An estimate of the economic effects of cattle tick (*Boophilus microplus*) infestation on Queensland dairy farms

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Objective To establish the cost to the Queensland dairy industry of cattle tick infestation and its control, excluding the costs incurred from control measures directed specifically at tick fever and morbidity and mortality arising from tick fever.

Study design Economic models are described that have been based on empirical data relating to liveweight and milk yield loss, and on a survey of control practices and tick infestation. The first two models were designed to estimate costs of control and losses resulting from tick infestation on a single dairy farm. The third model developed estimates of the cost of tick infestation for each of four regions within the tick-infested area of Queensland.

Results The overall cost to the Queensland dairy industry of the cattle tick (excluding the costs associated specifically with tick fever) and based on 1998 management practices, was $4,096,000 per annum. About 49% of this cost was related to the costs of control and 51% to losses in production.

Conclusion Cattle tick infestation represents a significant impost on dairy producers in Queensland, and although the actual cost will change as deregulation results in economic changes in the industry, infestations of ticks will continue to be expensive to control.

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Key words: Cattle tick, *Boophilus*, economic effect.

The first estimate of the cost of the cattle tick to Queensland was provided in 1959 by the Bureau of Agricultural Economics.[1] The estimated cost of lost production, mortality, hide damage and control was £9.5 million ($88.5 million in 1999). A similar finding was provided by the Cattle Tick Control Commission[2] in 1973, who assessed the production loss and control costs of tick infestation in beef and dairy cattle to be $15.5 million ($92.5 million in 1999). Recently, the cost of the cattle tick to the infested area of Queensland was estimated to be $132 million ($141 million in 1999)[3]. However, of these studies, only that by the Bureau of Agricultural Economics[1] provided separate estimates for the beef and dairy industries. Costs to the latter were estimated to be £1.555 million ($14.45 million in 1999). This estimate was based solely on estimates made by producers of lost production attributable to the cattle tick.

The aim of this study was to establish a cost of the cattle tick to the Queensland dairy industry by utilising recent empirical trials and survey data relating to tick infestations and control measures. As opposed to other approaches of estimating the economic effect of the cattle tick, it attributes costs to the full spectrum of current practices to control cattle ticks.

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In the existing literature on the impact of the cattle tick to the beef and dairy industries in Queensland, estimates of costs have been based on survey data and liveweight implications from experimental studies. Whereas the Bureau of Agricultural Economics[1] developed their estimates solely from data collected from surveys of producers, McLeod[3] based his analysis on a per-head reduction in productivity using the work of Sing et al in 1983[4] and on estimates of tick fever mortality from Mahoney and Ross in 1972.[5]

Both methods have certain advantages and disadvantages. Measures of proportional yield reduction calculated on a per-head or per-tick basis and derived from field trials have the advantage of a justification for the weight/milk loss effect. However, the trials that have been conducted have spatial and climatic significance, meaning that the numbers of ticks at the trial site may not be representative of other areas of Queensland.

Estimates of production loss based on the opinions of producers can be unreliable because a producer may find it difficult to estimate weight-loss effects attributed to cattle tick and not related to other factors, such as infestations of buffalo fly or drought. On the other hand, surveys of the producers can provide a detailed assessment of the assortment of control measures and the extent of their use.

In the model developed below, economic measures were established from data obtained from surveys and empirical research, to build on the relative strengths of each approach.

Materials and methods

Data sources

Data from a survey of cattle tick control on 199 dairy farms in Queensland, undertaken between October 1996 and June 1997, were used to determine the control practices of dairy farmers.[6] The purpose of the survey was to identify the farm factors likely to limit the adoption of best practices for tick control, those that result in heavier tick infestation or lead to the development of resistant strains of cattle tick. The sample was a proportional, random selection of dairy farms from each of four regions defined by the Queensland Dairyfarmers Organisation (QDO). There were 38, 28, 37 and 96 farms each from Far-North Queensland (FNQ), Central Queensland (CQ), Wide Bay-Burnett (WBB) and South-East Queensland (SEQ) respectively,, representing 17% of the 1203 dairy farms in the tick infested region of Queensland.

The following data were available from the survey and used in the model: a subjective estimate of the maximum number of engorging female ticks per cow, acaricides used to treat the milking and dry herds, method of acaricide application, number of acaricide applications per year, the volume of acaricide dip or spray fluid used to treat cattle, and farm data such as herd size and milk yield. Relationships between tick infestation and milk yield were derived from previous work at Mutdapilly Research Station.[7] Tick populations were estimated from typical population profiles determined from previous research at Amberley.[8]

Models

Three related models were constructed and built into Microsoft® Excel spreadsheets. The first model (Figure 1) was designed to estimate the costs of controlling infestations of cattle tick on a single dairy farm. The second model (Figure 2) estimates the losses in milk yield and liveweight gain on a single farm. Together, these models enable users to interactively evaluate the annual cost to individual producers based on the selection of variables such as number of cows and type and method of acaricide application. Estimates of total loss are then constructed, based on the specific combinations of variable values.

The third model (Figure 3), combined the first two models with the survey data to establish typical farms for each region and for each method of acaricide application. The total cost to control cattle ticks in a region was estimated from the number of farms using each control method, multiplied by the costs associated with each method of control. The model assumptions and parameters are discussed below.

Assumptions

The model is based on average regional values for farm variables for each of the four regions determined from the survey[6] and data from the Queensland Dairy Farm Accounting Scheme (QDAS).[9] All of the farms within each region are therefore assumed to have the same values for the number of milking cows and dry cows. Farms differ in the number of ticks seen and the methods of control used. The specifics of the assumptions used in the model are provided below and listed in Tables 1 and 2.

Production losses — Production losses are calculated on a per-engorged female tick basis. Estimates of per-tick losses were obtained from research that detailed the effect of each engorging tick as 8.9 (± 2.1) mL milk and 1 (± 0.38) g liveweight gain.[7] This is the equivalent of 0.081 MJ metabolisable energy lost per tick.

Number of ticks per head — The results of the model are dependent on estimates of tick populations for a typical farm using each of the control methods, within each of the regions. The most detailed empirical modelling on tick populations was conducted by Bourne et al in 1988.[8] They monitored and modeled untreated tick populations over a typical season in SEQ. These populations will vary due to the differences in environmental conditions for the cattle tick, with dairy farms in North Queensland having the most ticks. Treatments will reduce tick populations and this effect will vary depending on the timing of, and interval between treatments and the method of control used. In general terms, the number of ticks counted on cattle will be higher in March and April than in October and November. In the absence of more precise data measuring the effect of treatment on tick populations, it is proposed that the model of Bourne et al[8] provides the most meaningful approximation of the size of tick populations. Estimates of the total number of ticks engorging on single animals during a year, for each region and control method were calculated by proportionally converting the cumulative estimates provided by Bourne et al.[8] with the following equation:

$$Nf = Ns \times \frac{Pf}{Ps} \qquad (1)$$

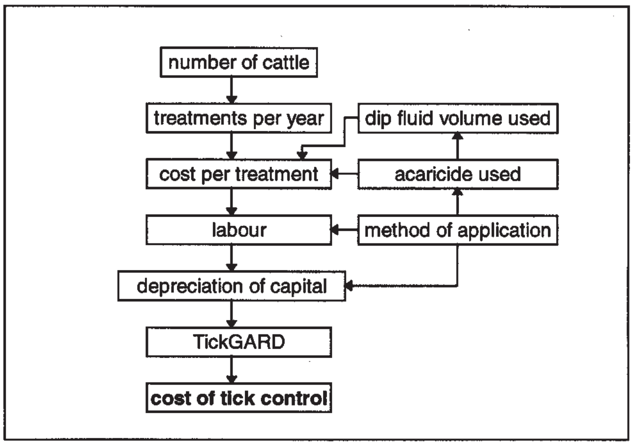

Figure 1. Model used to estimate the cost of controlling cattle tick infestation on dairy farms.

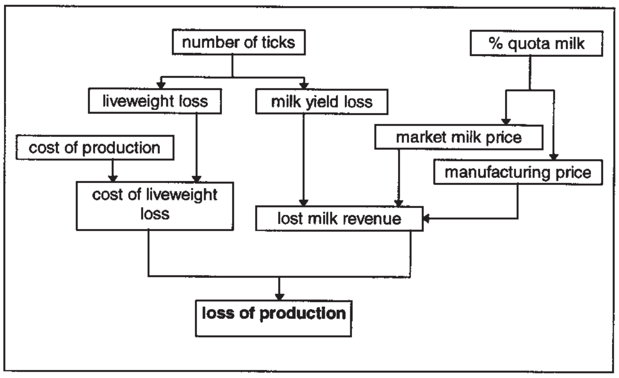

Figure 2. Model used to estimate the costs attributable to cattle tick infestation on dairy farms.

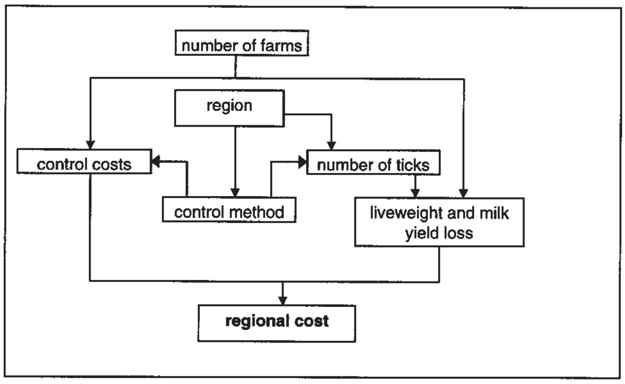

Figure 3. Model used to estimate the costs attributable to cattle tick infestation for each region.

Where *Nf* is the estimated mean number of ticks engorging on a typical animal over one year, *Ns* is the estimated mean number of ticks engorging on a typical animal over one year from Bourne et al[8] *Pf* is the farmer's estimate of the peak number of engorging ticks seen on individual animals, and *Ps* is the peak number of engorging ticks observed by Bourne et al[8] By this method, the shape of a tick population curve is combined with the farmer's observation of peak numbers, to estimate a cumulative population of ticks. This is required to estimate the losses due to infestation on the basis of the number of ticks per cow per annum.

Methods of control — Previous estimates of the cost of controlling cattle ticks have assumed that all farmers used the same method of acaricide application.[3] The survey[6] highlighted that different methods of acaricide application of various efficacy are used by dairy farmers. The four main methods of acaricide application are plunge dipping, spraying in races, pour-on treatments and hand spraying. Plunge dips and spraying in races are combined in the analyses because of their similar pricing structure and efficacy. The proportion of farms on which each method of application was used was incorporated into the third model. Each method has a different cost and different efficacy on tick populations. The efficacy for a typical farm was indicated by the estimates of peak tick numbers by farmers using that method of control. The costs of application were based on the chemical brands and the mean number of treatments indicated by survey respondents. For example, the proportion of producers who indicated the use of pour-on applications were then divided again into those using Cydectin (Fort Dodge) or Bayticol (Bayer). Acaricide costs were determined in March 1998 and are based on average application rates recommended by the manufacturers. Pour-on product costs are based on an average dose for a 550 kg adult cow and a 250 kg heifer.

Plunge dipping and spraying in races are assumed to have the greatest effect on tick populations. Chemical and labour costs per cow are also low, but these methods have the greatest fixed costs with installation costs, including labour, of $15,000 and $10,000 respectively and annual costs calculated over a period of 15 years and an annual discount rate of 6.5%.

Pour-ons are assumed to be equally as effective as plunge dipping and spray races, have no fixed costs but have high chemical and labour costs per application. There are high variable costs per treatment, however treatments are less frequent than those given by hand sprays.

The fixed costs of the hand spray method have been set at zero, because most farmers use very low cost equipment or equipment primarily used for other activities. To estimate costs of control for each region we used three types of acaricide application: hand spray, pour-on, and plunge dip or spray race.

Labour has been included at $15.60 per hour. Estimates of the time to treat animals using each of the three systems have been made on the basis of local experience. There is wide variation among farms, so in the model to estimate costs on an individual farm, labour time can be entered as a variable. In the regional components of the model the time required to muster and treat a herd of about 100 milking cows is 3 hours for users of hand sprays and 1.5 hours for users of spray races, plunge dips and pour-ons.

The use of TickGARD*PLUS* a recently introduced method of tick control was restricted to 14% of farmers in the survey. The use of TickGARD*PLUS* equated to about $0.42 per cow/year, which was held constant across all regions and for the main classes of chemical treatment mentioned above.

Tick fever-related costs — The costs relating to tick fever control were not included in the analysis.

Milk prices — The models enable the price of milk to be estimated using either market milk or manufacturing milk prices. In the summary provided below, a weighted-average milk price (manufacturing and market milk) is used.

Input costs per kg liveweight gain (LWG) — In McLeod (1995)[3] the major effect of tick infestation on beef cattle is reduced liveweight which is equated to the loss in meat yield. In the case of dairy production, loss in weight has to be regained and equates to additional input costs. These are based on a ration of barley and Callide Rhodes grass of 65 to 70% digestibility. The proportion is taken in relation to the cost; 60% of the total feed cost is derived from barley supplementation and 40% from pasture. The cost of production for Callide Rhodes grass is $0.08/kg DM. The price of barley is $0.23 per kg DM.

Table 1. Estimates of the cost of treatment with various acaricides used to control infestations of cattle ticks.

Item	Application	Cost per treatment ($)
Bayticol[a]	Pour-On	3.15
Cydectin[b]	Pour-On	6.75
Amitraz formulations	Dip	0.24
	Spray	0.82
Barricade 'S'[c]/Blockade-S[d]	Dip	0.61
	Spray	1.10
Tixafly[e]	Dip	0.62
	Spray	1.12
TickGARD[Plus] vaccine[f]	Injection	1.50

[a] Bayer Australia - flumethrin
[b]Fort Dodge Australia - moxidectin
[c]Fort Dodge Australia - cypermethrin and chlorfenvinphos
[d]Coopers Animal Health - cypermethrin andchlorfenvinphos
[e]Coopers Animal Health - deltamethrin and ethion
[f]Intervet Australia

Table 2. Commodity prices and infrastructure costs used for calculations of the cost of control and losses due to infestations of cattle ticks.

Item		Cost ($)
Labour per hour		15.60
Milk (per L)	Manufacturing price	0.26
	Market price	0.58
Barley grain (per kg DM)		0.23
Production of Callide Rhodes grass (per kg DM)		0.08
Installation of a plunge dip		15,000
Installation of a spray race		10,000
Depreciation on installations/year		6.5%

Four relevant issues that have not been included in the model but are worthy of mention are:

Dry cows and heifers — The effects of ticks on dry cows and heifers have not been estimated. Only the costs associated with treatment have been considered. There is insufficient information to estimate the potential production losses in these classes of stock as a result of tick infestation. However, it is highly likely that reduced liveweight gain would result in reduced milk yield in the following lactation.

Fertility — The effects of weight gain and milk production on fertility have not been considered. Although it is highly likely that the effect of ticks on weight gain will reduce fertility, there are no estimates relevant to Australian conditions.

Buffalo fly — It has been found that 55% of producers indicated a significant problem with buffalo fly.[6] Cattle ticks and buffalo fly have overlapping distributions, are significant pests that require management by producers, and both have an effect on production from cattle. In this analysis losses in production are estimated on the basis of being caused by ticks alone. Although several chemical measures are able to control both pests it is assumed that both pests are controlled independently because most measures are directed to one or other pest.[6]

Government expenditure — Queensland Government policy towards the cattle tick is directed to the maintenance of the 'tick line', which broadly divides Queensland into tick-infested and tick-free regions and specifies restrictions on stock movements. The cost of this policy to taxpayers is approximately $3 million per annum although this cost must be offset against the unquantified benefits received by dairy and beef producers in the tick-free region of Queensland. Costs relating to government expenditure on tick management are not included in the model.

Table 3. Summary of important survey data that were used and estimates of the annual direct costs of cattle tick infestation to South-east Queensland dairy producers, according to method of acaricide application, excluding losses related to tick fever and its control and the costs of movement and prescribed treatments. Where costs are expressed per cow, this means per milking cow.

Survey results and model outputs	Method of acaricide application		
	Handspray	Pour-on	Plunge dip or spray race
Survey data			
No. of farms	215	91	130
Mean no. of milking cows	93	93	93
Mean no. of dry cows + heifers	79	79	79
Estimated mean peak no. ticks/cow	68	46	46
Model outputs			
Variable treatment costs ($/cow)	10.19	23.70	8.21
Labour costs per cow ($/cow)	5.28	1.69	2.64
Fixed treatment costs ($/cow)	—	—	6.78
Lost milk yield ($/cow)	15.57	10.49	10.49
Lost liveweight gain ($/cow)	8.57	5.77	5.77
Total costs per cow ($)	39.61	41.64	33.89
Total costs per farm ($)	3,688	3,866	3,150
Total costs for all users of each method of application ($)	792,833	351,786	409,462
South-east Queensland region total annual loss			$1,202,295

Table 4. Summary of important survey data that were used and estimates of the annual direct costs of cattle tick infestation to Wide Bay-Burnett dairy producers, according to method of acaricide application, excluding losses related to tick fever and its control and the costs of movement and prescribed treatments. Where costs are expressed per cow, this means per milking cow.

Survey results and model outputs	Method of acaricide application		
	Handspray	Pour-on	Plunge dip or spray race
Survey data			
No. of farms	169	111	131
Mean no. of milking cows	93	93	93
Mean no. of dry cows + heifers	71	71	71
Estimated mean peak no. ticks/cow	28	25	25
Model outputs			
Variable treatment costs ($/cow)	8.52	34.99	8.57
Labour costs per cow ($/cow)	5.82	2.15	2.91
Fixed treatment costs ($/cow)	—	—	7.20
Lost milk yield ($/cow)	6.36	5.64	5.64
Lost liveweight gain ($/cow)	3.34	2.96	2.96
Total costs per cow ($)	24.04	45.74	27.28
Total costs per farm ($)	2,236	4,257	2,534
Total costs for all users of each method of application ($)	377,975	472,502	331,985
Wide Bay-Burnett region total annual loss			$1,182,461

Results

Tables 3 to 6 provide summaries of results for each of the four regions. The overall cost to the Queensland dairy industry of the cattle tick (excluding the costs of control, treatment, morbidity and mortality from tick fever) based on 1998 management practices is $4,096,000 per annum. Of this cost 49% is related to control costs and 51% to losses in production.

The majority of farmers used a hand spray, most likely charged with one of the amitraz products and took 3 hours to treat the whole herd, including mustering. Most users of hand sprays were likely to use 50% of the recommended volume of dipping fluid, six times a year. Approximately 50% of their milk was sold at the market milk price and 60% of the total feed related costs were purchased feed. The average farmer who used a hand spray in SEQ was milking 93 cows, with 79 dry cows and heifers (Table 3). The peak number of engorging ticks per side per day was 68. Variable treatment costs per annum were estimated to be $10.19 per milking cow, plus $5.28 labour. Likely milk yield loss was valued at $15.57 per cow per year and the loss in liveweight gain was valued at $8.57 per cow per year. The total tick related cost on this typical farm in SEQ was $39.61 per milking cow or $3,688.00 for the herd per year. For a farm producing 5,000 L milk per cow, this represents a cost per litre of milk of 0.8 cents. Although not evident from Table 3, the model shows that if the same producer were to use six applications of moxidectin for routine tick control and labour was reduced to 2 hours per herd treatment, annual losses due to infestation and control of ticks would be $9,974.00. This represents an impost of 2 cents per litre of milk produced.

Tick related costs to each region

Tables 3, 4, 5, and 6 list the fixed and variable costs for SEQ, WBB, CQ and FNQ regions respectively. The total losses incurred were estimated to be $1,202,295, $1,192,461, $766,356 and $945,339 for SEQ, WBB, CQ and FNQ respectively. Whereas the estimated loss per farm is likely to be higher in CQ and FNQ, the number of farms in those regions is less than in other regions, leading to lower estimates of the total loss.

Table 5. Summary of important survey data that were used and estimates of the annual direct costs of cattle tick infestation to Central Queensland dairy producers, according to method of acaricide application, excluding losses related to tick fever and its control and the costs of movement and prescribed treatments. Where costs are expressed per cow, this means per milking cow.

Survey results and model outputs	Method of acaricide application		
	Handspray	Pour-on	Plunge dip or spray race
Survey data			
No. of farms	74	28	542
Mean no. of milking	85	85	85
Mean no. of dry cows + heifers	73	73	73
Estimated mean peak no. ticks/cow	91	91	91
Model outputs			
Variable treatment costs ($/cow)	8.58	73.22	5.54
Labour costs per cow ($/cow)	4.92	2.39	2.46
Fixed treatment costs ($/cow)	—	—	8.37
Lost milk yield ($/cow)	20.73	20.73	20.73
Lost liveweight gain ($/cow)	11.47	11.47	11.47
Total costs per cow ($)	45.70	107.81	48.57
Total costs per farm ($)	3,867	9,117	4,165
Total costs for all users of each method of application ($)	286,163	255,285	224,908
Central Queensland region total annual loss			$766,356

Table 6. Summary of important survey data that were used and estimates of the annual direct costs of cattle tick infestation to Far-North Queensland dairy producers, according to method of acaricide application, excluding losses related to tick fever and its control and the costs of movement and prescribed treatments. Where costs are expressed per cow, this means per milking cow.

Survey results and model outputs	Method of acaricide application		
	Handspray	Pour-on	Plunge dip or spray race
Survey data			
No. of farms	119	21	60
Mean no. of milking	107	107	107
Mean no. of dry cows + heifers	99	99	99
Estimated mean peak no. ticks/cow	70	59	59
Model outputs			
Variable treatment costs ($/cow)	12.29	39.53	10.01
Labour costs per cow ($/cow)	5.72	2.21	2.86
Fixed treatment costs ($/cow)	-	-	5.62
Lost milk yield ($/cow)	15.97	13.47	13.47
Lost liveweight gain ($/cow)	9.15	7.71	7.71
Total costs per cow ($)	43.12	62.92	39.66
Total costs per farm ($)	4,626	6,750	4,219
Total costs for all users of each method of application ($)	550,451	141,741	253,147
Far-North Queensland region total annual loss			$945,339

Discussion

The above analysis indicates that infestations of cattle tick represent a major cost disadvantage of over $4 million per annum to producers in the tick-infested region in Queensland. With the Queensland milk industry in the process of deregulation, the higher production costs of over $30 per milking cow per annum to dairy producers in the tick-infested region markedly reduces their competitiveness against producers in tick-free areas. This disadvantage is heightened if the economic effect of the second major tropical pest, buffalo fly, is considered.

It has been previously stated[10] that the use of costing estimates such as the one conducted in this paper have limited policy relevance due to their inability to provide information relating to alternative policy options. Despite this criticism, costing the effect of a pest represents an important first step in animal health public policy by providing an indication of the extent of the pest problem. Moreover, the interactive design of this model enables certain policy issues to be examined in the future.

Some limitations in the useful bounds of the model are evident. The models do not allow for estimates of the effect of tick infestations that are heavier than those seen in the presence of current control measures. The effect of relaxing control measures cannot be estimated because as tick infestations become very heavy, the probability of mortality caused by tick infestation increases. In the study of tick ecology that was used as a basis for our model,[8] the *Bos taurus* cattle that were untreated suffered severe tick infestations and many died.

We estimated that over all of the four regions in this study, the costs associated with control of ticks and the losses attributable to infestation are approximately equal. The costs arising from control of tick infestations are directly derived from survey data and we believe that they can be interpreted with a high level of confidence. Losses in milk production and liveweight gain that are attributable to infestation have been estimated using a combination of survey data and experimental results, so there would be more error in this component. It is likely that the greatest sources of error are in the farmers' estimates of the peak number of ticks seen and in the assumption that there is a constant relationship between peak tick number and the total annual infestation. Given the labour intensive nature of the work, it is unlikely that the controlled observations required to validate the assumption will ever be undertaken.

Some inference can be made on the consequences of acaricide resistance to the Queensland dairy industry. Any increase in the prevalence of resistance to the cheaper synthetic pyrethroid and amitraz acaricides will lead to a greater number of producers using more expensive pour-on products such as moxidectin, with a higher frequency of applications in the short to medium term. This has been seen in Central Queensland where resistance is most common, and where a small proportion of producers are applying up to nine pour-on treatments, estimated to cost more than $73 per cow. If such management practices were adopted widely, the sustainability of the dairy industry in the tick-infested area would be questionable.

It is certain that the size of these estimates will change over time. Factors that are likely to decrease the total loss due to tick infestation include a reduction in the number of dairy farms in the tick-infested area and a reduction in the price of milk paid to farmers. These trends are expected to occur with deregulation of the dairy industry. Balancing these factors, however, is the increase in prevalence of resistance to the cheaper acaricides with the consequent increase in usage of more expensive macrocyclic lactone products. Cattle tick infestation represents a significant impost on dairy producers in Queensland, and although the actual cost will vary over time, tick infestation will continue to be expensive to control.

Acknowledgments

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BOOK REVIEW

***Viral Diseases of Cattle**. 2nd edn. Kahrs RF, Iowa State University Press, Ames, 2001, 324 pages. Price US $54.95. ISBN 0 8138 2591 1.*

This book provides both the scientific principles of virology and the practical day-to-day application of theory in dealing with viral diseases of cattle. The author's objective was to make this reference book applicable to practitioners, students, teachers, diagnosticians, animal scientists, regulatory officials, trade negotiators and scientists.

The introductory chapter on viruses and virology briefly discusses virus structure, replication and classification. The important issues of viral infections including clinical presentation, endemic and exotic disease, inapparent infection, emerging disease, clinical diagnosis and multifactorial disease are presented in chapter two. This material flows logically into chapter three; the epidemiology of bovine viral infections, which presents the (very) basic epidemiological principles of infectious disease.

Diagnostic and investigative techniques are presented in chapter four. These techniques include physical examination, postmortem examination, techniques for examining herd outbreaks, and laboratory tests. The role of antibodies in the diagnosis of viral disease is discussed with emphasis upon the effect of passive immunity, role of single and paired serum samples and the individual laboratory tests, such as ELISA. Vaccines and vaccination are discussed in chapter five. The effectiveness, advantages and disadvantages of both modified live and inactivated vaccines are presented along with the basic principles of a vaccination program. The important clinical manifestations of viral disease are presented in chapter six. These include abortion, diarrhoea, bovine respiratory disease, mucosal diseases, vesicular diseases, and neurological, ocular and other system disorders. Disinfection is presented in chapter seven. The impact of bovine viral diseases on international trade is presented in chapter eight.

Individual chapters are provided for adenoviruses, bluetongue, bovine immunodeficiency-like virus, bovine leukemia virus, bovine viral diarrhoea, coronavirus, enteroviruses, papillomaviruses, herpes mamillitis, infectious bovine rhinotracheitis, malignant catarrhal fever, papular stomatitis, parainfluenza type-3, parvovirus, poxvirus, pseudorabies, rabies, respiratory syncytial virus, rhinoviruses, rotavirus, vesicular stomatitis, akabane and bunyavirus, ephemeral fever, foot-and-mouth disease, lumpy skin disease, rift valley fever, rinderpest and bovine spongiform encephalopathy. Each chapter presents aetiology, clinical signs and lesions, effects on the developing foetus, necropsy findings, diagnosis, epidemiology, prevention and control and issues on eradication, international trade and public health. Each chapter is self-contained and provides a useful summary of each disease.

This text covers a broad range of subject matter in order to provide a wide appeal. The moderate length of the book has resulted in a brief discussion on each topic. As a result this text is at best an introduction to many viral diseases and principles (such as disinfection, vaccination and epidemiology). This text would be a useful addition to university libraries for student access. Practitioners and specialists would find little extra information in this book that cannot be obtained from other available sources.

R Shephard

Dr Richard Shephard is a veterinarian and farm advisor working at Maffra Herd Improvement Co-operative, Maffra, Victoria.