DEER HERD HEALTH AND PRODUCTION PROFILING : THE METHOD

L.J.M. Audigé; P.R. Wilson; R.S. Morris
Department of Veterinary Clinical Sciences
Massey University

Deer farming has been successful for about 20 years in New Zealand, supported by extensive development and research. Deer have adapted well to intensive farming because of their ability to cope with the new farming environment and also because humans have developed new farming practices adapted to various species of deer. Knowledge is currently available about the nutritive and reproductive biology of farmed deer as well as their susceptibility to diseases (Mackintosh, 1992a; Haigh and Hudson, 1993).

So far, most research on deer health has been reactive, to overcome emerging clinical diseases (Mason, 1985; Conway, 1990). Application of new control measures on farms, mostly by the use of chemicals or vaccines, helped reduce the occurrence of some health problems such as lungworm (Mackintosh and Mason, 1985; Mackintosh et al., 1990), some bacterial diseases (Mackintosh, 1992b) and fading elk syndrome (Waldrup and Mackintosh, 1992). More recently, the development of "Yersiniavax" to control Yersiniosis in deer is also very promising (Mackintosh et al., 1992).

Most surveys on deer diseases in New Zealand have been carried out on one particular disease or syndrome either at slaughter houses (Mackintosh and Henderson, 1985) or from veterinary practices (Wilson and Collier, 1981; Smythe, 1986; Lawrence, 1986). Attempts have been made to estimate the relative prevalence of diseases observed on farms (Beatson, 1981, 1985; Gladen, 1981) or, more recently, at slaughter houses (Selwyn and Hathaway, 1990). Although the results were very informative, none of these surveys could accurately measure the prevalence of diseases on farms.

Since the beginning of deer farming, the pattern of diseases has changed through adapted management practices by farmers and ,possibly, acquired genetic resistance by deer. Some acute and apparently highly prevalent health problems such as malignant catarrhal fever, lungworms, and stress-related problems have been partly controlled, leaving the emphasis on more insidious and chronic disorders. These emerging health problems do not always cause the death of the deer, but may have a significant negative impact on deer production or reproductive performance. Their control is difficult as they are not caused by a single agent on an animal, but are the convergence point of a series of predisposing environmental factors.

Also, the recent decrease in deer stock values encourages deer farmers to optimise their return through reduced production

costs, and achievement of production targets. It is recognised that farmed deer "do well" under management practices which enhance their health and well-being, thus bringing good production and profitability. However, little is known about the achievable production targets given a range of farm or animal characteristics; most estimates in the literature are based on data from research farms or from specific research projects rather than appropriately sampled farm populations. Little is known also on the relative importance of these characteristics on animal health or how, through the occurrence of diseases, they affect production and profitability.

Epidemiological science provides the techniques to investigate both multifactorial diseases and production factors on farms.

What is herd health and production profiling ?

"Health and production profiling" (Morris, 1991) combines health and production studies in a holistic epidemiological approach and is a tool for studying complex inter-relationships between factors which influence herd performance. It involves gathering a variety of categories of relevant information about the whole farm, including physical and climatic characteristics, farmer characteristics, management practices, animal health, production outcomes, and individual sentinel animal parameters. These are then analyzed by advanced multivariate statistical techniques at the levels of whole farm, herd or mob, or individual animals.

Deer herd health project objectives

The objectives of this project were :
- To explore the basic health problems and production results for red deer from selected farms.
- To identify and quantify the risk factors [environmental factors, farm characteristics, management practices, etc] that are **associated** with a range of outcomes including health problems, diseases and mortality, reproductive performance, growth, carcass and antler production.
- To investigate a range of deer biological characteristics as markers for risk factors for sub-optimal production levels and potential health problems.

1. FARM AND ANIMAL SELECTION - DEFINITIONS

A mail questionnaire inquiring about possible participation was sent to 370 deer farmers in the districts surrounding Palmerston North [Manawatu, Wanganui, Taihape, Bush, Hawkes Bay]. From the 83 answers, 17 potential participants were selected on the basis of the following requirements; they had to farm red deer, with at least one breeding herd of red hinds, without the use of wapiti type deer as a terminal sire in 1991; and they had to have adequate handling facilities for collection of blood and faecal samples and the recording of data from individual deer [a weighing machine in particular was required].

Final selection was made after a short-listed group of potential farmers had been individually visited and the research protocol explained. Because the study was **observational** and not interventionist, it was stressed that information could not be disclosed until its completion. Some data, however, could be

disclosed to their veterinarian, if requested, as part of their usual monitoring programme.

Fifteen farms were finally selected; their locations and characteristics are presented in Figure 1 and Table 1. As two farms withdrew early in the study, two other farms were immediately selected as replacements.

Deer were identified by sex and age :
- Weaners (or weaned deer)[WS as Weaner Stags; WH as Weaner Hinds] were deer from weaning at about 3 months of age until March 1 when they were about 15 months of age.
- Yearlings (yearling deer)[YS as Yearling Stags; YH as Yearling Hinds] were deer from 15 to 27 months of age, from March 1 one year to March 1 the next year.
- All other deer were identified as adult deer [AS as Adult Stags; AH as Adult Hinds]

A mob was defined as any group of animals (deer, cattle and sheep) that was managed separately from other animals on the deer farm. All mobs that were grazing within the deer fenced area were surveyed, on all selected farms but one.

On each farm, 5 deer of each age and sex class were randomly selected and identified as "Sampling deer" with a second ear-tag. New sampling deer were selected in replacement if any sampling deer left the farm or could not be handled during visits.

When stags were missing or could not be handled, hinds of the same age were selected to maintain 30 sampling deer per farm.

2. RECORDING OF INDIVIDUAL FARM CHARACTERISTICS

Records, observations and sampling are being undertaken over a 2-year period commencing March 1992. Individual farm characteristics were recorded by direct measurements on farms or by questionnaires sent to the farmers. It is not the objective to list here all characteristics that were recorded, but to give an overview of the various areas for data collection. Details of all variables will be published elsewhere in due course.

2.1. Farmer profile

In an attempt to identify farmer profiles, farmers were asked to answer a direct questionnaire as well as an opinion questionnaire (Luquet and Desaymard, 1989). Farmers were asked specific questions on subjects such as their family, their education and training, their involvement and commitment in deer farming, some farm characteristics (altitude, size, stock wintered) and the disease history of the deer farm.

The opinion questionnaire was conducted to obtain spontaneous responses from farmers about subjects that are directly related to their farming enterprises (Luquet and Desaymard, 1989). Sixty five sentences were identified from an open discussion with farmers on subjects such as the farmer's past, his family, his decision to become a deer farmer, etc ; the farmer's confidence in the industry, the current and future markets, etc; the deer as an animal to handle, as a farm animal, etc; and deer health and deer diseases, in particular their attitude towards health

Figure 1 :

Location of selected red deer farms

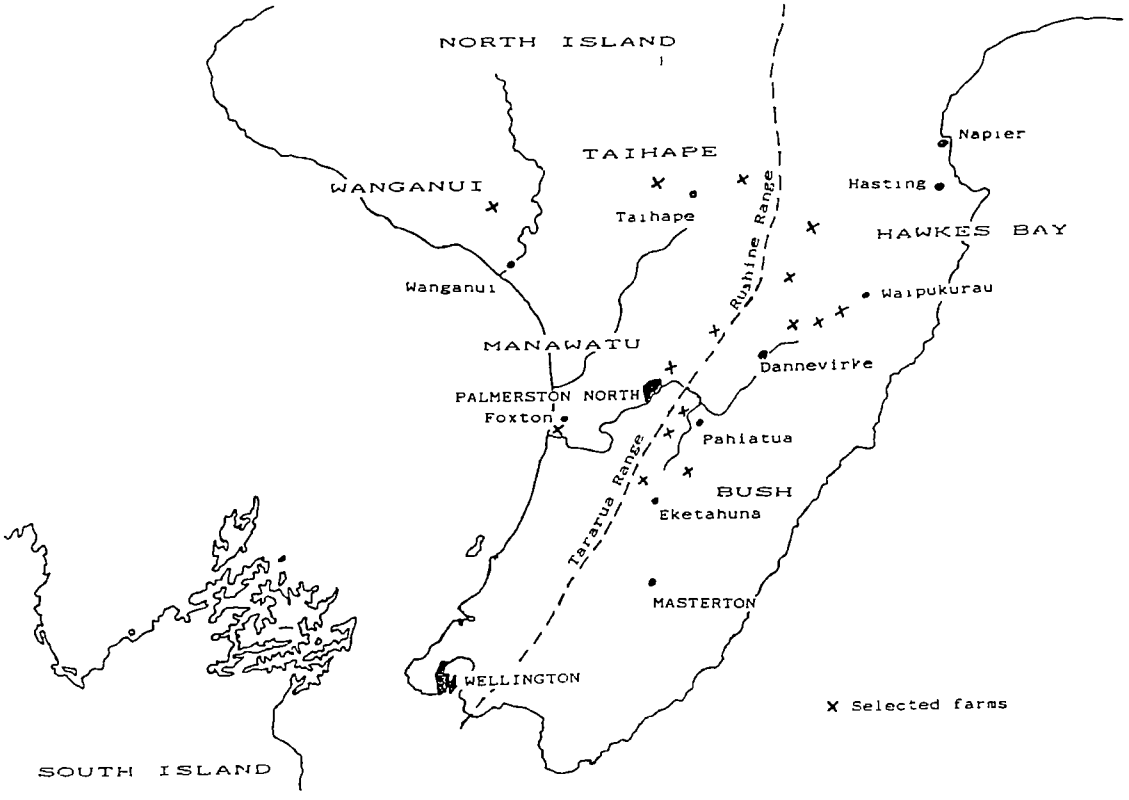


Table 1 : Selected red deer farms

District	Farm	Total Area (Ha)	Deer Fenced Area	Deer Stock[1]				Other Stock[2]	
				Weaners	Hinds	Stags	Cattle	Sheep	Goats
MANAWATU	1	57	42	60	90	90	50	0	0
	2	445	48	100	142	75	602	6255	185
	3	24	24	45	80	34	6	9	19
TAIHAPE	4	230	62	100	235	15	183	1314	0
	5	450	53	71	87	31	401	3122	0
WANGANUI	6[3]	168	79	89	124	50	42	1670	0
BUSH	7	61	61	90	115	84	0	5	2
	8	360	55	100	215	10	251	2465	0
	9	516	45	40	160	50	106	4811	0
	10	180	20	62	81	3	73	438	0
HAWKES	11[3]	39	38	47	205	38	0	0	0
BAY	12	404	55	75	182	112	200	2355	1
	13	611	70	58	157	75	403	4770	0
	14	274	274	250	1140	570	372	74	0
	15	791	453	324	1155	201	637	4352	1000
Total			1379	1511	4168	1438			

1 Figures reported by farmers on a mail questionnaire in Sept 1991
2 Figures in June 1992
3 Farms selected in May 1992

problems and animal welfare. Then each farmer had to give his opinion for each sentence by scoring them from 1 to 5. The scores were; 1 = I strongly agree; 2 = I agree; 3 = I don't know; 4 = I disagree; 5 = I strongly disagree. The analysis of this data will be presented elsewhere.

2.2. Farm layout

Farm layouts were described using maps. Each deer fenced paddock was described with characteristics such as area, topography, water supply, type of fence, shelter, exposure to wind, pasture type and weeds. Paddock areas were calculated using the computer package "Farmtracker"[1]. Lane characteristics and yard designs were also described.

3. FARMER RECORDING

Farmers recorded their management practices using specific recording sheets that covered areas such as nutrition management, handling of deer, production and reproduction performance and health problems (see table 2).

3.1. Recording of farm management practices

3.1.1. Grazing management

Using "Pasture height and stock" recording sheets [see Appendix 1], farmers reported the movement of mobs within the deer fenced area. A new line was filled in each time there was a change of paddock, a change in stock numbers or at least every 7 to 10 days, if mobs were set stocked for more than two weeks.
Each line in this report defined a "grazing interval" and contained the following information; the identification of the mob and paddocks; the starting and ending dates of the grazing interval; the pasture characteristics such as the initial and residual sward heights, an estimation of the clover content of the pasture, the seed head height and the seed head density; the deer mob composition detailed by sex and age class, and the presence of other livestock species.
The tag IDs of deer were tentatively recorded for each mob at any time to identify deer that had been under the same grazing management.

The pasture height was measured as the length from the ground to the tip of the green leaves of the grass using a simple ruler. The clover content of the pasture was estimated by a visual assessment which gave three classes "G" as "Grass dominant", "M" as "Mixed", and "C" as "Clover dominant".

3.1.2. Food supplementation

For each mob of deer, all types of food supplement were recorded as the nature of the food supplement [pasture hay, silage, maize, etc], the quantity that was given each day to each mob and an estimate of the waste. Samples of hay or silage were analyzed to estimate their nutritive value [MJ metabolizable energy/kgDM] and

---

[1] FarmTracker, Physical Farm Management Software, B.M. Butler Computing Ltd, Palmerston North, New Zealand

percentage dry matter.

Table 2 : Recording sheets used by farmers

Recording of farm management practices	
Deer mobs	* Pasture height and stock * Food supplementation * Management record
Paddocks	* Paddock management record
Questionnaires	* Mating management * Calving management * Deer handling
Recording of deer health problems	
Diseases	* Health problems * Individual disease report * Disease outbreak report * Calving problems * Slaughter report
Deaths	* Post-mortem examination report * Calf mortality report
Other recording	* Farm maps * Climate data report

3.1.3. Deer work in the yard

Farmers reported on the "management record" sheet all other deer management practices (Appendix 1). Most of them were related to deer work that was carried out in the deer yard such as sorting deer mobs and weighing deer; disease prevention programme such as vaccination, parasite control, trace element supplementation, tuberculosis testing; disease treatment; velvetting.

3.1.4. Reproductive management

The management of hind mobs and their composition during the mating season were recorded along with the date when sire stags were mixed with hind mobs, back-up stags were used, withdrawal of sire stags, and individual characteristics of each sire.

Calving mobs were identified before set stocking for calving. A short questionnaire was completed to investigate human presence around hinds during calving.

3.1.5. Deer handling

Questions were asked on the way farmers handled their deer in the paddocks and in the yards, and how farmers perceived the behaviour of their deer.

3.1.6. Other recording

The management practices for deer paddocks were recorded

including topping, fertilizing, spraying for weeds, making hay or silage, and fencing.

Climatic data were recorded daily on farms. Reports were completed with minimum and maximum temperatures, rainfall, wind strength [using the Beaufort scale] and direction, and sunshine; and were sent back monthly. When some farmers did not record part of these data, the climate data were obtained from the nearest meteorological station.

3.2. Recording of deer production

3.2.1. Liveweights and velvet yields

The individual deer liveweights were regularly monitored as shown in Table 3. Except on one farm, all deer under survey were individually monitored. In total about 2000 weaner deer, 2500 hinds and 1200 stags were individually monitored. Updated computer listings of deer were regularly sent to farmers to report bodyweights or other types of data such as velvet weights and grades.

3.2.2. Reproduction

Depending on farm management practices, all or part of the following information was recorded for each hind: status of udder at weaning, sex and weight of calves at weaning, and calving dates.

Hinds were pregnancy tested in June (see section 4.1.3). Their pregnancy status was checked before calving by direct palpation of the udder and bodyweight changes between June and October/November.

3.2.3. Slaughter

Tag numbers, carcass weights and GR measurements were provided by slaughter companies[2].

3.3. Recording of health problems

All health problems noticed by farmers were reported on the "Health problems" sheet [Appendix 1], giving dates, deer and mob identifications and brief descriptions of the problems. Health problems were any observations that should not be seen on an apparently healthy deer, such as injuries, abscesses, lameness, scouring, fading, and obviously death.

In an attempt to accurately diagnose the cause of each disease or death, symptoms, treatments or post-mortem observations were recorded on specific sheets [Appendix 2 and 3]. A post-mortem form was provided to farmers to guide them through any autopsy they would perform themselves, in particular for the collection of organ samples. It was preferred, however, that post-mortem examinations be carried out by the researchers or local

---

[2] Venison New Zealand at Feilding (Manawatu) and Hasting (Hawkes Bay)
Venex at Waiora (Hawkes Bay)

veterinarians.

During the calving season, farmers reported problems such as dystocia and perinatal mortality. A simple post-mortem examination of dead calves was carried out by answering a short list of questions [Appendix 4].

At the DSP at Feilding, Hastings or Wairoa, MAF veterinarians examined slaughtered deer and reported back to Massey the gross lesions they observed using the sheet presented in Appendix 4.

4. FARM VISITS

In addition to periodic visits to collect and collate data, each farm was visited three to four times each year in March, June, September and November (Tables 3 and 4) specifically to collect samples from animals, pastures and soils. Some measurements and observations were also made on the deer and on each deer-fenced paddock of the farm. All these observations were made directly by the researchers.

4.1. Recording of individual deer data and sample collection

4.1.1. Sampling of selected deer

The schedule of deer sampling is presented in Table 4. Sampling deer were selected or sorted out and isolated in the yards. Depending on the class of the deer and time of year, some measurements and observations were recorded from selected deer including thorax girth, body height, body weight, body condition score, signs of hair losses, coat density, coat length, and teeth score.

Blood samples were collected and the behaviour of the deer during collection recorded; 40 ml of blood were collected for serum, and 5 ml of blood collected into EDTA for haematology. Faeces were sampled for parasite egg and larvae counts. When necessary, farmers collected faeces samples from 10 randomly selected fawns before their first anthelmintic treatment.

4.1.2. Body condition score

A body condition scoring chart has been defined, ranging from 1 [very lean deer] to 5 [very fat deer] with half-unit increments; the detailed chart will be published in due course. A body condition score [BCS] was given to all hinds that were mated, in March before mating, in September before calving and in March of the next year at weaning.

4.1.3. Pregnancy testing

All hinds that were mated were pregnancy tested by ultrasound using a rectal probe, 15 to 70 days after sire stags were withdrawn from hinds. Hinds were classified as having conceived before May 1st, after May 1st or as being not pregnant. The dates of scanning were chosen to maximise the accuracy of the test. Results were based on foetal and placental measurements used to estimate the age of foetus of red deer (Revol and Wilson, 1990).

Table 3 : Schedule of deer mob recording and paddock sampling

MONTH	DEER FENCED PADDOCKS Samples	CLASS OF DEER		
		Weaner deer	Yearling & adult hinds	Yearling & adult stags
MARCH	Pasture	Weight	Weight Bodycondition score	Weight of yearling stags
JUNE	Soil	Weight	Weight Pregnancy test	Weight
SEPTEMBER	Pasture	Weight	Weight close to calving period	
NOVEMBER		Weight		Weight Velvet

Table 4 : Schedule of measurements and sample collection from selected sampling deer

MONTH	CLASS OF DEER		
	Weaner deer (3-15 months)	Yearling & Adult hinds	Yearling & Adult stags
AT EACH VISIT	Thoracic girth, Weight Blood & faeces samples	Weight, Size, Thoracic girth Condition score Coat length Blood samples	Weight, Size, Thoracic girth Condition score Coat length Blood samples
MARCH		Teeth faeces samples	Teeth
JUNE	Coat length Coat density[1]	Pregnancy test	faeces samples
SEPTEMBER	Coat length Size	faeces samples	
NOVEMBER[1]	Coat length Size		faeces samples

1 : only during the first year of survey

4.2. Recording of paddock data

From each deer-fenced paddock, pasture characteristics were recorded including sward height, clover content score, seed head height, seed head density score, ragwort and thistle density score, pasture cover using a rising plate meter and fence pacing score.

The signs of *fence pacing* by deer were scored by visual assessment of the damage caused along fences using the following scale; 0 = No fence pacing, there was no visible track along the fence, the grass was growing up to the fence; 1 = Slight fence pacing, there was a small walking track along the fence, no more than 30 cm wide and no more than 5 cm deep; 2 = Moderate fence pacing (observation between 1 and 3); 3 = Strong fence pacing, there was severe damage of the pasture along the fence on an area at least 1 m wide or at least 20 cm deep. From each paddock, the worst signs of fence pacing were recorded.

The presence of weeds were recorded after visual assessment using a *Ragwort score* and a *Thistle score*; 0 = there was no ragwort or thistle that were seen in the pasture while walking through the paddock; 1 = there were a few plants of ragwort or thistle that were sparse in the paddock; 2 = there were many plants of ragwort or thistle scattered in some area of the paddock; 3 = There were a lot of plants of ragwort or thistle that were covering large areas of the paddock.

Pasture samples were collected before grazing in March and September from 3 paddocks that were grazed by different mobs. Soil samples were taken in June from 4 or 5 paddocks that were selected to assess soil fertility in various part of the deer farm.

4.3. Processing and analysis of samples

Blood samples that were collected on EDTA were immediately cooled on ice, and a smear was prepared on farms. Other blood samples were clotted for 2 to 4 hours at environmental temperature, then were centrifuged to extract the serum. Serum samples were cooled on ice for 4 to 5 hours before being frozen. Faeces samples were cooled on ice immediately after collection until analysis the day after collection.

In the laboratory, a range of blood and faeces analyses were performed as described in Table 5. Blood on EDTA was analyzed for haematological characteristics within 24 hours of collection; white cell counts [WCC], and haemoglobin concentration [Hb] were performed using haematology analyzer[3]. Packed cell volumes were determined after centrifugation of capillary tubes. Sera were analyzed for biochemical, mineral and serological characteristics within 3 months after being frozen. Faecal egg counts [FEC] and faecal larval counts [FLC] were determined from faeces samples the day after collection. The detailed description of laboratory analytical methods will be presented elsewhere in due course.

---

[3] CELL-DYN 900 Haematology Analyzer , Sequoia-Turner Corporation, Montain View, California 94043

Table 5 : Schedule of sample analyses

MONTH	SAMPLING DEER	SAMPLES	LABORATORY ANALYSIS CARRIED OUT
MARCH & SEPTEMBER	Weaners & Hinds	EDTA blood Serum Faeces	WCC, Diff., Hb, PCV, G.S.H.Px TP, Alb, P, GGT, BUN, Cu, B12, Peps FEC, FLC
	All deer	Serum	Serology Leptospirosis
	Weaners	Serum	Serology Yersiniosis
		Pasture	Micronutrient profile : Cu, Co, Se, Mn, Mo, Zn, Fe, S
JUNE	Weaners & Stags	EDTA blood Serum Faeces	WCC, Diff., Hb, PCV, G.S.H.Px TP, Alb, P, GGT, BUN, Cu, B12, Peps FEC, FLC
	All deer	Serum	Serology Leptospirosis
	Weaners	Serum	Serology Yersiniosis
		Soil	Olsen P, Exch. K, S, pH
NOVEMBER [in 1992 only]	Weaner deer & Stags	EDTA blood Serum Serum Faeces	WCC, Diff., Hb, PCV, G.S.H.Px TP, Alb, P, GGT, BUN, Cu, B12, Peps Serology Leptospirosis FEC, FLC
	Weaners	Serum	Serology Yersiniosis

Blood — WCC: White Cell Count; Diff: Differential leucocyte count; Hb: Haemoglobin; PCV: Packed Cell Volume; TP: Total Proteins; Alb: Albumins; P: Phosphorus; GGT: Gamma Glutamyl Transferase; BUN: Blood urea nitrogen; Cu: Copper; B12: Vitamin B12; FEC: Faecal Egg Count; FLC: Faecal Larval Count; G.S.H.Px: Glutathione peroxydase; Peps.: Pepsinogen

Pasture — Cu: Copper; Co: Cobalt; Se: Selenium; Mn: Manganese; Mo: Molybdenum; Zn: Zinc; Fe: Iron; S: Sulphur

Soil — Olsen P: Olsen phosphate; Exch.K: Exchangeable potassium; S: Sulphur

Blood smears were stained, covered and stored to be read later. Differential leucocyte counts were performed by counting 100 cells under magnification [x40]. Leucocytes were classified as polynuclear neutrophils, eosinophils, basophils, band cells [immature neutrophils], lymphocytes, monocytes and "Odd lymphocytes".

"Odd lymphocytes" were cells that could not be properly identified as lymphocytes or monocytes. These cells appeared to be peculiar to deer as they are not seen in other domestic species of animals. In some instances, these cells have been seen in abundance in weaner deer affected by Yersiniosis (Cross, personal communication).

5. THE COMPUTER DATABASE

5.2. Primary and secondary datasets

Data were entered into the relational database "Paradox"[4]. Multiple datasets, called "primary datasets", were used to enter raw data that were recorded on farms or at the laboratory. After the verification of data, calculations were subsequently performed for mob and farm characteristics; the results of these calculations were automatically entered in "secondary datasets". The detailed description of all variables and their calculations will be published elsewhere.

For instance, calculations were made to monitor the production performance of mobs such as the average growth rate of weaner deer during a defined grazing period, but also to investigate during this period factors that may influence this growth such as climatic variables, average paddock characteristics from individual paddock data, mean pasture measurements, food supplementation levels, stocking rates, average mob composition and mob size.

5.2. Data entry validation

The circulation of information relating to data entry, checking and validation is described in figure 2.

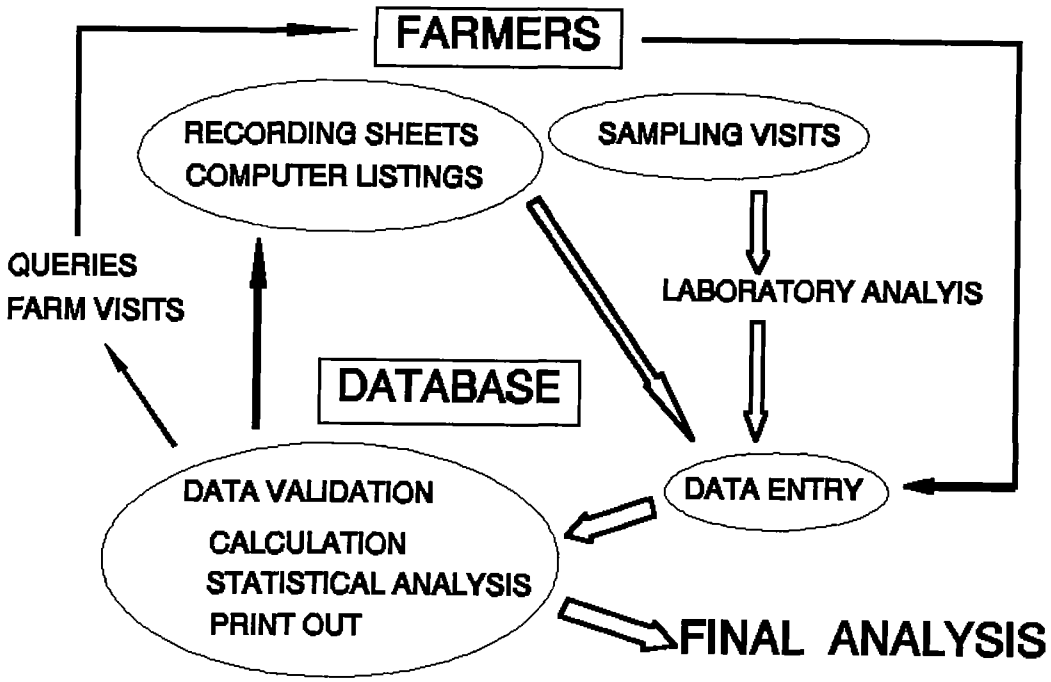
Data were entered into primary datasets as soon as possible after collection. The computer data was then checked for each dataset by printouts, basic calculations and basic statistical analysis. Databases were corrected where possible for erroneous and missing information by reference back to farmers. Computer listings of deer tag identifications were sent regularly to farmers to record information such as deer bodyweights, mob identification and slaughter reports. These listings were very useful both to avoid the misreading of tag identifications on the deer at recording, and to ease the computer data entry, thus minimising mistakes.

6. DATA ANALYSIS

Preliminary data analyses were being initiated at the time of

[4] Paradox, Borland International Inc., Scotts Valley, CA 95067-0001, USA

Figure 2 : Collection and validation of data before final calculations and statistical analysis



writing.

As sample units were farms, mobs or individual deer, data were analyzed at these levels of recording. Variables were grouped according to the sampling unit they described. Once validated, continuous variables were checked for normality of distribution and transformed if appropriate.

Preliminary analyses were carried out to identify associations between single descriptive variables and the outcome variables under investigation. The variables which showed sufficient evidence of an association in this analysis will be included in a multivariate analysis [multiple linear or logistic regression], so potentially important variables could be considered together (Kleinbaum et al., 1982). Path analyses will be used to identify interrelationships between explanatory variables and to quantify their direct and indirect effects on the outcome variables (Pedhazur, 1982; Saris and Stronkhorst, 1984).

7. DISCUSSION

Although a reasonable amount of information is available on deer health and production characteristics, some reference data were likely to be out of date or were missing. The deer industry needed updated data on production and productivity of New Zealand deer farms. The holistic approach is able to provide reference values for a range of production, reproduction and health characteristics (McDermott et al., 1991).

The study of some deer diseases in the laboratory is limited because they are, or may be, caused by a multiplicity of factors. In some instances, researchers encountered difficulties in experimentally reproducing diseases such as enzootic ataxia (McTaggart et al., 1981) or yersiniosis (Mackintosh et al., 1990). Using the multivariate approach, all factors can be studied in a way which allows their individual effects on the occurrence of health problems to be distinguished. In dairy cattle for instance, disease patterns could be related to factors such as climatic variations, housing and hygiene, farmer profiles and management practices (Faye, 1986). A comparable approach was also used to identify risk factors for lameness in dairy cattle in the Taranaki district (Chesterton et al., 1989).

This multivariate approach has been extensively applied for the study of diseases in dairy cattle, beef cattle, sheep, and goats. "Health and production profiling" extends this concept to the study of outcomes that are related to animal production performance, not just to disease occurence.

Commercial farms are used as the field of study, so it should be possible to identify risk factors that could be subsequently modified. After identification of risk factors, new management practices can be developed to control health and production even if the mechanisms of occurrence are not fully understood (Ganière et al., 1991; Perestrelo et al., 1988; Lepercq et al., 1989).

In this study, the contact with farmers and farm visits were primarily performed by one investigator, thus limiting the number of surveyed farms to fifteen. Cost was also a major limiting factor. In some studies in cattle, between about 80 and 130 farms have been surveyed, requiring many observers to visit farms within their district. These people were veterinarians, farm advisers, controllers, etc who already had good contact with the surveyed farms (Barnouin and Brochart, 1986). In our study, 15 farms provided significant numbers of mobs or animals to enable appropriate statistical analysis. As we considered animals, mobs and farms as different statistical units, mob risk factors and individual risk factors could be studied.

The selection of apparently "good" farms is unavoidable, although possibly the only common characteristic of all participating farmers at selection was a willingness to improve their management practices. They showed an interest in recording data and learning from them. To optimise the quality and quantity of observations that were made, the farm selection was primarily based on the farmer's willingness to participate and record a large amount of data in a form suitable for scientific investigations.

The protocol of data collection, along with the recording sheets has been modified during the study to facilitate farmers' recording and meet what could be achieved on farms. The sheets presented here were those used at the time of writing. In some instance, specific sheets (not presented here) were created for one or two farmers.

Farm visits were planned at times when deer could be handled easily in the yards with minimum interference with farm management. The first visit was scheduled in March because, on

most commercial red deer farms, calves are weaned and this was the earliest period when calves could be handled. March also marks the onset of the mating season and farmers would handle hinds at that time. Unfortunately, most adult stags could not be safely mustered and handled during this visit.
The second farm visit was scheduled in June as the onset of winter. Hinds were also tested for pregnancy about 30 to 40 days after sire stags were isolated from hinds, so nearly 100 % of pregnant hinds could be diagnosed (Revol and Wilson, 1990).
The third round of farm visits was carried out in September or early October, as the end of the winter season. Stags could also be handled before growth of velvet antler, and hinds before pregnancy became too advanced.
In November, hinds could not be handled as they were set stocked for calving. As only weaners and, only a limited number of stags could be handled at that time because of velvet growth, it was decided that the November farm visits would not be carried out during the second year of survey.

The amount of information that is being collected during this study is substantial and enables the study of multiple outcome variables. The intensity and accuracy of recording, however, varied between farms. Consequently, some calculations and statistical analysis were carried out using the data that were collected on less than 15 farms, providing the number of sample units was satisfactory.
For instance, the monitoring of perinatal mortality depended on individual calving management practices. In some farms no calf post-mortems could be performed, while in others, most dead calves were necropsied.

Conclusion - Application

This study represents the first application of herd health and production profiling to commercial deer production. The basis of this project is to consider the farms themselves as the unit of study. Through an observational approach, it enables the study of associations between outcomes [eg diseases and production levels] and multiples of individual or environmental factors that may influence those outcomes. This holistic approach enables us in the short term to :

- Quantify production and reproduction targets on which farmers and veterinarians can base their decision to implement health programs on farms (Wilson, 1987; Wilson and Walker, 1988)
- Develop new management strategies for deer farmers that enable cost-effective prevention of diseases, enhancement of performance and associate quality and productivity.
- Identify the most relevant fields for further research.
- Identify problems that were unknown at the start of the study.

The medium term prospect is to establish a computer model for deer production, as an aid to decision making on deer farms.

It must be remembered, however, that herd health and production profiling identifies associations between events and outcomes, but does not give a complete explanation of aetiology or pathogenesis, ie it does not prove conclusively that the associations are cause-effect relationships. Other epidemiological methods such as cohort study or intervention

study are required to test the hypotheses which arise out of the initial study. However, this technique is a very cost and time efficient method for identifying the likely cause and effect relationships which can then be targeted for research, thus avoiding potential wastage of resources.

Acknowledgements

We wish to thank farmers, veterinarians, and research technicians for their active collaboration during this health and production research project. Funding was provided by Game Industry Board, Deer Branch of the NZVA, Massey University, Pitman Moore, Rhône Mérieux, Cyanamid, Ag-Research, Allflex and Te Pari Products.

References

1. Barnouin J. and Brochart M. (1986) Enquete eco-pathologique continue: les objectifs et leur realisation, le choix et la typologie des elevages. Annales de Recherches Veterinaires, 17 (3):201-207

2. Beatson N.S. (1981) Disease survey in farmed deer in mid and South Canterbury. Proceedings of a Deer Seminar for Veterinarians, Deer Branch NZVA, edited by Wilson P.R.,39-42

3. Beatson N.S. (1985) Field observations of malignant catarrhal fever in red deer in New Zealand. Biology of deer production, edited by Fennessy, P. F.; Drew, K. R., Bulletin 22 :135-137

4. Chesterton R.N.; Pfeiffer D.U.; Morris R.S.; Tanner C.M. (1989) Environmental and behavioural factors affecting the prevalence of foot lameness in New Zealand dairy herds - a case- control study. New Zealand Veterinary Journal, 37 :135-142

5. Conway A. (1990) Fading elk syndrome: case study. Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., No 7 :148-151

6. Faye B. (1986) Facteurs de l'environnement et pathologie non-parasitaire de la vache laitiere. Donnees bibliographiques et syntheses des resultats de l'enquete eco-pathologique continue. Bulletin Technique du Centre de Recherche Zootechnique Veterinaire de Theix, Institut National de Recherche Agronomique, 64 :9-20

7. Faye B. and Barnouin J. (1987) Motivations et objectifs de l'enquete eco-pathologique Bretagne. Bulletin Technique du Centre de Recherche Zootechnique Veterinaire de Theix, Institut National de Recherche Agronomique, 69 :9-13

8. Fayet J.C.; Genest M.; Chacornac J.P.; Chonion N.; Faye B.; Barnouin J.; Paccard P.; Chassagne M.; Brochart M. (1986) Enquete eco-pathologique continue: 6. Influence de facteurs zootechniques et spatio-temporels sur quelques variables biochimiques chez les vaches laitieres. Annales de Recherches Veterinaires, 17 (3):215-223

9. Gladden N. (1981) National deer farm survey - 1980. Proceedings of a Deer Seminar for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., 34-35

10. Haigh J.C. and Hudson R.J. (1993) Farming wapiti and red deer. Mosby-Year Book Inc., St Louis, Missouri.

11. Kleinbaum D.G.: Kupper L.L.; Morgenstern H. (1982) Epidemiologic research - Principles and quantitative methods. Lifetime Learning Publications, New York.

12. Lawrence D.W. (1986) A survey of cervine dystocia. Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., No 3 :196-199

13. Lepercq M.; Martınat-Botte F.; Madec F.; Jacquemet- Foncelas C.; Gueraud J.M.; Barıteau F. (1989) The epıdemıologıcal tool ın the control of fertılıty dısorders ın a pıg farm. Bulletın des G.T.V., 5 :45-47

14. Luquet F.; Desaymard F. (1989) Utılısatıon du questıonnaıre d'opınıon pour l'etablıssement de donnees comportementales dans les enquetes d'ecopathologıe. Epıdemıologıe et sante anımale, 15 :33-42

15. Mackıntosh C.G. (1990) Dıseases of farmed deer ın New Zealand. Veterınary Annual., 30 :59-63

16. Mackıntosh C.G. (1992a) Observatıons on the relatıve susceptıbılıty to dısease of dıfferent specıes of deer farmed ın New Zealand. ın : The bıology of deer, edıted by Brown, R. D., Sprınger-Velag, New York, 113-119

17. Mackıntosh C.G. (1992b) Vaccınes for control, preventıon and eradıcatıon of dısease ın farmed deer. Proceedıngs of a Deer Course for Veterınarıans, Deer Branch NZVA, edıted by Wılson P.R., No 9 :92-96

18. Mackıntosh C.G.; Buddle B.; Grıffın J.F.T. (1990) Yersınıosıs vaccıne research. Proceedıngs of a Deer Course for Veterınarıans, Deer Branch NZVA, edıted by Wılson P.R., No 7 :200-203

19. Mackıntosh C.G.; Buddle B.M.; Grıffın J.F.T. (1992) Yersınıavax efficacy under fıeld condıtıons ın weaner red deer. Proceedıngs of a Deer Course for Veterınarıans, Deer Branch NZVA, edıted by Wılson P.R., No 9 :107-110

20. Mackıntosh C.G. and Henderson T.G. (1985) Survey of red deer stags for yersınıosıs at slaughter. Bıology of deer productıon, edıted by Fennessy, P. F.; Drew, K. R., No Bulletın 22 :159-162

21. Mackıntosh C.G. and Mason P.C. (1985) Anthelmıntıcs and lungworm ın red deer. Bıology of deer productıon, edıted by Fennessy, P. F.; Drew, K. R., No Bulletın 22 :131-133

22. Mackıntosh C.G.; Mason P.C.; Taylor M. (September 1990) A Pılot Study of the Efficacy of Topıcal Ivermectın Agaınst Lungworm in Young Red Deer (Cervus-Elaphus). New Zealand Veterınary Journal, 38 (3):112-113

23. Mason P.C. (1985) Bıology and control of the lungworm Dıctyocaulus vıvıparus ın farmed red deer ın New Zealand. Bıology of deer productıon, edıted by Fennessy, P. F.; Drew, K. R., No Bulletın 22 :119-121

24. Mcdermott J.J.; Alves D.M.; Anderson N.G.; Martın S.W. (1991) Measures of Herd Health and Productıvıty ın Ontarıo Cow-Calf Herds. Canadıan Veterınary Journal - Revue Veterınaıre Canadıenne, 32 (7):413-420

25. McTaggart H.S.; Lowe V.P.W.; Barden P.J.; Gellatly J.B.M. (1981) Copper status of red deer on the ısland of Rhum. Veterınary Record, 109 (8):155-157

26. Morrıs R.S. (1991) Informatıon systems for anımal health: objectıves and components. Rev. Scı. Tech. Off. Int. Epız. 10 :13-23

27. Pedhazur E.J. (1982) Multıple regressıon ın behavıoural research. Holt, Rınehart and Wınston, 2nd edıtıon, Fort Worth, Texas, USA.

28. Perestrelo R.; Perestrelo H.; Madec F. (1988) Prevention of reproductıve dısorders ın pıgs usıng the concept of rısk factors. Proceedıngs Internatıonal Pıg Veterınary Socıety 10th congress,:337

29. Revol B. and Wılson P.R. (1990) Rectal ultrasonographıc pregnancy dıagnosıs and foetal ageıng of red deer. Massey Unıversıty, Palmerston North, New Zealand.

30. Saris W.E. and Stronkhorst L.H. (1984) Causal modelling in nonexperimental research. Sociometric Research Fondation, Amsterdam, The Netherlands.

31. Selwyn P. and Hathaway S. (1990) A study of the prevalence and economic significance of diseases and defects of slaughtered farmed deer. New Zealand Veterinary Journal, 38 :94-97

32. Smythe A.B. (1986) Practice survey of cervine dystocia. Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., No 3 :192-195

33. Waldrup K. and Mackintosh C.G. (1992) Fading elk syndrome research. Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., No 9 :170-174

34. Wilson P.R. (1987) Deer Herd Health & Productivity Management : Data collection ans assessment. Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., No 4 :54- 80

35. Wilson P.R. and Collier A. (1981) Lungworm in deer: A survey of veterinary practices. Proceedings of a Deer Seminar for Veterinarians, Deer Branch NZVA, edited by Wilson P.R.,:78-93

36. Wilson P.R. and Walker I.H. (1988) Content for Deer Herd Health workshop. Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA, edited by Wilson P.R., No 5 :207-215

Appendix 1

PASTURE HEIGHT AND STOCK

FARM IDENTIFICATION PADDOCK or MOB ID .

MOB or PADDOCK ID	DATE START	INITIAL SWARD HEIGHT	G M C	SEED HEAD HEIGHT	S H D	DATE END	FINAL SWARD HEIGHT	DEER STOCK						OTHER STOCK	INFO
								WH	WS	YH	YS	AH	AS		

FOOD SUPPLEMENTATION

FARM IDENTIFICATION

MOB ID	DATE START	DATE END	FREQUENCY	NATURE	QUANTITY (kg)	WASTAGE (%)	LABOUR
				Cost			Labour units Time (hours) Cost assistant
				Cost			Labour units Time (hours) Cost assistant
				Cost			Labour units Time (hours) Cost assistant

MANAGEMENT RECORD

FARM IDENTIFICATION

MOB ID	DATE	EVENT	INFORMATION ABOUT DRUGS	LABOUR	VET FEE
			Drugs Dose Cost drugs	Labour units Time (hours) Cost assistant	
			Drugs . Dose Cost drugs	Labour units Time (hours) Cost assistant	
			Drugs Dose Cost drugs	Labour units Time (hours) Cost assistant	

HEALTH PROBLEMS

FARM IDENTIFICATION

DATE	PADDOCK ID	MOB ID	DEER IDENTIFICATION Age - Sex - Tag No	HEALTH PROBLEMS OBSERVATIONS

INDIVIDUAL DISEASE REPORT

FARM IDENTIFICATION :

MOB or SUB-GROUP identification :

DEER IDENTIFICATION (Circle) :

SEX : Male / Female AGE (year): Tag No :

DATE OF FIRST OBSERVATION

Please, fill the back of this sheet to list the observed symptoms.

DIAGNOSIS :

Veterinary Diagnosis : Yes / No On the farm / By phone

LABORATORY ANALYSIS : Yes / No (If Yes, keep laboratory reports)

TREATMENT OF THE DISEASED ANIMAL : Yes / No

PRESCRIPTION : Drugs :

Dose :
Duration :

OUTCOME : Chronic illness / Recovery / Death

POST-MORTEM EXAMINATION : Yes / No
(If yes, fill out the post-mortem report)

SUPPLEMENTARY INFORMATION :

Deer removed from the herd : Yes / No Date
Deer returned in the herd Yes / No Date :

Preventive treatment of the other deer of the same herd : Yes / No
If Yes, give protocol

COST OF INTERVENTION : Veterinary fees :
Drug costs :

DISEASED DEER - SYMPTOM IDENTIFICATION

HISTORY Explain briefly how the disease occured· weather condition, diet, contact with other deer, manipulation,. .

Please circle the observed symptoms in the following list :

SIGNS OBSERVED :

Deer on its own	Fence pacing
Loss of condition	Loss of appetite
Lean deer	Depression
Hair losses on the head	Dull coat
Hair losses on the back	
	Light colored coat
Skin lesion	Abscess (exept on foot)
Lameness	Unsteadyness back legs
Loss of balance	Recumbency
Tremor of the head	Jaw champing
Tremor of the back	Deer prone to excitation
Deer hit obstacles	Aimless walking

Body temperature (if possible measurement) [C]

HEAD .

Swelling of the face	Head shaking
Rubbing lesion	Scabby lesion
	Pus under the scab
Colour of the white of the eye :	Nasal discharge
Pink White	Crust around muzzle
Red Yellow	Ocular discharge
	Salivation
Ticks	

THORAX - ABDOMEN :

Coughing	Panting
Abdominal pain at palpation	Hunched back
Swollen belly	
Physical aspect of faeces :	Colour of the faeces
Normal Pasty liquid	Red Very red (evenly)
	Black Normal
Smelly diarrheoa	Faeces on the hocks

LEGS :

Injury	Foot abscess
Fracture	Swelling joint

ALL OTHER OBSERVATIONS (or change of symptoms):

Appendix 3

POST-MORTEM EXAMINATION

Farmer identification :

Date of the post-mortem examination :

To answer, please write the proper code in the box or cross the wrong answer and circle the right answer !!

Deer identification : **Tag ID :**

Sex 1 = Male
2 = Female ..... [ ]

Class of stock (Circle) Weaner - Yearling - Adult

Mob identification .. .. [ ]

Paddock identification where the deer died ..... [ ]

HISTORY : 1 = Deer found dead
2 = Following a disease < 48 hours long
3 = Following a disease > 48 hours long
4 = Misadventure (You have seen the event) .... [ ]

OBSERVATIONS :

The deer has been found : 1 = along the fence
2 = in bushes, trees,...
3 = in the water
4 = other : .... [ ]

Damages to the vegetation around the deer
0 = no
1 = yes : specify :
..... . [ ]

EXAMINATION OF THE DEER

Lesion on the head : 1 = scabby lesions
2 = rubbing lesions ..... [ ]

Colour of the white of the eye : 1 = white
2 = yellow
3 = pink/red ..... [ ]

Swollen belly (bloat) : 1 = yes, 0 = no ..... [ ]

Area on the back without hair : 0 = no lesion
1 = yes, pink skin
2 = yes, dark skin .... [ ]

Dull coat : 1 = yes, 0 = no .... [ ]

Bodycondition score (see scoring chart) .... [ ]

Discharge from : 1 = nostrils 4 = eyes
2 = mouth 5 = anus
3 = vulva .... [ ]

Appearance of the discharge : 1 = liquid 3 = frothy
2 = thick 4 = crusty
5 = bloody ..... [ ]

Presence of faeces around the anus or on the hocks
1 = yes, 0 = no .. .. [ ]

External parasites : 0 = no
1 = ticks (mainly in the ears)
2 = ... [ ]

Signs of trauma : 0 = no 2 = fracture
1 = bruise 3 = injury ..... [ ]

Sign of infection (pus, absces,..) : 0 = no 1 = yes ... [ ]

WHEN OPENING THE VARIOUS CAVITIES

Fluid in the cavities : 0 = no
1 = liquid over 1 ml
2 = blood
3 = pus
4 = thready material
found in the Thorax (chest)..... ..... [ ]
Abdomen (belly)..... . [ ]

LUNGS Are lungs .. 1 = inflated (spongy) ?
2 = collapsed (firm/hard) ? ..... [ ]

The lungs stick on the ribs : 1 = yes
0 = no .... [ ]

Colour : right lung :
1 = pink 2 = evenly red
3 = unevenly red (patches) .. ... [ ]
left lung :
1 = pink 2 = evenly red
3 = unevenly red (patches) ..... [ ]

Abscess (creamy patches) : 1 = yes
0 = no .... [ ]

TRACHEA Froth in the trachea (windpipe) : 1 = yes
0 = no . .... [ ]

Lungworm in the trachea : 1 = no
2 = a few
3 = full ... . [ ]

KIDNEYS Give the approximate size :

Consistency : 1 = firm
2 = pasty
3 = almost liquid .... [ ]

When cut in two parts : 0 = see nothing
1 = red spots
2 = pus
3. Other : . ... [ ]

BLADDER Colour of urine in the bladder : 0 = Red
1 = Yellow
2 = clear ... [ ]

Red spots on the inner surface of the bladder
1 = yes, 0 = no .... [ ]

LIVER Consistency : 1 = firm
2 = soft (easly crushed between the fingers).. .... [ ]

Colour & aspect : 1 = white spots
2 = small red spots
3 = very red
4 = pale, yellowish
5 = abscess .. .. [ ]

GUTS Answer the next group of questions after identifying
(Intestines) the abomasum (4th stomach) A [ ]
the small intestine ..... B [ ]
the large intestine ..... C [ ]

****

Outer surface of the guts : 1 = pink
2 = red spots
3 = very red .... A [ ]
B [ ]
C [ ]

Contents : 1 = no contents
2 = pasty contents
3 = liquid contents ... . A [ ]
B [ ]
C [ ]

Bloody contents : 0 = no
1 = yes, even/uniform
2 = yes, flecked .. .. A [ ]
B [ ]
C [ ]

Parasites : 0 = no
(Worms) 1 = a few parasites
2 = a lot (guts almost full) ... A [ ]
B [ ]
C [ ]

Inner surface of the guts : 1 = pink
2 = red spots
3 = very red .... A [ ]
B [ ]
C [ ]

Do the guts have any of the following :
1 = thickened wall
2 = erosion of the inner surface
3 = perforation .... A [ ]
B [ ]
C [ ]

OTHER OBSERVATIONS :

CONCLUSION (Your suspected diagnosis) :

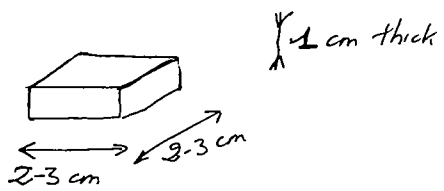
POST-MORTEM SAMPLES · Take a piece from the following organ.
LUNG, LIVER, KIDNEY, BRAIN, SMALL INTESTINES

FOLLOWING A REQUEST FROM THE PATHOLOGY DEPARTMENT AT MASSEY THIS IS THE

GUIDE FOR ORGAN SAMPLING

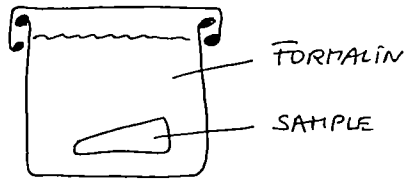
TO ENABLE FORMALIN TO FIX THE ORGAN TISSUES SAMPLES SHOULD BE A BIG AS THAT

REAL SIZE

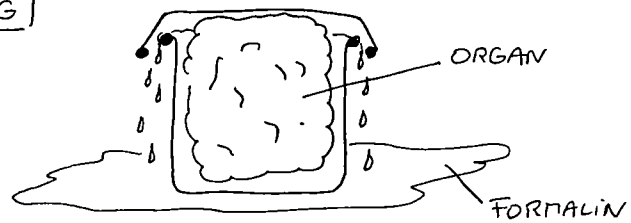


WHEN SAMPLES ARE IN THE FORMALIN, THEY SHOULD LOOK LIKE THIS

GOOD



WRONG



SLAUGHTER REPORT

MAF VETERINARIAN

DEER SLAUGHTER PREMISES :

FARM NAME · DISTRICT : NUMBER

DATE OF SLAUGHTER :

DEER IDENTIFICATION

Number of	Age < 1 year	Age 1-2 years	Age > 2 years
Male			
Female			

ERVATIONS :

Deer Ident.	Gross pathology - Defect	Outcome Carcass		
		OK	Retained	Rejected

CALVING PROBLEM REPORT

FARMER IDENTIFICATION :

CALVING MOB HIND ID : DATE .

CALF Male / Female Weight (kg) ·

DYSTOCIA · Alive calf / Dead calf / Mumified calf
Front legs first / Back legs first / Head back
Describe calf posture :

Veterinary Diagnosis Yes / No At the phone / On the farm

INTERVENTION : Veterinary intervention / Farmer intervention
Drugs used for restrain
for other treatment

OUTCOME Hind . Survived and healthy / Survived but diseased / Dead

Calf . Survived and mothered / Survived but hand reared / Died

Cost of intervention Veterinarian
Drugs :

CALF MORTALITY REPORT

FARM IDENTIFICATION

DATE OF OBSERVATION								
CALVING MOB ID								
PADDOCK ID								
HIND ID								
SUSPECTED PROBLEM : - DYSTOCIA DYS - MISMOTHERED MIS - VICTIMISED VIC - FOUND DEAD DEA Specify if other !'								
SEX OF THE CALF (M/F)								
APPROXIMATE AGE : (DAYS)								
CALF BODYWEIGHT (KG). (IF FRESH CARCASS)								
PLEASE, ANSWER BY "YES" OR "NO" THE FOLLOWING QUESTIONS ?								
HAS THE CALF BEEN FOUND THROUGH THE FENCE ?								
IS THERE ANY SIGN OF TRAUMA ON THE CALF ?								
Specify your observation								
ARE THE HOOVES WORN ?								
ARE LUNGS SPONGY ?								
IS THERE ANY MILK IN THE STOMACH ?								
IS THERE ANY SIGNS OF DIARRHEA (liquid faeces in the gut) ?								
Specify any other observations .								