

A SURVEY OF CATTLE TICK CONTROL PRACTICES IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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ABSTRACT

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Current cattle tick control practices and producer attitudes towards tick control in the eastern Cape Province of South Africa are discussed. These were ascertained from answers to a questionnaire survey to which 31,2 % of farmers responded.

In general, producers favoured intensive tick control. Beef and dairy farmers had a definite preference for synthetic pyrethroid acaricides, the majority followed a 25 times p.a. treatment frequency and most changed acaricides because of price. Beef producers favoured pour-on application of acaricides while the majority of dairy producers utilized plunge dipping.

Producers who used hand spray techniques experienced the highest percentage of confirmed acaricide resistance. A costs of R11,27 for acaricide treatment per bovine per annum was calculated from data gained in this survey. A cost index of 2,496 was calculated by relating acaricide cost to the prevailing price of beef in the region.

Only a small number of producers used heartwater, babesiosis and anaplasmosis vaccines. Relative tick borne disease mortality ratios indicated higher heartwater mortalities at high acaricide treatment frequencies. These results are discussed in relation to the tick control regimes practised.

INTRODUCTION

The cost effectiveness and socio-economic and environmental desirability of intensive acaricidal treatments to control ticks and tick borne diseases have for some time been subjects of debate (Norval, 1981; Sutherst, 1981). A policy of integrated tick control, based on host resistance combined with strategic acaricidal treatments and appropriate immunisation, suited to local conditions, has been proposed as a viable alternative. The latter policy has, however, suffered the drawback of inadequate empirical data on most aspects essential for its successful application (Norval, Sutherst, Kurki, Gibson & Kerr, 1988). Recent research has confirmed the tick resistance potential of indigenous and other cattle breeds in South Africa (Spickett, De Klerk, Enslin & Scholtz, 1989; Rechav, Dauth & Els, 1990; Rechav & Kostrzewski, 1991). It has also provided some data on the economic implications of the utilization of host resistance (Scholtz, Spickett, Lombard & Enslin, 1991; Norval *et al.*, 1988; Norval, Sutherst, Jorgenson, Gibson & Kerr, 1988). However, an aspect requiring attention is that of current tick control practices in specific regions, the effectiveness of these practices and the attitudes of producers to tick control in general.

This paper discusses the results of a questionnaire survey conducted amongst a relatively small but geoclimatically well defined sector of commercial cattle producers in South Africa and attempts to relate specific farm management procedures and tick control practices to economic and disease control parameters.

MATERIALS AND METHODS

The survey questionnaire, involving direct and

multiple choice answers, assessments or judgements and personal opinions, was similarly designed to one used in Australia (Elder, 1979). That survey was conducted prior to major efforts aimed at introducing tick management on an economic basis primarily through the use of tick resistant animals. Of necessity many questions in our survey were adapted from the Australian one to suit local conditions, while others were unique to South Africa.

Direct questions established the name, locality and size of the property as well as the type of farming practised. Some direct questions were purposefully inserted in order to confirm or reject answers to differently phrased multiple choice questions on the same subject. Multiple choice questions were aimed at establishing:

- (1) the extent and cost of tick control with regard to type of acaricide used, technique and frequency of application;
- (2) the extent of immunisation procedures against tick borne disease;
- (3) the extent of tick borne disease mortalities in relation to treatment procedures practised;
- (4) the extent of, and producer attitudes towards acaricide resistance.

Direct estimates on the extent of tick borne disease supplied by producers do not necessarily imply that all cases were clinically confirmed, but many producers included diagnoses made by private or state veterinarians. Answers to questions on the extent of confirmed acaricide resistance reflect the results of tests conducted for the benefit of producers by chemical companies, usually when the field efficacy of an acaricide was under suspicion.

Questions requiring assessments/judgements were used to confirm multiple choice answers and to ascertain management regimes and producer attitudes towards tick control and tick borne disease vaccination procedures.

A total of 1 000 questionnaires were dispatched to all registered stock farmers in the Bathurst, Albany

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and Alexandria districts of the eastern Cape through the Tick Research Unit, Grahamstown. The area surveyed is classified as Valley Bushveld interspersed with Eastern Province Thornveld (Acocks, 1975) with non-seasonal rainfall, the majority of which occurs during the spring and summer months. Animals farmed in the region are subject to a high level of challenge by most of the economically important tick species encountered in South Africa (Rechav, 1982; Horak & Knight, 1986; Petney & Horak, 1987).

Only the 312 returns received from the Bathurst, Albany and Alexandria districts of the eastern Cape Province were included in the final analysis. Returns were entered onto a database and analyzed on a relative percentage basis. The analyses included tick control for both cattle and small stock and this paper reports on the cattle tick control practices of producers in this region.

RESULTS AND DISCUSSION

It is seldom possible to conduct surveys of this type and, even though the quantitative data collected is unique to the specific region, it is relevant to future tick control practices and to other aspects of the cattle industry.

Sample size

Results are based on a 31,2 % return of questionnaires from cattle producers in the Bathurst, Albany and Alexandria districts of the eastern Cape Province. Returns represent producers farming as few as 25 to more than 1 000 cattle per production unit (Fig. 1). Most producers in this sample (21,5 %) ran from 51–100 cattle with a decreasing percentage (all less than 10% of producers in the sample) owning higher numbers of cattle. All respondents with more than 851 cattle were exclusively dairy producers (3 % of the sample in total), while all respondents farming 651–700 cattle and 67 % of those farming 701–850 cattle were beef producers.

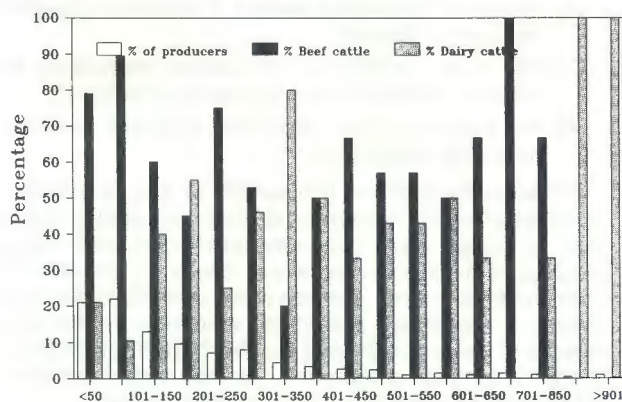


FIG. 1 Percentage of producers owning different numbers of cattle and relative percentages farming beef and dairy cattle contained in a sample of respondents to a questionnaire survey of tick control practices in the eastern Cape Province

Type of stock farming

Most producers ranch beef cattle with dairy cattle

of second choice (Fig. 2). Other major stock farmed in the region surveyed, in order of producer preference are Angora goats, mutton sheep, wool sheep and Boergoats.

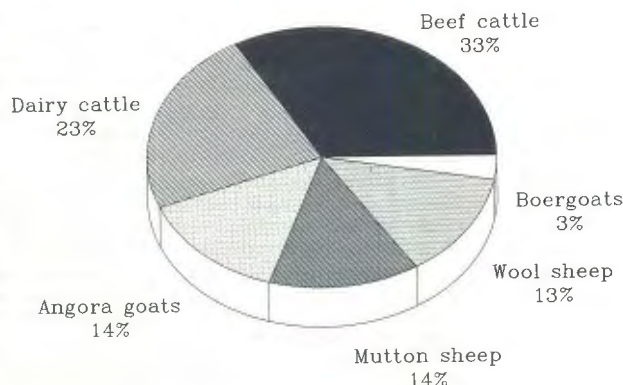


FIG. 2 The relative percentages of producers practising the 6 main types of stock farming in the eastern Cape Province

Cattle breed choice is given in Table 1. This indicates that most producers (55,7 %) farm cross-breeds (mainly Bonsmara), but these animals comprise only approximately 30 % of the total number of cattle in the region. Of these cross-breeds, the majority (60 %) are utilized as beef cattle, while a surprisingly high percentage (37 %) form a dairy component. Approximately 38 % of producers own *Bos taurus* breeds which comprise the majority of cattle in the region, and these are mainly utilized as dairy cattle (55 %), and include a few producers with very large dairy farms. Only 17 % of taurine breeds are utilized as beef cattle. *Bos indicus* cattle (21 % of cattle in the region), which are almost exclusively Brahman and Nguni, are farmed by only 6 % of producers, all as beef cattle.

Comment: For the purpose of this survey we regarded indigenous Nguni cattle (*Bos taurus africanus*) as *B. indicus* due to their host resistance being comparable to the latter species.

Mixed stock farming is common in the region and 26 % of beef producers (Fig. 3) and 45 % of dairy producers (Fig. 4) utilize cattle as the major component in combination with small stock.

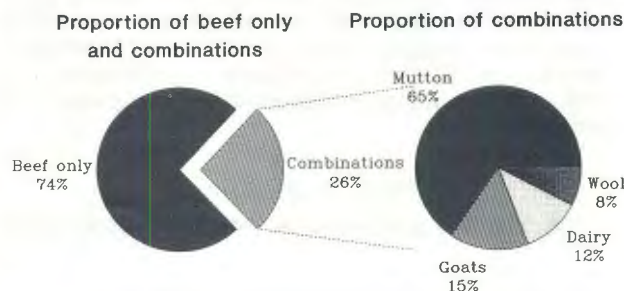


FIG. 3 The proportion of producers (%) farming beef cattle only and those combining beef with other stock and the relative proportion of these combinations in the eastern Cape Province

TABLE 1 Cattle breed utilization by percentage producer breed preference and the percentage of each breed of cattle farmed in the eastern Cape Province

Breed	Percentage of producers	Percentage utilization			Percentage of total cattle
		Beef	Dairy	Dual	
<i>Bos taurus</i>	38	17	55	27	49
<i>Bos indicus</i> *	6	100	0	0	21
Crossbreed	55,7	60	37	3	30

* Nguni are regarded as *B. indicus* here

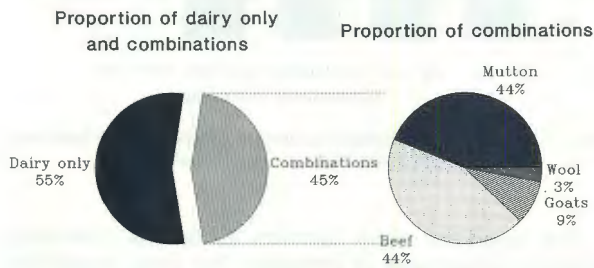


FIG. 4 The proportion of producers (%) farming dairy cattle only and those combining dairy cattle with other stock and the relative proportion of these combinations in the eastern Cape Province

Beef producers (Fig. 3) show a distinct preference to combine beef cattle with mutton sheep farming, while dairy producers (Fig. 4) show equal preferences for dairy/mutton and dairy/beef combinations. Only 7 % and 2 % of producers respectively farm either only mutton sheep or only Angora goats.

Despite these mixed farming practices, producers regard the different stock types as separate entities with regard to tick control, thus allowing separate assessments of cattle and small stock tick control practices.

Acaricide usage

The synthetic pyrethroids are by far the most utilized group of acaricides by both dairy and beef cattle farmers (Fig. 5). These are followed by the formamidines, the organophosphates and to a considerably lesser extent the combination products, i.e. the pyrethroid/organophosphate (PO), organophosphate/organophosphate (OO) and pyrethroid/formamide (PA) formulations. Of the combination products, the PO and PA groups are not used on beef and on dairy cattle respectively. While the synthetic pyrethroids are used to about the same extent on beef and dairy cattle, fewer producers use formamide acaricides on dairy than on beef cattle, probably because fly control is an important prerequisite for many dairy farmers.

Excluding carbamate compounds the relative proportions of registered acaricides currently available for use on cattle in South Africa, are synthetic pyrethroids, 44,1 %; organophosphates, 32,4 %, combination formulations, 14,7 % and formamidines, 8,8 %.

Producer preference for the synthetic pyrethroids accounted for 62,3 % of overall acaricide usage on

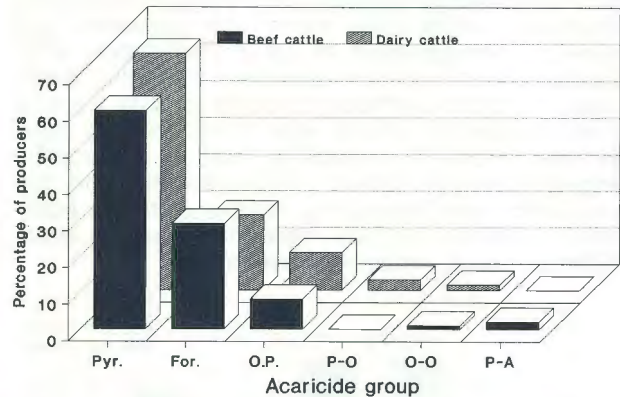


FIG. 5 Relative percentage preference of beef and dairy producers for the different acaricide groups (Pyr. = synthetic pyrethroids; For. = formamidines; O.P. = organophosphates; P-O = pyrethroid/organophosphate combination; O-O = organophosphate/organophosphate combination; P-A = pyrethroid/formamide combination) in the eastern Cape Province as displayed by acaricide usage

cattle in the eastern Cape region, the formamidines for 24,8 % and the organophosphates for 9,3 %, while the combination compounds (PO, PA and OO) together accounted for only 4,6 % of acaricide usage. No producers indicated usage of carbamate acaricides.

Acaricide preference of producers in relation to acaricide availability indicates a definite under-utilization of the older generation organophosphates, a disproportionately high usage of the formamidines and a reluctance to use the newest generation of combination formulations. These discrepancies are most probably due to a combination of factors such as product promotion strategies by chemical companies, relative price and efficacy spectra of the individual acaricides concerned, traditional tick control techniques and other unidentified producer attitudes towards tick control.

It is interesting to note that acaricides in the synthetic pyrethroid group, which has the highest number of registered products, are based on 9 active ingredients. The second most preferred group, namely the formamidines, contains the least number of registered products and these are based on only 1 active ingredient. The organophosphate group comprises the second highest number of registered products and these are based on the highest number of active ingredients (14).

Change of acaricide

Sixty-eight per cent of producers changed their

acaricide during the past 5 years, the main reason given for the change being the price of the product (38 %). The second most important reason for changing acaricides was producer fear of resistance developing (20 %), followed by ease of administration (18 %) and confirmed resistance (12 %).

Producer reasons for changing acaricides are shown separately for beef and dairy cattle in Fig. 6. Fear of developing resistance and price of acaricide were of major concern to dairy producers, followed by ease of administration. On the other hand, beef producers listed price, confirmed resistance and ease of administration of equal importance when deciding to change an acaricide. Changing acaricides to improve efficacy appears to play a minor role in acaricide choice with both beef and dairy farmers. However, should a lack of efficacy be experienced, producers considered that the tick population was developing resistance to the acaricide in use and list their reason for changing acaricides as fear of resistance developing.

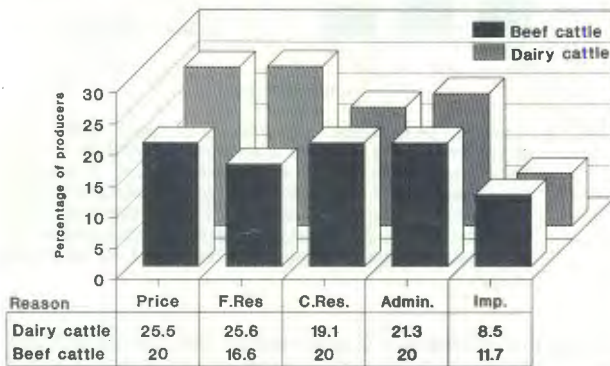


FIG. 6 The reasons given by beef and dairy producers in the eastern Cape Province for changing acaricides during the past 5 years (F. Res = fear of developing resistance; C. Res = confirmed resistance; Admin. = ease of administration; Imp. = improved efficacy)

Fear of resistance developing, listed as the main reason for changing acaricide by dairy producers and as an important reason by beef producers, is probably one of the major factors leading to the current under-usage of the organophosphate acaricides. Simply by being on the market for longer than 20 years places the possibility of resistance developing under strong suspicion by producers.

Ease of administration, listed as important by beef producers, is reflected in the usage of pour-on formulations and this would also account for the high incidence of synthetic pyrethroid utilization as the latter comprise the active ingredients of these formulations.

Acaricide application technique

Beef and dairy cattle farmers differ markedly in the techniques they employ to apply acaricides (Fig. 7). While beef producers favour pour-on application to dip tank usage, dairy producers show a higher preference for dip tank usage (43,6 %) than for pour-on application (28,2 %). More beef producers make use of hand spraying (21,8 %) and spray races (15,9 %) than do dairy producers (12,7 % for

both techniques). Only a very small percentage of dairy farmers use patch treatment on their animals and this is always in combination with one of the 2 main treatment techniques.

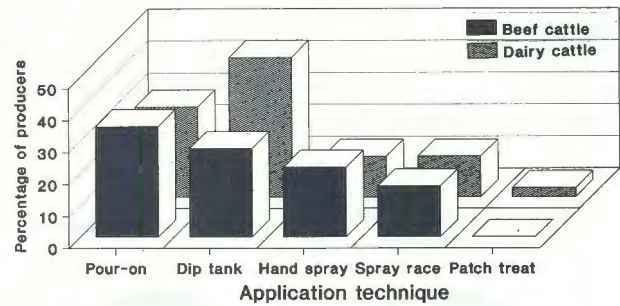


FIG. 7 Acaricide application technique preference by beef and dairy farmers in the eastern Cape Province

The need for dairy farmers to opt for intensive acaricide treatment is probably the most important reason for their preference for dip tank application. Other considerations are the generally lower price of dip formulations compared to pour-on formulations and the capital already laid out on existing facilities. Pour-on application is used almost exclusively on dry cows and heifers.

Beef producers prefer pour-on application because of the extensive nature of their farming operations and they suggest a further downward trend in dip tank usage should the relative prices of the acaricides involved be competitive. The advent of pour-on acaricides has certainly facilitated tick control for the small producer. However, a surprisingly high percentage of beef producers, mostly amongst those owning less than 100 head of cattle do not have dip tank facilities and utilize hand spraying, considering this technique to be efficacious and economical in their particular situation.

In order to clarify the relationship between acaricide resistance and acaricide application technique, the relative percentage of producers listing fear of resistance and those with confirmed resistance are shown in Fig. 8 for the 4 main application techniques practised.

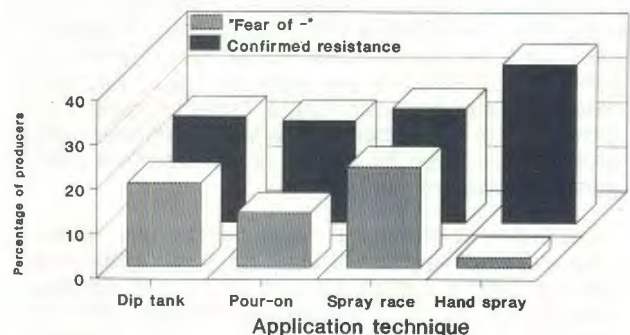


FIG. 8 Percentage of producers with fear of resistance developing and confirmed resistance within the 4 main acaricide application techniques practised in the eastern Cape Province

The results show that the highest percentage of producers who have experienced confirmed acaricide resistance practice hand spraying (35,7 %). In direct contrast, this group also has the lowest percentage of producers listing fear of acaricide resistance (2,4 %). Relatively high percentages of producers also experienced confirmed acaricide resistance with spray race application (25,8 %), dip tank application (23,9 %) and pour-on application (23 %). The percentage of producers showing the most fear of resistance are those using spray race application (22,6 %), followed by those using dip tanks (18,2 %) and pour-on application (12,2 %). The ratios of producers showing confirmed resistance over concern (= fear of resistance) within the 4 main application techniques practised are spray race, 1,1; dip tank, 1,3; pour-on, 1,9 and hand spray application, 14,9. Producers utilizing spray race and dip tank application techniques thus show concern on a par with their respective confirmed acaricide resistance experience. The highest discrepancy between the percentages of producers listing fear of resistance and confirmed resistance exists firstly with those using hand spraying and secondly with those using pour-on application. This strongly implies that hand spraying techniques are promoting the incidence of acaricide resistance while producers who utilize this technique are the least concerned about it. Producers who practice pour-on application techniques display less concern than manifested by their experience of confirmed acaricide resistance. This is probably because this group believes that the newest available control technology should be less conducive to the development of resistance.

Acaricide treatment frequency

The relative percentage of beef and dairy producers practising various acaricide treatment frequencies are shown in Fig. 9. Similar trends for both groups are evident in that the highest percentage of dairy and beef producers treat their animals from 21–25 times p.a. Forty per cent of dairy producers treat more than 26 times p.a. and 33,5 % treat less than 21 times p.a. Similarly, 42 % of beef producers treat more than 26 times p.a. and 34 % less than 21 times p.a. Only 1,5 % of dairy and 2,3 % of beef producers utilize less than 6 treatments p.a. while 11,5 % of dairy and 7 % of beef producers treat their animals more than 41 times p.a.

A producer tendency towards a high acaricide treatment frequency is indicative of high tick challenge in this region and also reflects the attitude of the majority of farmers towards intensive tick control. A minor segment of beef producers farming animals with high host resistance potential, are aware of this attribute and treat less than 6 times p.a. Those dairy producers treating less than 6 times p.a. predominantly utilize zero grazing for their animals.

Fig. 10 (dip tank and pour-on) and 11 (spray race and hand spray) illustrate the treatment frequencies preferred by producers utilizing the different application techniques. By far the most producers using spray races, dip tanks and hand spraying, treat their

animals from 21–30 times p.a. The large majority of producers using pour-on application, however, treat only from 11–20 times p.a. No producers using spray race or pour-on applications treat less than 10 times or more than 41 times p.a. Cumulative percentages of producers with treatment frequencies from 21–40 times p.a. are spray race, 74,2 %; hand spray, 64,6 %; dip tank, 58,9 % and pour-on application, 31,1 %.

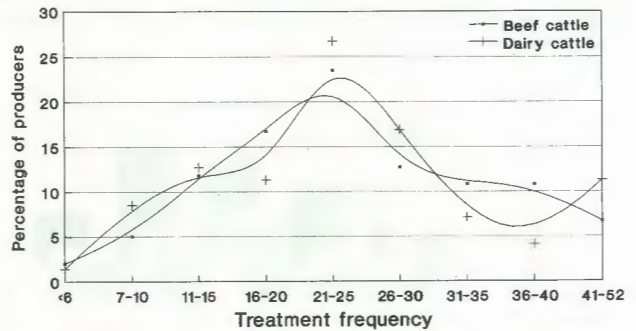


FIG. 9 The acaricide treatment frequencies practised by beef and dairy producers in the eastern Cape Province

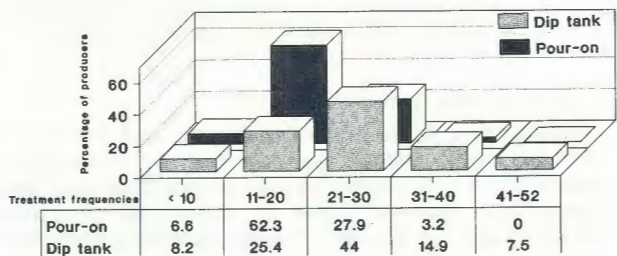


FIG. 10 The frequency of acaricide treatment for plunge dipping (= dip tank) and pour-on application techniques in the eastern Cape Province

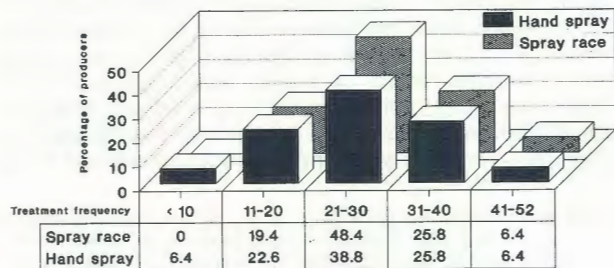


FIG. 11 The frequency of acaricide treatment for hand spray and spray race application techniques in the eastern Cape Province

If treatment frequencies are related to the percentages of producers with a fear of and confirmed acaricide resistance (Fig. 12), it is clear that the highest rate of confirmed acaricide resistance is experienced by producers treating from 31–40 times p.a., and this predominantly includes the spray race and hand spray preference sector of producers (Fig. 11). This group also shows a disproportionately low concern about resistance, 13,6 % as opposed to

19,1 % of producers treating from 21–30 times p.a. At a treatment frequency range of 21–40 times p.a., the percentage of producers who have experienced confirmed acaricide resistance increases to 61,7 % (Fig. 12). This frequency range also predominantly contains producers practising spray race and hand spray application techniques (Fig. 11). The lowest incidence of confirmed acaricide resistance was that for producers treating less than 10 times p.a. (Fig. 12) of which dip tank users are a majority (39 %) over pour-on (31 %) and hand spray (30 %) users (Fig. 10).

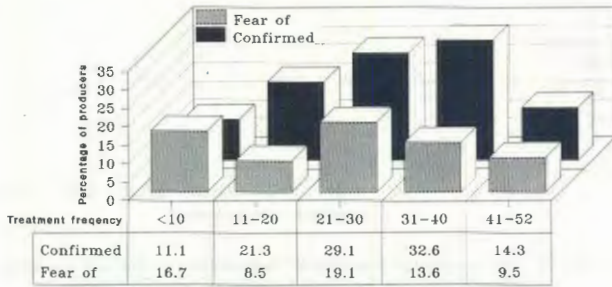


FIG. 12 Percentage of producers indicating fear of developing acaricide resistance and confirmed resistance within the different acaricide treatment frequencies practised

Cost of acaricide treatment

The annual total cost of acaricide and the numbers of cattle farmed as supplied by producers, enabled the calculation of mean acaricide cost per bovine per annum (Table 2). Individual producer cost estimate claims with means outside 2 standard deviations of the sample mean were regarded as spurious and discarded in the final analysis. The results (Table 2) show an overall acaricide cost of R11,27 per bovine p.a. The overall mean price for beef as supplied by the Meat Board for this region (Port Elizabeth) during the period of the survey was 451,5 c/kg. The calculated cost of acaricide treatment (R11,27) related to the prevailing beef price yields a cost index of 2,496. Acaricide cost was lower for dairy cattle, regardless of breed, than for beef cattle where the cost for taurine breeds was the highest. The costs for indicus and crossbred beef

TABLE 2 Cost of acaricide per bovine p.a. and mean number of cattle per production unit according to questionnaire survey data supplied by producers in the eastern Cape Province

Type of cattle ranchered	Cost of acaricide per head per annum	Mean number of cattle per production unit
Crossbreed (B. t. × B. i.)	R11,97	164
– Dairy cattle	– R11,39	– 154
– Beef cattle	– R12,29	– 172
Bos indicus	R12,30	116
Bos taurus	R10,74	269
– Dairy cattle	– R10,15	– 331
– Beef cattle	– R13,77	– 246
Overall mean	R11,27	203,8

cattle were similar. The lower cost for dairy cattle is probably due to the preference of these producers for generally lower cost dip tank acaricide formulations (Fig. 9) and the utilization of zero grazing.

Vaccination against tick borne disease

Low percentages of producers responded positively to the use of vaccines against tick borne disease, confirming in general, a positive producer attitude towards intensive tick control. We regarded analysis differentiating between dairy and beef producers as spurious due to the few producers using vaccines. Regular vaccination is practised against anaplasmosis by 12,6 %, against heart-water by 8,6 % and against babesiosis by 4 % of producers. The majority of producers (32 %) regarded vaccination to be unnecessary under conditions of intensive tick control; 22 % of producers considered vaccination to be counter-productive because of the complexity of administration as well as the necessity for subsequent monitoring and treatment of adult animals; 9 % were under the impression that vaccination would spread the organism concerned because of subsequent tick infection, thus causing clinical cases in unvaccinated animals; 6 % of producers were of the opinion that vaccination did not work. One per cent of the producers surveyed were unaware that vaccines for tick borne disease were available.

These results indicate the necessity for a major information campaign to acquaint producers with the availability, usage and benefits of tick borne disease vaccines. In addition, the development of more efficient vaccines, easy to administer without the necessity of subsequent monitoring and treatment of adult animals, would encourage their use.

Mortalities

Mean mortalities from heartwater, babesiosis and anaplasmosis per production unit are illustrated in relation to dipping frequency in Fig. 13. For ease of comparison, the mean mortalities experienced within different treatment frequencies, are summarized as relative ratios per production unit in Table 3.

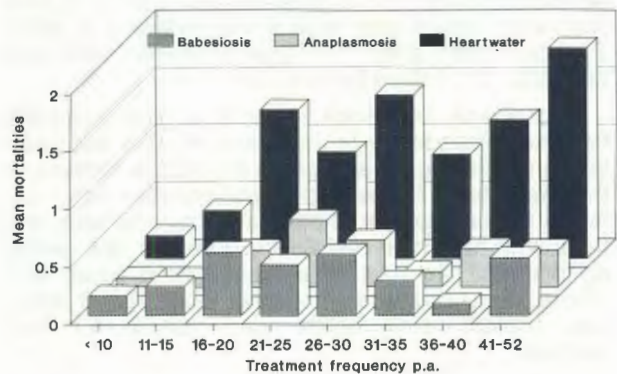


FIG. 13 Mean heartwater, babesiosis and anaplasmosis mortalities per production unit experienced by producers practising different acaricide treatment frequencies

Producers practising acaricide treatments at a

TABLE 3 Relative mean heartwater (HW), babesiosis (Ba) and anaplasmosis (An) mortality ratios experienced by producers practising and not practising immunisation within low and high frequency acaricidal treatment regimes in the eastern Cape Province

Treatment frequency per annum		Disease mortality ratio					
		-Immunisation			+Immunisation		
		HW	Ba	An	HW	Ba	An
Low	1-10	20	17	8	0	100	100
	11-15	42	25	8	0	167	100
High	36-40	121	10	33	500	—	100
	41-52	184	50	32	—	—	—

TABLE 4 Mean number of ticks permitted to infest different cattle breeds and mean number of acaricidal treatments practised to maintain such infestation by producers as opposed to those who do not allow any infestation, as well as relative mean heartwater, babesiosis and anaplasmosis mortality ratios experienced within the 2 management regimes

	Cattle breed							
	<i>B. indicus</i>		Composite (= Bonsmara)		Crossbreed (<i>B.t.</i> × <i>B.i.</i>)		<i>B. taurus</i>	
Mean number of ticks allowed	4,9	0	2,7	0	5,1	0	2,4	0
Mean number of treatments p.a.	18	30	24	32	22	28	24	28
Mortality ratio								
—Heartwater	15	24	9	11	7	12	13	1
—Babesiosis	0	6	0	1	2	2	4	8
—Anaplasmosis	6	4	1	4	3	3	4	6

frequency of 41–52 times p.a. did not immunise their animals against tick borne diseases (Table 3). Producers that do immunise and that treat from 36–40 times p.a. utilized the heartwater and anaplasmosis vaccines but not the babesiosis vaccine. The highest mortalities due to heartwater were encountered by those producers that immunised within the 36–40 times p.a. treatment frequency group, compared to the relatively low mortality for the same treatment group that did not immunise. Producers who immunised and treat from 1–15 times p.a. experienced no heartwater mortalities. Lower babesiosis and anaplasmosis mortalities were experienced by producers that do not immunise, compared with those that do within the 1–10 and 11–15 treatment frequency groups. The lowest anaplasmosis mortalities occurred within the 1–15 treatment frequency group of producers who do not immunise. Relatively higher anaplasmosis mortalities were recorded by all producers who do immunise, compared to those who do not, regardless of treatment frequency favoured.

In general the results indicate that the higher the treatment frequency favoured, the higher the mortalities due to heartwater (Fig. 13). Babesiosis mortalities fluctuated from low at low treatment frequencies (1–15) to peak around the middle treatment frequencies (16–30), decreased from 31–40 treatments p.a. and peaked again at 41–52 treatments p.a. (Fig. 13, Table 3). Anaplasmosis mortalities fluctuated from low at low treatment frequencies (1–15), peaked around the middle treatment frequencies (16–30), reached a low level at 31–35 treatments p.a. and higher levels from 36–52 treatments p.a. (Fig. 13).

These results strengthen arguments for the establishment and maintenance of a stable enzootic situation, especially as regards heartwater (Howell,

De Vos, Bezuidenhout, Potgieter & Barrowman, 1981; Norval & Lawrence, 1979; Bezuidenhout & Bigalke, 1987). Continued immunity against heartwater and the absence of clinical disease seems insured only by immunisation and the application of judicious low frequency acaricidal treatments. The relatively high incidence of babesiosis and anaplasmosis mortalities amongst immunised animals treated at low frequencies are, however, not clear and probably account for the negative producer attitude towards immunisation. It could, however, also be speculated that the frozen anaplasmosis/babesiosis vaccines have become available only recently and that fresh blood vaccines, assuming that these had been used, with their specialized transport and storage needs, were ineffective when eventually administered. Amongst unvaccinated animals, however, the relatively low babesiosis and anaplasmosis mortalities experienced at low treatment frequencies (1–15 times p.a.), compared to those at high treatment frequencies (above 36 times p.a.) tend to support the concept that adequate exposure to ticks bestows a degree of immunity to these diseases and to a large extent prevents, if not negates, the occurrence of clinical disease.

Tick control regimes

Although the general producer attitude indicates a marked tendency towards intensive tick control, definite individual preferences are evident as regards usage of acaricide, treatment frequency and vaccination procedures. Two main tick control management regimes were identified for producers who do not immunise against tick borne diseases, i.e. producers who allow a certain number of ticks on their animals and those who do not. The mean number of ticks permitted by these producers on various cattle breeds, the mean number of treatments p.a. practised and the relative mortality ratio

experienced with each management regime are presented in Table 4. In the case of producers permitting ticks to infest their animals, acaricidal treatments are applied at such intervals as deemed necessary to maintain the required number of ticks. Those who do not allow ticks on their cattle follow a regular acaricidal treatment regime even if their animals are not tick infested.

Of the producers allowing ticks to infest their animals, those farming crossbreed cattle (*B. indicus* × *B. taurus*) allowed marginally more ticks than those farming *B. indicus* cattle. The latter breed required the least acaricidal treatments. Producers farming composite breed cattle (= Bonsmara) allowed slightly more ticks to infest their animals than did those farmers ranching *B. taurus* cattle, who in turn permitted approximately only half the number allowed by crossbreed owners. Producers who permitted no ticks on their cattle applied more acaricidal treatments for all breeds with resulting higher costs. In addition, the relative heartwater mortality ratios were higher in this group for all farmers except those farming *B. taurus* animals.

These results show the potential cost effectiveness of practising tick management through judicious acaricidal treatment. The exception is farming with *B. taurus* breeds, where an intensive acaricidal treatment policy under conditions of heavy tick infestation is indicated. It is suggested that permitting higher numbers of ticks to infest *B. indicus* (including indigenous animals), composite and crossbreed animals than presently allowed by producers, would increase their immunity to tick borne diseases.

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