Riley, Neser, Roux & De Lange, 1982), sheep (De Lange *et. al.*, 1987; Vermunt, West, Cook, Alley, & Collins-Emerson, 1994), horses (Wood, 1994), and dogs (Faine, 1994). *Leptospira pomona* infections in adult cattle are typically sub clinical, but may produce mild clinical signs, whereas the acute haemolytic disease is seen more commonly in calves (Hunter *et. al.* 1994). Abortions and "mastitis" are more consistently seen in adult cows (Hunter *et. al.* 1994). A recent serological survey of slaughter pigs in South Africa revealed a 0.2% prevalence of antibodies to *L. pomona*, with antibodies to serovars *icterohaemorrhagiae* (12.6%), *hardjo* (12.1%) and *bratislava* (7.5%) being much more prevalent (Potts, Lotter & Robinson, 1995). *Leptospira pomona* has been isolated from pig kidneys and foetuses (De Lange, 1987; Hunter *et. al.* 1987; Hunter *et. al.* 1987; Hunter *et. al.* 1994) and from bovine urine (Herr *et. al.* 1982) in South Africa.

[1] Department of Production Animal Studies, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110, South Africa. Tel: +27-12-5298290 Fax: +27-12-5298315 E-mail: pthompson@op.up.ac.za

Little has been published on the transmission and source of leptospirosis in South African mixed farming units. This paper describes an epidemiological investigation that examined an outbreak in a mixed farming unit. The investigation concentrated on the introduction and spread of the disease through the farm in order to implement effective control measures and prevent further outbreaks. The outbreak involved several leptospiral serovars and was, as far as could be determined, unusual in several respects.

OUTBREAK DESCRIPTION

The outbreak occurred in a 250-cow Jersey herd in the northwestern Free State, South Africa. The herd was on a zero-grazing system and fed a total mixed ration. Also situated on the farm was a 60-sow unit, an enterprise that was of secondary importance to the farmer and poorly managed. The calves were housed in groups in close proximity to the piggery. Also adjacent to the piggery was a camp where sick cows were kept. The water supply for both the dairy and the piggery came from boreholes and seasonal dams.

The referring veterinarian reported that, over a period of four months, 40 cows, representing 16% of the herd, had died. Apart from a single one-year-old animal, all affected cows were over three years of age. No unusual sickness or deaths had been reported amongst the calves. The major clinical signs observed in the affected animals were the acute development of anaemia and icterus. The farmer also noted red urine, presumably haemoglobinuria, in the majority of cases. Many of the cows that were pregnant at the time aborted. The course of the disease varied from two to ten days, with a few cows responding temporarily to oxytetracycline and/or diminazene treatment. However, most of these then relapsed and died between three and seven days later. The overall case fatality rate was approximately 75%.

A few sick animals showed small numbers of *Babesia bigemina* or *Anaplasma marginale* organisms on blood smears, which may have accounted for the temporary response to treatment in some cases. However, only three out of 13 recovered animals bled showed serological evidence of exposure to *Babesia* using the complement fixation test. Some affected animals showed an inflammatory leukogram and there was also evidence of liver damage in individual cases. Normal serum inorganic phosphate levels and liver copper levels helped rule out other haemolytic disorders such as post parturient haemoglobinuria and chronic copper toxicity.

The temporal distribution of mortalities on the farm (Fig. 1) began with an initial cohort of animals dying, probably due to a common source exposure. This was followed by a propagating epidemic pattern over the next 50 days, after which sporadic deaths occurred. The propagating epidemic pattern is what one would expect to see with an infectious disease within a susceptible herd. It appears that after about 50 days a sizeable proportion of the herd had been exposed and those that had not died would have had sufficient immunity to move out of the leptospiraemic phase of the disease and no longer be at risk of dying. This hypothesis was supported by the serological results.

Leptospiral antibody titres were initially measured in 13 sick or recently recovered cows using the microscopic agglutination test (Herr, Hunter & De Lange, 1987) and it was found that seven of these animals had a positive titre to one or more leptospiral serovars. A subsequent herd test showed that 50% (104/209) of the entire herd had a titre of 1:100 or greater to one or, more commonly, multiple leptospiral serovars. Many of these titres were

high, with 19% (39/209) being 1:800 or greater, indicating recent exposure. A rising titre was

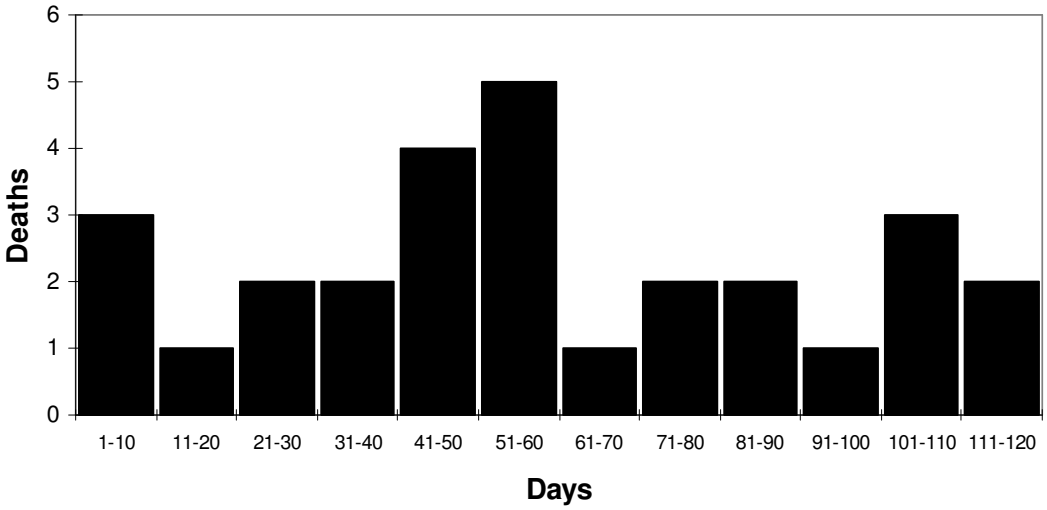


Figure 1. Temporal distribution of mortalities (epidemic pattern) seen amongst cattle on the farm.

(Reproduced, with permission, from the *Journal of the South African Veterinary Association*)

demonstrated in several animals where a repeat test was done. The predominant leptospiral serovars detected were *icterohaemorrhagiae*, *pomona* and *bratislava*, with *hardjo* and *szwajizak* also represented. There was no history of vaccination against leptospirosis on the farm.

Leptospiral titres were also detected in several pigs (9/20), where *pomona* and *bratislava* were the predominant serovars detected. None of the farm dogs (0/8) or the rodents (0/8) captured on the farm had detectable titres.

Culture of leptospiral organisms was then attempted from various fluids and tissues of cows, pigs and rodents. Serovar *pomona* was the only serovar isolated, being found in bovine urine (3/12), the kidney of a near-term aborted bovine foetus and several pig kidneys (6/16).

RECOMMENDATIONS

Based on the serological results, it was decided to vaccinate all cattle four months and older with a multivalent, inactivated leptospiral vaccine. Once the entire herd had been vaccinated, no further clinical cases were reported.

In a report to the farmer, attention was drawn to the fact that leptospirosis is a zoonosis with the potential to cause severe disease in humans and which can be difficult to diagnose. In addition, the following recommendations were made regarding the control and eradication of the disease on the farm. They are listed roughly in order of priority.

1. Treatment of sick cows. Any animal showing clinical signs of leptospirosis should immediately be treated with dihydrostreptomycin at 25mg/kg/day for three to five days.
2. Piggery management. Cattle should no longer have any chance of contact with runoff from the piggery and workers should not move from the piggery to the cattle without disinfection of hands and boots. The piggery should be well managed, including regular

vaccination with a multivalent leptospiral vaccine. Alternatively the pig facility should be closed down.
3. Vaccination of cattle. All cattle older than four months should be vaccinated every six months with a multivalent leptospiral vaccine. Once contamination from the piggery has been reduced or eliminated, annual vaccination should be sufficient.
4. Elimination of the carrier state. Leptospiral organisms can be carried in the kidneys and shed in the urine for varying periods of time. Treatment of all cattle with dihydrostreptomycin at 25mg/kg/day for three days will drastically reduce or eliminate urine shedding. However, this is an expensive option.

DISCUSSION

The first interesting feature of this outbreak was that it occurred in a relatively dry area of the country, with an average annual rainfall of about 550mm, at the beginning of the dry season and was not associated with any obvious water source. These factors could mislead a veterinarian into disregarding leptospirosis as a possible diagnosis. In this particular case study it emerged, after the pigs were shown to be positive for leptospiral antibodies, that effluent from the piggery had temporarily accumulated in the pen that housed sick cows from the dairy herd. This was probably the source of exposure for the cattle.

The second unusual feature was that clinical signs were seen only in adult cows, whereas calves are usually far more susceptible to the acute form of the disease. This may further mislead a veterinarian in making a diagnosis. It transpired that, despite their close proximity, the calves had not been exposed to runoff from either the piggery or the cows. This added circumstantial evidence to support the hypothesis that the effluent was the source of the outbreak.

Thirdly, it is unusual to see such a high incidence of severe clinical disease and mortality in adult cows. In adults the sub acute or inapparent forms are far more common and the mortality usually very low. In this outbreak, the severity of the disease was probably due to the sudden exposure of immunocompromised, susceptible cows to high concentrations of organisms in the hospital pen, where animals were suffering from concurrent disease. The concurrent diseases were in most cases anaplasmosis and occasionally babesiosis, which served to mask the clinical signs of acute leptospirosis and make diagnosis difficult.

Although it is likely that serovar *pomona* was the primary agent involved in this outbreak, active, concurrent infection with serovars *icterohaemorrhagiae* and *bratislava* was also shown to occur. It is possible that serovar *icterohaemorrhagiae* may also have played a role in the clinical disease and perhaps originated from the rodents, although this could not be shown. The role played by *bratislava* is even less clear, although it probably originated from the pigs and is unlikely to have been involved in the development of clinical disease.

CONCLUSION

This case study highlights the potential for certain management factors to contribute to the transmission and propagation of *L. interrogans pomona* within a mixed farming unit. These factors included:
1. Failure to properly manage or maintain open effluent drainage systems by allowing run off of effluent into surrounding areas and free access to effluent by other species.

2. Failure to adequately monitor and keep records for the secondary farming units within the mixed farming system, that might alert the farmer to potential problems.
3. Improper or no vaccination of animals, and in particular pigs, on these types of farms.

The study also supports the findings of Bolt *et al.*[1] that rodents do not appear to play an important role in the epidemiology of *L. pomona* outbreaks.

The role of other serovars in *L. pomona* outbreaks is difficult to determine and remains inconclusive. Immune compromised animals are however at higher risk, as evidenced in this case study, and concurrent infection with multiple serovars and other diseases may make animals more susceptible to the effects of *L. pomona* infections.

The purpose of this paper was therefore to make the veterinarian aware that in mixed farming operations, especially where suitable environmental conditions exist, the planning of prevention and control strategies must incorporate all the multifactorial aspects of leptospirosis to be effective.

REFERENCES

Bolt, I., Marshall, R. B. (1995). The epidemiology of *Leptospira interrogans* serovar *pomona* in grower pig herds. *New Zealand Veterinary Journal* 43: 10-15

Christianson, W.T. (1992). Stillbirths, mummies, abortions and early embryonic death. *Veterinary Clinics of North America: Food Animal Practice* 8: 623-639

De Lange, J.F., Gummow, B., Turner, G.V., Redman, A.R. (1987). The isolation of *Leptospira interrogans* serovar *pomona* and related serological findings associated with a mixed farming unit in the Transvaal. *Onderstepoort Journal of Veterinary Research* 54: 119-121

Ellis, W.A., McParland, P.J., Bryson, D.G., Thiermann, A.B., Montgomery, J. (1986). Isolation of leptospires from the genital tract and kidneys of aborted sows. *The Veterinary Record* 118: 294-295

Faine, S. (1994). *Leptospira* and leptospirosis. Boca Raton: CRC Press, Inc., Florida

Heath, S.E., Johnson, R. (1994). Leptospirosis. *Journal of the American Veterinary Medical Association* 205: 1518-1523

Herr, S., Hunter, P., De Lange, J.F. (1987). *Leptospirosis manual: A practical laboratory guide to the serology and isolation of* Leptospira. The Reproduction Section, Veterinary Research Institute, Onderstepoort

Herr, S., Riley, A.E., Neser, J.A., Roux, D., De Lange, J.F. (1982). *Leptospira interrogans* serovar *pomona* associated with abortion in cattle: isolation methods and laboratory animal histopathology. *Onderstepoort Journal of Veterinary Research* 49: 57-62

Hunter, P., Van Der Vyver, F.H., Selmor-Olsen, A., Henton, M., Herr, S., De Lange, J.F. (1987). Leptospirosis as a cause of "white spot" kidneys in South African pig abattoirs. *Onderstepoort Journal of Veterinary Research* 54: 59-62

Hunter, P., Herr, S. (1994). In: Coetzer J A W, Tustin R C, Thompson G R (eds.) *Infectious Diseases of Livestock in Southern African*. Oxford University Press

Kingscote, B.F. (1986). Leptospirosis outbreak in a piggery in southern Alberta. *Canadian Veterinary Journal* 27: 188-190.

Mercy, A.R. (1979). Leptospirosis in pigs. *Western Australian Department of Agriculture Farmnote* No 6/79

Potts, A. D., Lötter, C., Robinson, J.T.R. (1995). Serological prevalence of leptospiral antibodies in pigs in South Africa. *Onderstepoort Journal of Veterinary Research* 62: 281-284

Thiermann, A.B. (1987). Swine leptospirosis: new concepts of an old disease. *Proceedings of the United States Animal Health Association* 91: 491-496

Vermunt, J.J., West, D.M., Cooke, M.M., Alley, M.R., Collins-Emerson, J. (1994). Observations on three outbreaks of *Leptospira interrogans* serovar *pomona* infection in lambs. *New Zealand Veterinary Journal* 42: 133-136

Wood, J.L.N. (1994). How important are leptospiral infections as a cause of equine disease? *Equine Veterinary Journal* 26: 88

MOLECULAR CHARACTERIZATION OF AFRICAN SWINE FEVER VIRUS FIELD ISOLATES: NEW EPIDEMIOLOGICAL INSIGHTS

A.D.S. BASTOS[1,2], B.I. PHOLOGANE[2], J.L. EDRICH[1], C.I. BOSHOFF[2] & M.L. PENRITH[2]

ABSTRACT

African swine fever (ASF) is a highly infectious viral hemorrhagic disease of domestic pigs, which is caused by a double stranded DNA virus of between 170 and 190 Kbp in length. As no discernable serotypes occur, differentiation of field strains is reliant on genetic characterization methods. Restriction fragment length polymorphism (RFLP) analysis can be used to distinguish genotypes, but this method is time-consuming and has low-resolution powers. For this reason, alternative PCR-based methods have been investigated in order to establish a rapid and reliable means of determining the origin and tracing the course of epizootics. We describe the development of a *p72* gene amplification and sequencing approach whereby the major ASF genotypes can be identified within 48 hours of receipt of a clinical specimen. Following identification of the genotypes, further within-genotype genetic resolution is possible by targeting the *9RL* open reading frame genome region in which tetrameric repeats occur. The latter additional genetic characterization method was applied to viruses from Europe and those from southern, eastern and western Africa, subsequent to *P72* genotype determination. The results provide new epidemiological insights into the spread of the disease on both a continental and intercontinental scale. It is shown here that ASF was introduced into Europe on at least three separate occasions, that the same virus caused the outbreaks in the 1980's in Belgium and the Netherlands and that the 1998 outbreak in Madagascar is directly related to an outbreak strain from Mozambique and therefore most likely due to an introduction from that country. The results further indicate that different genetic lineages occur within the European-West African virus genotype, which has assisted in determining the spread of the disease between different West African countries in the late 1990's. Genetic characterization of field isolates by means of the two-step PCR based approach outlined here is therefore advocated for molecular epidemiological studies of ASF on the African continent and elsewhere.

[1]Department of Zoology & Entomology, University of Pretoria, Pretoria, 0002, South Africa.
Tel: +27 12 420-4612. Fax: +27 12 362-5242. E-mail: ADBastos@zoology.up.ac.za
[2]ARC-Onderstepoort Veterinary Institute, Private Bag X5, Onderstepoort, 0110, South Africa

CONSTRAINTS INVOLVED IN INVESTIGATING THE EPIDEMIOLOGY OF AFRICAN SWINE FEVER IN MANKWE/BAFOKENG DISTRICT OF NORTH WEST PROVINCE

C.M. MCCRINDLE[1] & E.J. MANENZHE

SUMMARY

Small-scale pig farmers of Mankwe and Bafokeng districts of North West Province are considering increasing the size of their enterprises so as to become commercially profitable. There are approximately 2000 warthogs (*Phacochoerus aethiopicus*) in Pilanesburg National Game Park, which is situated in Mankwe district close to the area where farmers are located.

According to the animal disease control regulations, Mankwe and Bafokeng districts fall within an African Swine Fever (ASF) controlled area. Pig farmers are compelled by law to sell pigs to the ASF approved abattoir that is situated in Olifantsfontein, 340 kilometres away. Considering the escalating petrol price, (R3-60/L) it costs R129-60 in petrol to deliver pigs to Olifantfontein abattoir, which also buys pigs at a lower price than Rustenburg abattoir, which is nearer but falls within an ASF free zone. This obviously decreases the profitability of farming with pigs.

In order to make suggestions regarding the marketing of pigs in the ASF controlled area, an epidemiological survey of ASF in warthogs and tampans is being undertaken. A GIS map of Pilansberg and Mankwe/Bafokeng district has been drawn up to indicate the sampling of warthogs and warthog burrows and the distribution of small scale pig farmers proximate to the Pilansberg Park. Constraints involved in the sampling procedure will be discussed and current regulations regarding ASF reviewed.

INTRODUCTION:

African Swine Fever, as it occurs in Africa, is primarily a systemic, fatal disease of swine caused by a cytoplasmic dsDNA virus, of argasid tick origin, with wild *suidae* acting as carriers in nature (Francki *et al*, 1991;Haresnape, 1984; Pan and Hess, 1983; Pena *et al*, 1993; Plowright *et al* 1994; Thomson *et al* , 1980). ASF is characterised by extremely high mortality in domestic pigs and it was first observed in settlers' pigs in Kenya (Montgomery, 1921). In South Africa the first recorded outbreak occurred in 1926 in the Northern Transvaal - now called Northern Province (Pini, 1977). The disease was found in Potgietersrus district, where the presence of wild pigs has been recorded (Pini and Hurter, 1975). In Southern Africa there is a close association between the presence of *O. moubata/porcinus* and the occurrence of ASF virus in warthog populations, it is thus concluded that argasid ticks effect infection of warthogs. These ticks, known as Tampans, have been shown to transmit the infection readily while feeding, virus being present in saliva, coxal fluid and guanine or malpighian excrement (Horak *et al*, 1988; Thomson, 1985; Thomson *et al*, 1983).

It appears that neonatal or young warthogs undergo ASF virus infections which are manifested by a viraemia which may exceed 10^2 HAD_{50} /ml for up to about three weeks, but is thereafter intermittent and of very low titre (Thomson *et al*, 1994).

[1] Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort 0110. Tel 012 5298347, Fax 012 529 8143, e-mail *mccrindl@op.up.ac.za*

The small-scale pig farmers of Mankwe and Bafokeng districts are considering increasing the size of their enterprises so as to become commercially profitable. There are financial implications of scaling up production and buying in breeding pigs. Planned housing for pigs needs to comply with state veterinary regulations for an African Swine Fever (ASF) controlled area – this makes it expensive. Marketing of pigs is complicated by the regulations regarding ASF, for instance 21 days quarantine before slaughter – profitability is therefore less.

Mankwe, Bafokeng and Pilanesberg National Park fall within an African Swine Fever (ASF) controlled area, and there are approximately 2000 warthogs in Pilanesberg Park of which the ASF carrier status is unknown. Warthogs are also present outside the Park and may contact domestic pigs. In order to properly assess the risk of ASF in Mankwe/Bafokeng, surveillance of the ASF carrier status of warthog and tampan species and the distribution of domestic pig farming units is required.

Several factors have to be considered in regard to the epidemiology of ASF and the profitability of small-scale pig farming. These include:

- Animal Disease Control Legislation
- Cost of approved piggeries in terms of ASF legislation
- Proximity to Pilansberg National Park (warthogs)
- Informal and communal farming practices (scavenging pigs)
- Distance to approved abattoirs
- Marketing of pigs through sale
- Lack of knowledge of farmers about ASF
- Reporting of diseases by farmers

Access to agricultural funding requires a business plan that includes these factors. They can be put together in terms of an epidemiological approach that includes the animal, vector and environment. In addition socio-economic factors play an important role in the prevention and control of the disease in pigs, as they are constraints to the implementation of ASF control regulations. These are summarised in Table 1, below.

Table 1: Summary of ASF control regulations

- All infected or contaminated things fed to pigs in the RSA must be boiled for 60 minutes, or sterilized before feeding to pigs.
- Pigs may not range freely
- A movement permit is needed for all movements of pigs and wild pigs and their product to or from a controlled or from one farm to another within the controlled area.
- Live domestic pigs within the controlled area that are not kept in pens, may not move to an abattoir for slaughter.
- Pigs must be kept in pens for at least 3 weeks after transport to an ASF-free area.
- Movement of live wild pigs and their products is strictly controlled and monitored accordingly.

All commercial piggeries have to be approved and only these piggeries will be able to move their pigs to an approved abattoir for slaughter. Approval is only given to *bonafide* pig farmers. The requirements for an approved piggery are listed below in Table 2.

Table 2: Requirements for an approved piggery.

- Built from bricks / concrete with concrete floors & solid metal gates, covered with metal plate, diamond mesh or "vark draad" (thoroughly pig- proof).
- Fences must be at least 1.3m high and be anchored by means of 30cm high underground concrete or brick walls
- Perimeter fence of >1.3m high must be erected around the pigsty complex, 3 m away from the pigsties, unauthorised entry not permitted
- No other pigs except those in an approved structure are allowed in the premises. Good hygiene standards must be maintained.
- Owners or managers of approved piggeries must keep records of the number of pigs as well as increases or decreases.
- Must be inspected by State veterinary officials at least every 6 weeks.
- State veterinarian allocates a region/district/farm number to each
- SV or an experienced state veterinary official must carry out the approval inspection.

METHODS

In order to do an epidemiological survey; the demographics of pig farmers and the farming systems must be achieved in addition to the sampling of warthogs and tampans for ASF virus antibodies. The theory regarding epidemiological sampling is well known, however, in practice there are many constraints to implementation of a classic random survey.

Constraints to the sampling of demography of pig farmers are:

- There are only 5 approved piggeries, but many villagers also own pigs
- Backyard farming of pigs is illegal so farmers are not contacting the SV
- Number of farmers and total number of pigs is therefore not known
- Scavenging pigs are difficult to count. May not know the owners
- Traditional practices of pig farming are not suitable for ASF control
- All pigs sampled in previously in the area were negative – may not be a representative sample

Constraints to sampling warthogs in Pilansberg are:

- Animal welfare and wildlife ecology determine which animals and how many are chosen
- Animals are wild and are consequently shot in different areas
- Sampling is therefore quite difficult to randomise

Constraints to sampling warthog holes for tampans are:

- Predators and dangerous animals limit the locations which can be sampled
- Some areas are inaccessible

RESULTS

In order to get a better picture, considering these constraints, Geographical Information Systems (GIS) co-ordinates were used. The GIS maps also indicate the terrain and may be used to build a better picture of the epidemiology of ASF in the area.

GIS Maps show:

- Prevalence of warthogs in the park
- Places where warthogs used for sampling were culled
- Farmers who own pigs
- Villages
- State Veterinary Offices
- Service Centres (State Veterinary Services)
- Abattoirs
- Roads and geographical features

DISCUSSION AND CONCLUSIONS

GIS allows for a better picture to be obtained of the distribution of farmers and warthogs sampled. It is important to realise the constraints involved in sampling for an infectious disease in a rural area where communal farmers and wild game live in close proximity and this will have to be very carefully considered when looking at the risk of ASF in the area.

REFERENCES

Coetzer, J.A.W, Thomson, R.C., Tustin (eds.) (1994). *Infectious Diseases of Livestock with reference to South Africa*. 1st Ed. Oxford University Press, U.K.

Francki, R.I B., Fauquet, C.M., Knudson, D.L., Brown, F. (1991). *Classification and nomenclature of viruses.* Archives of Virology Supplement 2, Vienna, New York : Springer Verslag

Government Regulation No. R2026 of 26 September, 1986

Government Regulations GG No : 10469. (1986). Regionalisation/Zoning/Legislation Notes: c13, *Control areas including ASF*. Proposed amendments, 1997

Haresnape, J.M. (1984). African Swine Fever in Malawi. *Tropical Animal Health & Production* 16: 123-125

Horak, I.G., Boomker, J., De Vos,V., Potgieter, F.T. (1988). Parasites of domestic and wild animals in South Africa XXIII. Helminth and arthropod parasites of warthogs, *Phacochoerus aethiopicus*, in the Eastern Transvaal Lowveld. *Onderstepoort Journal of Veterinary Research*, 55: 145-152

Malmquist, W.A., Hay, D. (1960). Haemabsorption and cycopathic effect produced by African Swine Fever in swine bone marrow and buffy coat cultures. *American Journal of Veterinary Research,* 21: 104-108

Malmquist, W.A. (1962). Propagation, modification and haemabsorption of African Swine Fewer virus in cell cultures. *American Journal of Veterinary Research*, 23: 241-247

Mongomery (1921)

Nana-Nukechap, M.F., Gibbs, E.P. (1985). Socio-economic effects of African Swine Fever in Cameroon. *Tropical animal health production* 17,183-184

Pan, I.V.C., Hess, W.R. (1983). Diversity of African Swine Fever virus. *American Journal Veterinary Res.* 46(2): 314-320

Pena, L., Yanez, Y., Vinuela, E., Salas, M.L. (1993). African swine fever virus guanyl transferase. *Virology* 193, 319-328

Pini, A., Hurter, L.R. (1975). African Swine Fever: an epizootiological review with special reference to the South African situation. *Journal of the South African Veterinary Association* 46 (3): 227-232

Pini, A. (1977). African Swine Fever: Some observation and considerations. *South African Journal of Science*, 73: 133-134

Plowright, W., Parker, J., Piene, M.A. (1969). African Swine Fever virus in ticks (O*rnithodoros moubata, dunrray*) collected from animal burrows in Tanzania. *Nature* 221: 1071-1073

Plowright, W., Parker, J., Pierce, M.A. (1969). The Epizootiology of African Swine Fever in Africa. *The Veterinary Record*, 85: 668-674

Snijders, A.J. (1997). Overview: A risk assessment of ASF. Government Gazette Public Services

Thomson, G.R. (1985). The epidemiology of African Swine Fever: The role of free-living host in Africa. *Onderstepoort Journal of Veterinary Research*, 52:201-209

Thomson, G.R., Gainaru, M.D., Van Dellen, A.F. (1980). Experimental infection of warthog (*P. aethiopicus*) with African Swine Fever virus. *Onderstepoort Journal of Veterinary Research*, 47: 19-22

Thomson, G., Gainaru, M., Lewis, A., Biggs, H., Neville, E. M., Van der Pypekamp, H., Gerber, L., Esterhuysen, J., Bengis, R., Bezuidenhout, J.D., Condy, J. (1983). *The relationship between African Swine Fever virus, the warthog and Ornithodoros spp in Southern Africa*. In Wikinson P J (ed) African Swine Fever. EUR.8466 En. Commission of the European Communities.

Plowright, Thomson, Neser. (1994). Swine Fever In Coetzer JAW, Thomson RC and Tustin R. (eds.) *Infectious Diseases of Livestock vol.2: page 965*

EAST COAST FEVER IN NORTHERN MALAWI: AN ATTEMPT TO EXPLAIN AN UNEXPECTED SEASONAL PATTERN OF DISEASE INCIDENCE

K. LORENZ[1]

SUMMARY

A field trial on strategic control of ticks and tick-borne diseases in local zebu calves and young stock up to one year of age was conducted in two different ecological zones in northern Malawi ("Central Plains" region and "Lake Shore" area respectively) from June 1993 to July 1994. The main focus was on economically sustainable control of East Coast fever by strategic tick control that would not interfere with possible endemic stability (Lorenz *et al*., 1995; Lorenz, 1997). However, some observations that may have serious implications on control strategies for East Coast fever in general have so far only been mentioned briefly and shall now be discussed more thoroughly.

In the trial areas East Coast fever (ECF), a *Theileria parva* infection of cattle that is mainly transmitted by *Rhipicephalus appendiculatus* proved to be the only tick-borne infection that caused severe clinical disease and death in calves and young stock. The occurrence of ECF in the Central Plains region showed to be highly seasonal with two peaks at the end of the dry season (September/October) and in the mid-rainy season (January to March). The frequent occurrence of ECF in the mid-rainy season corresponds well with the main season of activity of its most important vector tick *R. appendiculatus*. The unexpected accumulation of clinical cases of ECF at the end of the dry season must be attributed to a different vector since adult *R. appendiculatus* are at their lowest level of activity during that time of the year. Hence, transmission would be expected to be either by nymphs of *R. appendiculatus* or by a different rhipicephaline species.

The following rhipicephalids other than *R. appendiculatus* were found in cattle in the trial areas: *R. compositus, R. lunulatus, R. planus, R. pravus*, *R. punctatus* and *R. simus*. Species of other tick genera included *Boophilus microplus*, *Amblyomma variegatum*, *Hyalomma truncatum* and *Ixodes cavipalpus*. *B. microplus*, *A. variegatum*, *R. appendiculatus* and *R. compositus* were the most frequently recorded tick species.

Among all the rhipicephalids mentioned above, only *R. compositus* was found in reasonable numbers on the animals and has a seasonal pattern of activity that matches quite well with the peak of clinical cases of ECF at the height of the dry season. However, a closer analysis reveals that a peak of disease incidence due to *R. compositus* as a vector would rather be expected in November and December. Nevertheless clinical features of ECF cases in different seasons provide some evidence that *R. compositus* may in fact be the vector during the dry season. During that time the lymph nodes that were enlarged in cases of ECF were close to the preferred sites of attachment of *R. compositus* while during the rainy season the same applied to those lymph nodes that drain the preferred sites of attachment of *R. appendiculatus*. The most likely alternative explanation is transmission by nymphs of *R. appendiculatus* although these were not particularly abundant at the end of the dry season as

[1]Department of Animal Health and Industry, Blantyre ADD, P/Bag 379, Blantyre 3, Malawi. Tel.: +265-672022, Fax: +265-671843, E-mail: klorenz@malawi.net

compared to other months and do have almost the same favourite sites of attachment as the adult ticks.

INTRODUCTION

Malawi's national herd of cattle amounts to approximately 620,000 heads, 97 % of which are indigenous Malawi Zebu. These animals are mainly kept under traditional management systems in small herds using communal grazing areas and being herded by the owners themselves or by herd-boys throughout the day.

Tick-borne diseases, such as anaplasmosis, babesiosis, heartwater and East Coast fever, are endemic throughout the trial areas. However, East Coast fever (ECF), a *Theileria parva* infection of cattle that is almost exclusively transmitted by the vector tick *R. appendiculatus*, appears to be the only one of economic significance. According to the results of a dip tank survey conducted by Edelsten (1990), ECF is the most important infectious disease of cattle in the Northern and Central Regions in terms of number of cases and deaths. Another survey carried out by Soldan and Norman (1994) in the Central Region led to the conclusion that ECF accounts for up to 50 % of calf mortality and is by far the most important cause of mortality in young stock.

While it is widely accepted that *R. appendiculatus* is the main vector tick of East Coast fever, a total of ten *Rhipicephalus* and three *Hyalomma* species have been shown experimentally to be possible vectors of *T. parva* (Norval *et al.*, 1992). These are *R. appendiculatus, R. capensis, R. carnivoralis, R. compositus, R. duttoni, R. evertsi, R. kochi, R. pravus, R. simus, R. zambeziensis, H. anatolicum, H. dromedarii* and *H. impressum*. However, besides *R. appendiculatus* only *R. duttoni* and *R. zambeziensis* seem to be epidemiologically important vectors of ECF in certain areas of southern Africa (Lessard *et al*., 1990).

Walker *et al.* (2000) mention that *R. compositus* and *R. simus* have experimentally been shown to transmit *T. parva* but given the hosts of the immature stages (rodents and hares) both species are very unlikely to be significant field vectors. Nevertheless *R. compositus* has been mentioned as a possible vector of ECF during the dry season in Zambia by Matthysse as early as 1954 and more recently by Nambota *et al.* (1994).

The objective of this publication is to shed light onto the possible role of *R. compositus* in the epidemiology of East Coast fever in certain parts of northern Malawi.

MATERIALS AND METHODS

The trial was carried out in two different ecological zones ("Central Plains" and "Lake Shore") of the Mzuzu Agricultural Development Division (ADD) in the Northern Region of Malawi. The reference population consisted of 1,779 cattle (1992 cattle census) out of which 174 newborn calves were selected randomly and monitored for one consecutive year. 133 calves were identified in the Central Plains area and 41 in the Lake Shore region. Most of the calves were born between June and August (Table.1).

Table 1**:** Number of calves in the Central Plains group by month of birth

June 1993	July 1993	August 1993	Sept. 1993	Oct. 1993	Nov. 1993
33	28	36	21	12	3

The altitude of the trial area in the Central Plains is about 1,200 m with an average annual rainfall of well above 700 mm, a mean maximum temperature of 24°C and a mean minimum temperature of 12°C. The rainy season is from December until the end of April. The Lake Shore region is situated at an altitude of approximately 500 m. Mean maximum and minimum temperatures in this area are higher (28°C and 19°C respectively). The rainy season is slightly more extended from the end of November until mid-May and the average annual rainfall comes to about 1,700 mm.

Clinical examination of all calves was carried out every 2 weeks and included checking the body temperature, "body score" (3 categories), and enlargement of superficial lymph nodes. On the same occasion full body counts (classified in 6 categories) of ticks and nymphs were carried out. Tick samples were collected for identification. Blood slides as well as lymph node biopsy smears were prepared in case of any suspicion of East Coast fever (enlarged superficial lymph nodes and/or body temperature ≥40°C).

As the trial dealt with strategic tick control, approximately 50% of the animals were treated with acaricides. For the purpose of this publication only results for untreated animals ("control groups") were taken into account as far as tick burdens are concerned.

RESULTS

Boophilus microplus, Amblyomma variegatum, Rhipicephalus appendiculatus and *R. compositus* were found to be the most important cattle ticks with a clearly seasonal pattern of occurrence. *Boophilus microplus* was most abundant during the dry season (May-November), while the occurrence of adult *A. variegatum* was almost restricted to the rainy season (December-April).

R. appendiculatus was the predominating tick from the end of December until the beginning of April in the Central Plains region and more extended from January until July in the Lake Shore area (Fig. 1). The favourite sites of attachment of *R. appendiculatus* were the ear pinna, particularly the upper inner margin with its dense hair, the area around the eyes and the face in general. These ticks were only very rarely found anywhere else on the body. *Rhipicephalus*-nymphs in the Central Plains first appeared in April and were most numerous from May to October with a peak in June. In November they were uncommon, in December only found occasionally and from January to March they were not recorded at all. Their preferred sites of attachment included the inner surface of the ear pinna, the face and to a lesser extent the neck and the inguinal and axillar regions. It must be noted that nymphs were not identified to species level.

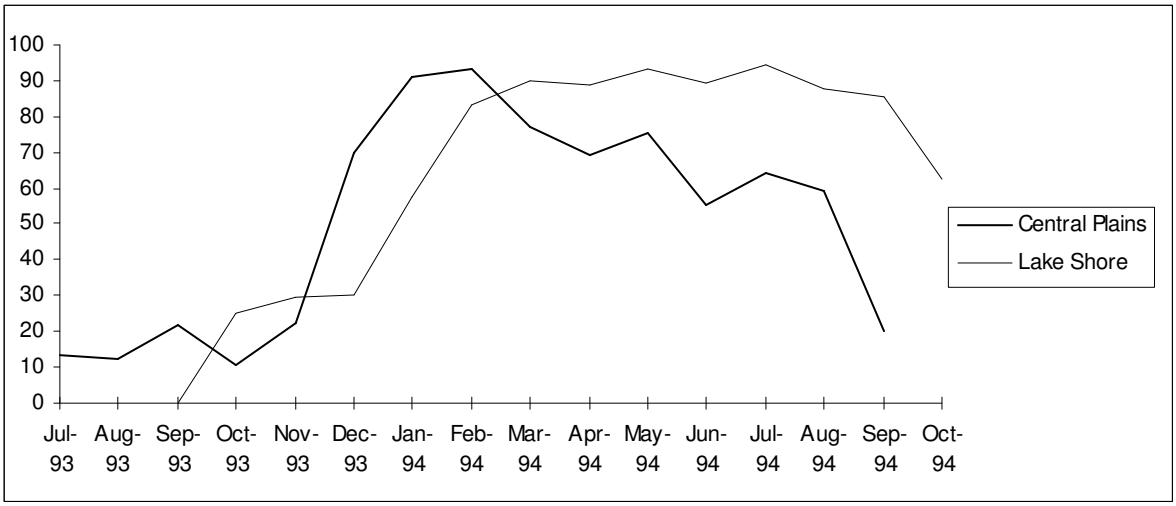


Figure 1: Seasonal occurrence of *R. appendiculatus*: Percentage of calves being infested

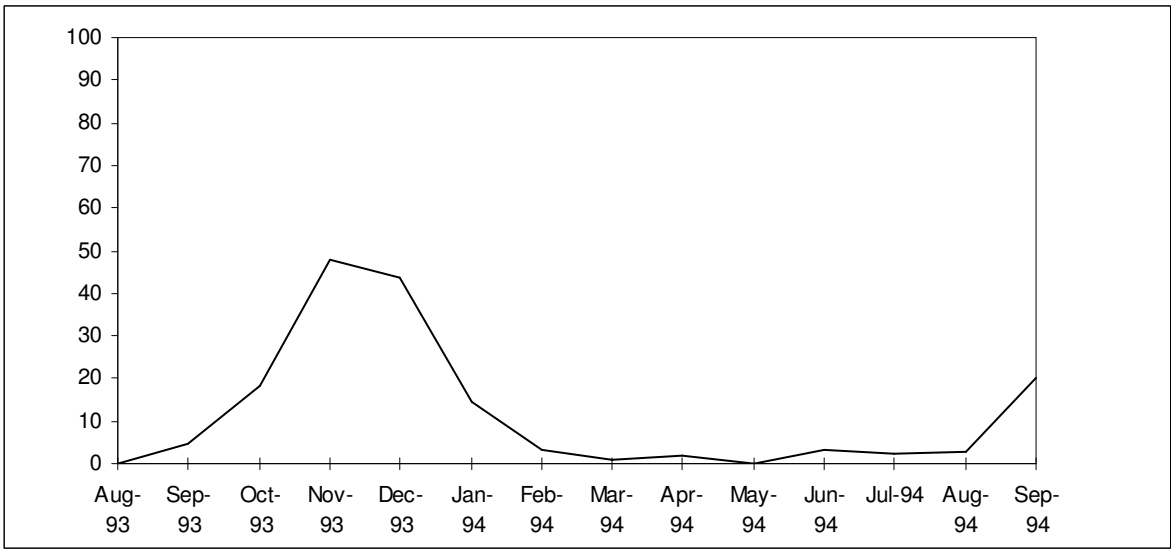


Figure 2: Seasonal occurrence of *R. compositus*: Percentage of calves being infested

R. compositus was only found in the Central Plains region with a highly seasonal activity during the hot and dry months at the end of the dry season just before the onset of the rains. They suddenly appeared in September and October to reach peak activity during November and December (Fig. 2). In January they were scarce and during all other months of the year only single specimens were recorded very occasionally. The predilection sites of this species were the inguinal area including the scrotum and the teats as well as the axillar region. Only rarely were these ticks encountered on the face or the ears.

Besides these predominating species *Hyalomma truncatum*, *R. lunulatus*, *R. planus*, *R. pravus*, *R. punctatus*, *R. simus* and *Ixodes cavipalpus* were found in comparatively small numbers and did not seem to have any notable adverse effect on animal health, possibly with the exception of *H. truncatum*, the bite of which commonly inflicted severe local inflammation. *R. pravus* and *R. punctatus* were found from February to August with a peak of activity from March to May and did mainly attach to the axillar and inguinal regions. These ticks were not recorded from September to January. *R. simus* and *R. lunulatus* were only found very occasionally in the wet season and were exclusively collected from the tail switch. *R. planus* was recorded from March to June but in very low numbers. Preferred sites of

attachment are unknown, as these ticks were not identified in the field. At first *R. lunulatus* had been misidentified as *R. tricuspis* and *R. planus* was referred to by its synonym *R. reichenowi* (Lorenz *et al*., 1995; Lorenz, 1997).

Total calf mortality was 34.4 % in the Central Plains and 57.3 % in the Lake Shore region with ECF accounting for 63.6 % of deaths (Central Plains) and 22.2 % (Lake Shore) respectively. The occurrence of clinical ECF cases in the Central Plains region showed to be highly seasonal with two peaks at the end of the dry season (8 cases in September and until mid-October) and in the mid-rainy season (7 cases from January to March). One case each was recorded in May and July (Fig. 3). Thus the total number of ECF cases in the Central Plains area was 17. There was evidence of a high incidence of ECF in the course of the calves' second month of life in the Central Plains region that corresponds very well with the peak of cases in September and October. Seven out of eight animals that suffered from ECF during this period were in their second month of life. Overall ECF morbidity in the Central Plains was 21.8 %.

In the Lake Shore area ECF morbidity turned out to be 12.7 % without any apparent seasonal peaks, which might be due to the low total number of cases (one case each in March, May and August).

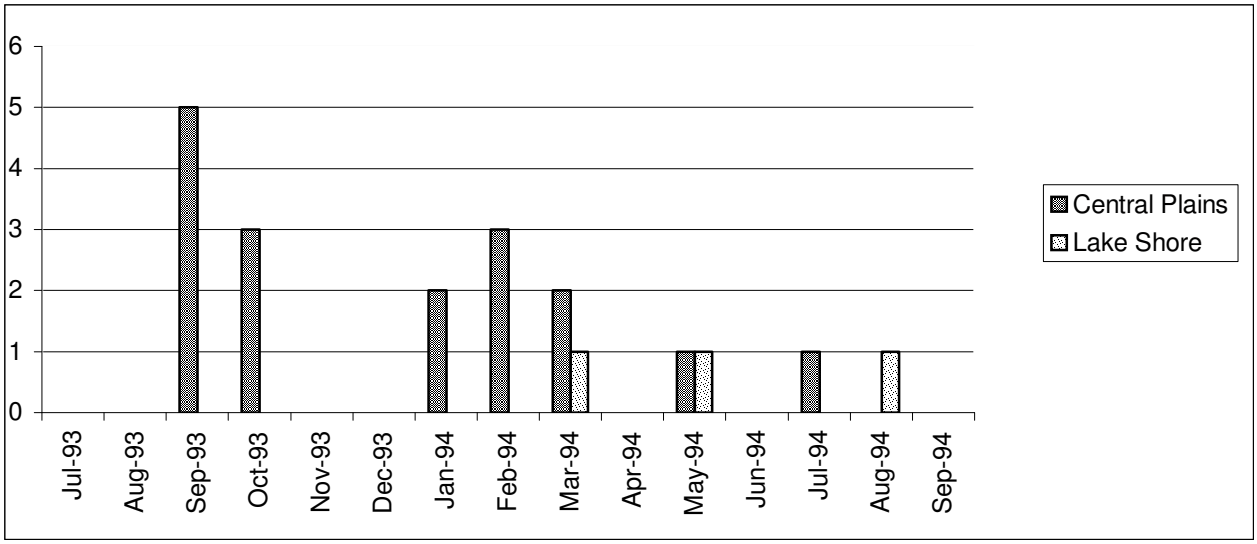


Figure 3: Seasonal occurrence of ECF cases in the trial areas (number of cases by months)

Only 14 out of the total number of 20 cases of East Coast fever were found while being sick so that a clinical examination could be carried out and samples could be taken (Table. 2). The remaining 6 animals died between two visits. Some of them had been seen by a veterinary assistant who in some cases even submitted slides. In all other cases farmers described a short and severe sickness with symptoms such as "swollen glands", "difficult breathing" and "running eyes". These descriptions were considered as sufficient evidence to warrant a diagnosis of East Coast fever as the cause of death under the prevailing circumstances. One animal that died shortly after it had been found recumbent with a body temperature of 38.2 °C and a high parasitaemia of *Theileria* piroplasms was considered to have been in the final stage of East Coast fever when the body temperature drops just before death. As no lymph node biopsy was examined, there is no real proof of death due to ECF in this case.

Table 2 Summary of data for all ECF cases encountered

Region and Tag No.	Date of Sickness	Age (weeks)	Body Temp (°C)	Other Symptoms / Reports by Farmers	Swollen Lymph Nodes			Blood Smear	Lymph Node Biopsy
					Parot.	Prescap.	Precrur.		
CP-1235	01.09.93	6.9	41.0	PCV 0.25	-	X	X	+	+
CP-1256	14.09.93	6.9	41.8		-	X		++	+
CP-1338	29.09.93	7.0	40.6	PCV 0.18; dyspnoea, lachrymation,	-	X	X	+++	+
CP-1295	29.09.93	4.6		"heavy breathing, swollen glands, running eyes"					
CP-1291	29.09.93	4.6	38.2					++	
CP-1269	11.10.93	16.0	41.1	PCV 0.12; dyspnoea,	-	X	-	+	+
CP-1240	11.10.93	4.6	40.0	"swollen glands; died"				+++	
CP-1296	13.10.93	7.6		"heavy breathing, swollen glands"					
CP-1355	04.01.94	12.4	41.8		-	X	-	+++	++
CP-1287	31.01.94	20.6	41.4		X	X	-	+++	++
CP-1354	01.02.94	17.1	41.1	dyspnoea	X	X	-	+	+
CP-1272	16.02.94	32.0	40.4		X	-	-	++	-
CP-1229	28.02.94	27.3	41.9		X	X	-	++	+/-
CP-1350	01.03.94	24.0	40.9		X	-	-	+	+
LS-1347	07.03.94	17.7	40.8		X	-	-	+	+
CP-1221	28.03.94	31.3	41.2		X	X	-	++	+
LS-1375	03.05.94	27.7	40.5		X	X	-	(+)	+
CP-1284	26.05.94	37.1	41.9	"sick with swollen glands"				++	+
CP-1397	24.08.94	37.1	40.6	"sick with swollen glands"				++	+
LS-1366	24.08.94	43.9	41.1		X	X	-	+++	++

Eleven out of the fourteen fully examined cases were encountered in the Central Plains, four at the end of the dry season and seven during the rainy season. In the Lake Shore area three cases of ECF were recorded, one each in March, May and August.

In all fourteen fully examined cases the calves had a high fever (40.4-41.9°C) and showed enlargement of superficial lymph nodes. In all cases except one the diagnosis was confirmed by examination of GIEMSA-stained lymph node biopsies.

In the Central Plains none of the animals that were affected during the dry season showed enlargement of the parotidal lymph node, while the prescapular lymph nodes were enlarged in all four of these calves and the precrural lymph nodes additionally in two of them. In the rainy season six out of seven affected calves were found with enlarged parotidal lymph nodes, while in three of these the prescapular lymph nodes were swollen as well. One animal did only show enlargement of the prescapular lymph nodes.

In the Lake Shore area all three clinically sick calves were found with enlarged parotidal lymph nodes while in two of them the prescapular lymph nodes were as well affected. None of these animals had enlarged precrural lymph nodes.

DISCUSSION

The findings concerning tick-fauna correspond well with the results of Wilson (1946, 1950) and Berggren (1978) who both found *A. variegatum*, *B. microplus*, *R. appendiculatus* and *R. compositus* to be the most important cattle ticks in the region, only that Wilson apparently described *R. compositus* as *R. capensis* (Matthysse and Colbo, 1987) and that records of *R. tricuspis* must probably be referred to as *R. lunulatus*. All other ticks that were recorded in the trial areas have been mentioned by the two authors although some of the species appeared as synonyms. Among the rhipicephalids, which were identified in this trial, Walker *et al*. (2000) describe all species as occurring in Malawi with the exception of *R. pravus*. This may require further clarification.

Remarkable differences have been found between the two respective areas concerning ECF incidence as well as seasonal abundance of *R. appendiculatus.* While the incidence of clinical ECF in the Lake Shore area was much lower than in the Central Plains region, the main vector tick showed a more extended seasonal abundance, being probably a result of the more favourable temperatures in the cool months of the year. Both facts may lead to the conclusion that endemic stability to ECF does exist in the Lake Shore area. Endemic stability has been defined by Norval *et al*. (1992) as the state in a cattle population where the large majority of the animals become infected and immune by six months of age and little or no clinical disease occurs. Since the number of calves in the Lake Shore area was quite low, the epidemiological state of this cattle population should be subject to further investigation.

In the Central Plains region ECF incidence was much higher accounting for 63.6 % of calves' deaths and showing a notable seasonal pattern with two peaks. While the rainy season's peak can easily be correlated to the high abundance of adult *R. appendiculatus* it remains to be clarified whether the second peak at the end of the dry season originates in nymphal transmission of *R. appendiculatus* or in transmission by other *Rhipicephalus*-species namely *R. compositus* or both. A possible transmission of *T. parva* by *R. compositus* in the dry season has been described by Matthysse (1954) and Nambota *et al*. (1994) for Zambia. Moreover Wilson (1953) described *R. compositus* as a possible vector of *T. parva*.

The accumulation of clinical cases of ECF in the course of the calves' second month of life might be due to declining protection by maternal antibodies while simultaneously being challenged and possibly weakened by other parasites such as certain gastrointestinal helminths. There was evidence of high burdens of *Toxocara vitulorum* in the second month of life and of *Strongyloides papillosus* in the second and third months of life.

The apparent co-incidence of seasonal abundance of *R. compositus* (while adult *R. appendiculatus* were conspicuously rare) and of clinical cases of ECF in young calves seems to provide evidence for the involvement of *R. compositus*. However two facts do not correspond well with this theory. First, the dry season's peak in ECF incidence lies in September / October when *R. compositus* have just become apparent in reasonable numbers. A peak in disease incidence due to transmission by *R. compositus* would rather be expected to occur in November and December. Secondly the apparently low prevalence of *R. appendiculatus* in September and October (21.9 % and 10.6 % of calves being infested by any number) is still more prominent than the prevalence of *R. compositus* at this time (4.7 % and 18.2 % of calves infested). On the other hand, if calves in their second month of life were particularly susceptible and if nymphs of *R. appendiculatus* were the vectors in the dry season, cases should have occurred from end of July to November according to the prevalence of the nymphs and the availability of young calves. As the trial started in mid-June, young calves of the relevant age group between one and two months were available throughout this period and nymphs were abundant from May to October with a peak in June. However, the concept of nymphal transmission does match well with the absence of cases in November and December when very few *Rhipicephalus*-nymphs were recorded.

The conspicuous pattern of the lymph nodes that were swollen in ECF cases of different seasons provides the most convincing evidence of a possible involvement of *R. compositus*. In the dry season the lymph nodes that were enlarged in cases of ECF were close to the preferred sites of attachment of *R. compositus*, namely the precrural and the prescapular lymph nodes (corresponding to the inguinal and axillary areas respectively). In cases that occurred during

the rainy season the same applies to those lymph nodes, which drain the preferred sites of attachment of *R. appendiculatus*, namely the parotidal and the prescapular lymph nodes (corresponding to the ears and the head). Both areas of preference do overlap in the region of the prescapular lymph nodes, which in fact were enlarged in eleven out of all fourteen cases monitored.

The parotid lymph nodes were swollen in seven out of eight cases during the rainy season while they were not affected in a single case during the dry season. These findings do not match well with the concept of transmission by nymphs of *R. appendiculatus* during the dry season as the nymphs have almost the same favourite sites of attachment as the adult ticks.

Figures from the Lake Shore area hardly contribute anything to support either theory. Only three cases of ECF were recorded, one each in March, May and August. There was no case in September or October, which coincides with the fact that *R. compositus* does not occur in the area. However, this is of little significance given the low total number of cases in the Lake Shore area.

It must be emphasized that a final conclusion with regard to the vector of East Coast fever at the end of the dry season cannot be drawn from the findings. However, the fact that eight out of twenty cases of ECF, which were observed, occurred during a season in which the activity of the recognized main vector tick *R. appendiculatus* is at its lowest is both surprising and alarming. Any strategic tick control programme aiming at the prevention of East Coast fever must take these epidemiologically important facts into account if it is to succeed. This does obviously apply to the trial areas in northern Malawi but possibly to other regions within the range of endemic East Coast fever.

REFERENCES

Berggren, S.A. (1978). Cattle ticks in Malawi. *Veterinary Parasitology*, 4:289-297.

Edelsten, R.M. (1990). *Diptank Survey, Malawi-CTVM Report No. 3*. Livestock Disease Evaluation Unit, Central Veterinary Laboratory, Lilongwe, Malawi.

Lessard, P., L'Eplattenier, R., Norval, R.A.I., Kundert, K., Dolan, T.T., Croze, H., Walker, J.B., Irvin, A.D. & Perry, B.D. (1990). Geographical information systems for studying the epidemiology of cattle diseases caused by *Theileria parva*. *Veterinary Record*, 126, 255-262.

Lorenz, K. (1997). *Untersuchungen zur strategischen Bekämpfung von "tick-borne diseases" bei autochthonen Zebu-Rindern (Bos indicus) in Malawi unter besonderer Berücksichtigung der Kälber*. Thesis for the doctorate, Freie Universität Berlin, 144 pp.

Lorenz, K., Leidl, K., Hörchner, F. & Schein, E. (1995). Strategic tick control on local zebu cattle in Malawi with special reference to the calves: effects on disease incidence and economic aspects in two different ecological zones. In: *Proceedings of the Eighth International Conference of Institutions of Tropical Veterinary Medicine* (AITVM), 25-29 September 1995, Berlin, Germany.

Matthysse, J.G. (1954). *Report on tick-borne diseases*. 28 pp. Lusaka, Government Printer.

Matthysse, J.G., & Colbo, M.H. (1987). *The ixodid ticks of Uganda*. Entomological Society of America, College Park, Maryland, 426 pp.

Nambota, A., Samui, K., Sugimoto, C., Kakuta, T. & Onuma, M. (1994). Theileriosis in Zambia: Epidemiology and control measures. *Jpn. J. Vet. Res*., 42(1):1-18.

Norval, R.A.I., Perry, B.D. & Young, A.S. (1992). *The Epidemiology of Theileriosis in Africa*. Academic Press, London, 481 pp.

Soldan, A.W. & Norman, T.L. (1994). *Livestock Disease Evaluation Project dipping trial 1993 report*. Central Veterinary Laboratory, Lilongwe, Malawi.

Walker, J.B., Keirans, J.E. & Horak, I.G. (2000). *The Genus Rhipicephalus (Acari, Ixodidae). A Guide to the Brown Ticks of the World*. Cambridge University Press, 643 pp.

Wilson, S.G. (1946). Seasonal occurrence of Ixodidae on cattle in Northern Province, Nyasaland, *Parasitology*, 37:118-125.

Wilson, S.G. (1950). A checklist and host-list of Ixodoidea found in Nyasaland with descriptions and biological notes on some of the Rhipicephalids, *Bulletin of Entomological Research*, 41:415-428.

Wilson, S.G. (1953). A survey of the distribution of tick vectors of East Coast fever in East and Central Africa. *Proceedings of the 15th International Veterinary Congress, Stockholm*, 1, 187-90.

POSTERS

A STOCHASTIC DECISION TREE MODEL TO ASSESS THE IMPACT OF GROUNDWATER POLLUTION ON LIVESTOCK

B. GUMMOW[1]

Due to concerns expressed by residents in the vicinity of a large steelworks that the steelworks was polluting their groundwater, a pollution forum steering committee was set up by local authorities to investigate the situation. Since the districts concerned comprised numerous small holdings and several farms, a subcommittee was set up to investigate what livestock were in the area and whether there was any significant impact on livestock health in the districts as a result of groundwater pollution. The investigation had to be completed within six weeks, with limited manpower and within a limited budget. Six districts (Rietspruit, Drakeville, Rietkuil, Louisrus, Steelvalley and Linkholm) were included in the study. A hazard assessment based on retrospective data from previous studies, established that livestock were at risk due to excess concentrations of sulphates, chlorides, iron, nitrates, phenols, *E. coli* and total dissolve solids. An exposure assessment was carried out using a door-to-door interview questionnaire census. One hundred and ninety one property owners were interviewed, which comprised approximately 85 % of the properties in the districts being investigated. The survey provided baseline data on the proportion of properties with animals, the species of animals found on these properties, sources of water and feed, and the perceived health status of the animals in the various districts. Risk characterisation was carried out using a decision tree model to establish the potential impact of exposure. The dose response assessment was quantified using economic measures as the response. The inputs for the model were based on the questionnaire survey results. To deal with the uncertainty inherent in the survey results, Latin-hypercube simulation techniques were applied at the various probability nodes in the decision tree model. This allowed for better risk characterisation. The study therefore combined Bayesian and stochastic principles to provide a novel approach for doing livestock impact studies when investigators are faced with limited information.

[1]University of Pretoria, Private Bag X04, Onderstepoort, 0110, South Africa. Tel. No. +2712 5298257, Fax. +2712 5298315; E-mail. bgummow@op.up.ac.za

GENETIC RELATIONSHIPS OF SAT2 TYPE FOOT-AND-MOUTH DISEASE VIRUS ISOLATES FROM OUTBREAKS IN WEST AFRICA, 1974-1991

O. SANGARE.[1,2], A.D.S. BASTOS[3], W. VOSLOO[2] & E.H. VENTER[1]

South African Territories (SAT) type 2 is one of the four foot-and-mouth disease (FMD) virus types known to circulate in West Africa, the other virus types being type O, A and SAT-1. From 1974-1991, SAT-2 was the virus type most frequently isolated from West African outbreak specimens submitted to the World Reference Laboratory (WRL) for FMD.

In order to determine the genetic relationships of these SAT-2 viruses, the C-terminus half of the VP1 genome region was amplified using a reverse transcriptase dependent polymerase chain reaction (RT-PCR). The nucleotide sequences of 28 SAT-2 viruses were determined following amplification and recovery of products. The characterized viruses comprised five 1974 isolates from Ghana, Ivory Coast, Liberia and Nigeria, five 1975 isolates from Nigeria and Senegal, three 1979 viruses from Gambia and Senegal, four 1983 viruses from Senegal, three 1990 isolates from Ghana and Ivory Coast and eight 1991 viruses from Ghana, Mali and Nigeria. A neighbor-joining tree based on 480 nucleotides of the C-terminal half of VP1 was used to determine the genetic relationships of SAT-2 viruses.

Three distinct evolutionary lineages were identified in West Africa, with viruses clustering according to year of isolation rather than sampling locality. Viruses recovered from outbreaks in five West African countries from 1974-1975, were shown to be part of the same epizootic. Similarly, isolates made from the 1990 and 1991 outbreaks were shown to have been caused by the same virus. The results further revealed that the virus causing the 1979 outbreaks was directly related to those recovered from the 1983 outbreaks in Senegal, pointing to a circulation period of four years in the field, for this particular variant.

This first study on the molecular epidemiology of SAT-2 type FMD viruses in West Africa illustrates how this approach can be used for identifying links between epizootics occurring in different years. It has also clearly shown that livestock and their diseases appear to move freely between different West African countries, thereby emphasizing a need for a regional approach to FMD control.

[1] Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, South Africa
[2] ARC-OVI, Exotic Diseases Division, Onderstepoort 0110, South Africa
[3] Department of Zoology & Entomology, University of Pretoria, 0001, South Africa

TUBERCULOSIS – A TIME BOMB IN SOUTH AFRICA'S KRUGER NATIONAL PARK?

A.L. MICHEL[1], D.F. KEET[2]. R. BENGIS[2]. & V. DE VOS[3]

Although known among South Africa's wildlife since 1928 the first case of tuberculosis in the Kruger National Park was diagnosed in an African buffalo (*Syncerus caffer*) in July 1990. Since that time the prevalence of *M. bovis* in buffalo herds has increased to up to 92% in the southern region and the disease is furthermore known to spread among herds having almost reached the northern border. Due to the high infection pressure and its wide host spectrum *M. bovis* has also spilled over into lion (Panthera leo), cheetah (Acinonyx jubatus), chacma baboon (*Papio ursinus*), greater kudu (*Tragelaphus strepsiceros* and leopard *(Panthera pardus*). In all affected species tuberculous lesions are mainly found in the lungs and lymph nodes associated with the upper and lower respiratory tract indicating transmission by droplet infection.

The epidemiology of tuberculosis in wildlife and its impact on these populations is only poorly understood at this stage. While it is accepted that lion and baboon contract the disease by feeding on infected buffalo carcases the possible sources of infection to kudu, cheetah and leopard are still unknown. Although the highly infected ecosystem must be considered such a potential source of infection we have recently demonstrated that the survival of *M. bovis* in naturally infected tissue in the KNP is limited to a few days up to 6 weeks under different macro- and microclimatic conditions. Genomic fingerprinting of *M. bovis* isolates therefore plays a crucial role in helping to shed light on aspects such as external sources of tuberculosis to the KNP and relationships between outbreaks within and among species.

[1]ARC-Onderstepoort Veterinary Institute, Onderstepoort
[2]Directorate Animal Health, Skukuza
[3]National Parks Board, Kruger National Park