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An Overview of the Status of Cattle Tick *Boophilus microplus* in Queensland

by

Rex Davis

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Rex Davis[1]

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The Commissioned Organization is the Queensland Department of Primary Industries. Collaborating institutions in Australia are CSIRO-ANHL, Geelong, Victoria and the University of Queensland (Department of Economics; Department of Geographical Sciences and Planning). In Thailand, the collaborating institutions are the Department of Livestock Development (National Institute of Animal Health; Disease Control Division), Chiang Mai University (Department of Agricultural Economics; Department of Animal Husbandry) and Thammasat University (Faculty of Economics). The collaborating institution in Laos is the Department of Livestock and Veterinary Services. Dr F.C. Baldock, Senior Principal Epidemiologist, Queensland Department of Primary Industries is the Project Leader in Australia and Dr P. Chamnanpood, Senior Epidemiologist, Thai Department of Livestock Development is the Project Leader in Thailand. Professor Clem Tisdell and Dr Steve Harrison, Department of Economics, University of Queensland are responsible mainly for the economic component of this project.

'The overall goal of this project is to develop and evaluate the .necessary tools to provide decision-makers with reliable animal health information which is placed in context and analysed appropriately in both Thailand and Australia. This goal will be achieved by improving laboratory diagnostic procedures; undertaking research to obtain cost-effective population referenced data; integrating data sets using modern information management technology, namely a Geographical Information System (GIS); and providing a framework for the economic evaluation of the impact of animal diseases and their control.

A number of important diseases will be targeted in the project to test the systems being developed. In Thailand, the focus will be on smallholder livestock systems. In Australia, research will be directed at the northern beef industry as animal health information for this sector of livestock production is presently scarce.'

For more information on *Research Papers and Reports Animal Health Economics* write to Professor Clem Tisdell (c.tisdell@economics.uq.edu.au) or Dr Steve Harrison,(s.harrison@uq.edu.au) Department of Economics, University of Queensland, Brisbane, Australia, 4072.

An Overview of the Status of the Cattle Tick *Boophilus microplus* in Queensland

ABSTRACT

The common cattle tick *Boophilus microplus* has been a major economic pest to cattle producers in the tick-infested area of Queensland since its arrival from Java in 1872. *Boophilus microplus* affects cattle directly by reducing potential yield and indirectly through the transmission of blood parasites. Estimates by the Cattle Tick Commission (1973) placed the total cost of control and lost production caused by *Boophilus microplus* at approximately $33 million per annum (approximately $183 million in 1995 dollar terms).

The long-standing policy of the Queensland Government towards the cattle tick is the maintenance of a ‘tick-line’ which divides Queensland into tick-free and tick-infested (ticky) areas. Regulations apply to the movement of cattle from the tick-infested to the tick free areas. This policy has been developed on a historical rather than economic basis and no real analysis of the costs and benefits of the current regulatory stance has been undertaken.

In recent years, however, a range of issues have emerged which have elements within the cattle industry and government questioning the long-term effectiveness of the current tick control strategies and regulations. These issues include:

- increased levels of resistance to the current stock of pesticides and the lack of development of new chemical compounds designed to treat *Boophilus microplus*;
- chemical residues in Queensland beef being found in the United States and Japan and the possibility of Queensland beef products being excluded from key export markets; and
- changing demands in the domestic and international markets for beef and greater productivity in the face of present and potential competitors in key export markets.

This paper presents a review of the status of the cattle-tick in Queensland and identifies issues that need to be addressed and quantified in order to evaluate the economic consequences of the current tick regulations. It also examines the issues involved in

developing alternative strategies, such as the removal of the tick-line or eradication of ticks.

Keywords: cattle tick, Queensland, *Boophilus microplus*

JEL Classifications: Q160

An Overview of the Status of the Cattle Tick *Boophilus microplus* in Queensland

1. Introduction

The common cattle tick, *Boophilus microplus*, is a major economic pest affecting producers in the tick infested area of Queensland: The cost in lost production and control of *Boophilus microplus* to producers and the Government was estimated by the Cattle Tick Control Commission (1973) as $33 million (approximately $184 million in 1995 dollar terms).

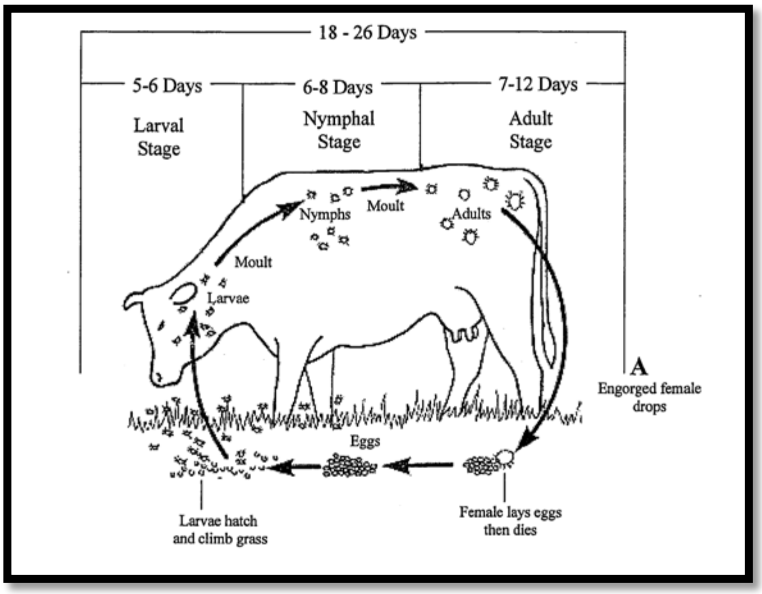
Historically, control of the cattle tick in Queensland has primarily been the responsibility of producers whose main defence against the effects of tick infestations has been the use of tick resistant breeds of cattle and chemicals. The Queensland Government's role in tick control is through the maintenance of the tick line which divides Queensland into tick-free and tick-infested (or 'ticky') areas. Movement between these areas is regulated.

Recent problems with chemical residues in meat in the United States and Japan, resistance by *Boophilus microplus* to existing pesticides, increased pressures in maintaining market share in key export markets and changing consumer demands have led to elements of the cattle industry and government to question the long-term effectiveness of the current tick regulations and to examine alternative approaches, such as removing all tick regulations on one hand, or eradicating the cattle tick on the other.

This paper outlines the current status of *Boophilus microplus* in Queensland, including the biology of the cattle tick, its history and distribution in Queensland, the economic effects of tick infestations on cattle, and the major methods of control. It also outlines the issues that need to be addressed and quantified in order to evaluate the economic consequences of the current tick regulations. Finally it examines the issues involved in developing alternative strategies for comparison with the effectiveness of current regulation and concludes by outlining future areas of research that are to be undertaken in the near future.

2. The Lifecycle of *Boophilus microplus*

The common cattle tick, *Boophilus microplus* is a one host tick. That is, it completes its three parasitic stages on the one host, normally cattle (Powell and Reid, 1982). The life cycle of the cattle tick can be seen in Figure 1.

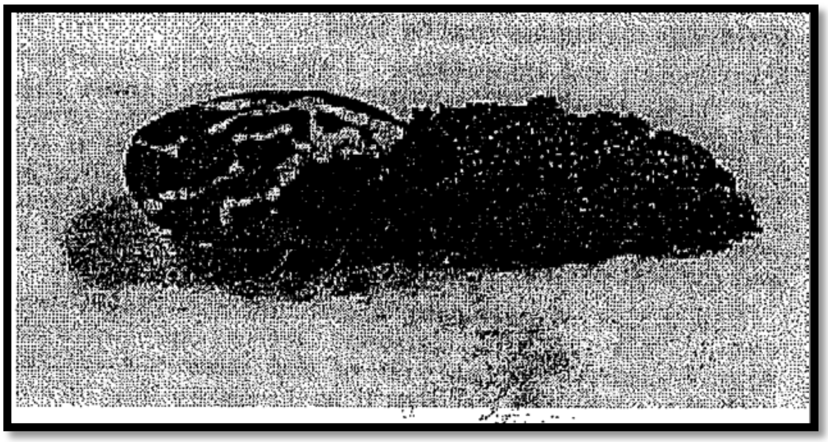


Source: Based on Powell & Reid (1982, p.281)

Figure 1: Life-cycle of *Boophilus microplus* - At **A**, the engorged female drops to the ground, lays her eggs and dies. The larvae hatch and climb grass to attach to passing hosts. While on the host, the larvae moult to become nymphs and moult again to become adults. Once fully fed, the engorged female detaches from the host to lay eggs.

At **A**, the thoroughly fed female drops off the beast and finds a suitable environment to lay her eggs. The pre-egg laying stage can last between 1 and 40 days and is dependent on the environmental temperature and relative humidity. The egg-laying stage is also dependent on temperature and ranges between 2 to 44 days (Stewart et al, 1981). Figure 2, shows a female tick laying eggs. A female tick can lay up to 3500 eggs, but the average is around 2500, with the temperature in the mid-twenties range (Stewart and de Vos, 1984).

Once the female has completed the egg laying task it dies. If the temperature is too low, below approximately 15° Celsius, the tick will not lay any eggs, and if the temperature is above 40° Celsius, the tick will desiccate and die without offspring (Stewart and de Vos, 1984).



Source: Stewart and de Vos (1984, p.295)

Figure 2: Engorged Female can lay as many as 3,500 eggs, however the average is approximately 2,500

The egg hatching process has a large variance, with eggs taking anywhere between 18 to 146 days to hatch. Once a tick has hatched it can last anywhere between 3 weeks in summer and 2 to 3 months in winter. The larvae detect the presence of cattle by smell, climb grass spears, and attach to the cattle when they enter the larvae's vicinity. The larvae bite immediately and begin to feed off the blood of the cattle. After 5 to 6 days the larvae, which are brownish, pin sized creatures, moult (shed their outer skin) to become eight legged nymphs. The colour of the tick changes from a light brown colour to a greyish blue. The nymphal stage lasts approximately 6 to 8 days, ending when the nymph moult again to become adult tick.

At this stage the sex of the tick can be determined. Males generally moult first, are much smaller and more active than the females, and can be found lying underneath engorged nymphs and female ticks, (Stewart et al, 1981: 305). The most notable ticks on an animal are the engorged females, which can be seen in Figure 3. At the adult stage the parasitic life of the tick is completed within 8 to 12 days. The male ticks may either remain on the host or detach with the female and can last up to 70 days on the host or in vegetation. The female ticks, once fully fed, drop from the beast to lay eggs.

Source: Central Station (2013)

Figure 3: An infestation of *Boophilus microplus*

3. The Economic Effects of *Boophilus microplus*

Elder (1980) observes that,

> "Control of *Boophilus microplus* is necessary for two main reasons - the prevention of live body weight losses from the direct effect of ticks and the prevention of clinical disease in cattle from infection from *Babesia* spp. and *Anaplasma marginale* parasites transmitted by the tick."

Boophilus microplus has a direct and indirect effect on cattle. The direct effect is twofold;

1. Reduced Potential Yield - Significant infestations of *Boophilus microplus* reduce the cattle's ability to reach its full weight potential. Detrimental effects of large numbers of *Boophilus microplus* arises from mild toxins in their secretions, loss of blood and irritation caused by feeding. This effect is given the common name of 'tick worry' (Stewart and de Vos, 1984, p.296).

2. Hide Damage – The economic value from the cattle's hide is reduced because of marks created by *Boophilus microplus* feeding on the cattle.

The indirect effect from *Boophilus microplus* is the production loss from tick fever, a serious disease which is caused by the tick transmitting blood parasites into the animal it is feeding upon. *Boophilus microplus* transmits three pathogenic parasites, *Babesia bovis* and *Babesia bigemina* which cause *babesiosis* and *Anaplasma marginal* which causes anaplasmosis. *Babesiosis* is the most common cause of tick fever in Queensland accounting for around 90% of all tick fever cases (Stewart and de Vos, 1984, p.296).

Once the cattle are infected the parasites invade red blood cells, develop, divide and then destroy the blood cell. The destroyed blood cells release a red pigment, haemoglobin which is excreted in the urine leading to the common name of *babesiosis* – 'red-water'. The blood cell cycle continues until the animal dies or its immune system is able to control the infection (Stewart et al, 1981, p.306).

Previous estimates of the cost of production losses in Queensland have been done by Bureau of Agricultural Economics (1959) and the Cattle Tick Commission (1973). A smaller study undertaken by Batholomew & Davis (1993) examined the cost of eradicating *Boophilus microplus* south of the Townsville - Mt Isa railway line and compared the results to the existing tick regulations. This study found that the annual cost in lost production was approximately $28 million ($29.4 million in 1995 dollar terms). The Cattle Tick Commission (1973) found that the cost of lost production was around $15.5 million pa (approximately $86 million in 1995 dollars) and the cost of tick fever deaths at around $1.2 million pa ($6.5 million in 1995 dollars). The Bureau of Agricultural Economics (1959) evaluation found the cost to producers at approximately, $9.5 million dollars, (approximately $831 million in 1995 dollars) however at the time of that study, the proportion of *Bos taurus* breeds (highly susceptible) of cattle was much higher and the information on tick control practices was much lower.

The lack of a major study into the cost of the cattle tick and tick regulations since the 1970s is a major missing item of information. The figure of the cattle tick costing $100m per year which is often quoted in cattle tick literature (see for example Willadsen & Kemp, 1988) is an unquantified approximation.

4. Control of *Boophilus microplus* by Producers

To avoid costs associated with losses to production, producers use a range of techniques to control tick population levels. These can be broken into two groups, direct effect control measures, aimed at reducing tick populations and indirect effect control measures, aimed at controlling the outbreak of tick fever. Obviously, methods that control tick populations will also reduce the likelihood of indirect effects occurring. None of the measures listed below are used exclusively. Generally, a producer will employ a variety of measures concurrently to reduce cattle tick infestations[1].

A. **Chemical Control** -The first and predominant method of controlling *Boophilus microplus* over the past century has been through the application of chemicals to cattle. The popularity of chemical control relates to its ability to produce the instant result of removing the vast majority of pests and the residual toxicity of the application providing the treated cattle with a further period of protection.

Depending upon the producer's pest-control strategy, chemicals may be applied strategically at specific times in the year to counter the population dynamics of the cattle tick population or as a reaction to the visible tick population on the cattle when it reaches a certain level of infestation. Strategic dipping has been shown to produce significantly greater benefits as it reduces the amount of dipping often undertaken by producers (Sing et al, 1983).

The application of chemicals as a form of tick control began with the use of arsenic in 1895. Over the past century, a range of chemical treatments have been utilised as the cattle-tick gradually became resistant to each new pesticide.

B. **Tick resistant cattle**

When *Boophilus microplus* first invaded Australia, the losses from tick fever were very high. These large losses were largely attributed to the cattle industry at the tum of the century comprising solely European breed (*Bos taurus*) cattle. The search for cattle that were resistant to cattle-ticks led to the importation of Zebu (*Bos indicus*) cattle from the United States in 1933 (Skelsey, 1983).

> “Cattle breeds vary greatly in their level of favour to ticks, with Zebu cattle from Asia being less favourable than European cattle. Although most European cattle are favourable hosts, as are a few of the Zebus, the occasional European animal and the majority of Zebus allow only a few ticks to survive on them, and those cattle are said to be highly resistant. From 10% to 30% of tick larvae may feed successfully on

animals with low resistance, while only 1 to 2% may do so on highly resistant cattle." (Powell and Reid, 1982, p.6)

Today the tick-infested area of the Queensland cattle industry is characterised by cattle with a considerable level of Zebu blood. Research by Johnstone & Haydock (1969), Corlis and Sutherland (1976), Bums et al. (1977), Utech et al. (1978), Sutherst et al (1979), Sutherst et al. (1980) Sutherst et al. (1983), Mellor et al. (1983) have all shown that there are considerable productivity gains in using cross-bred steer with at least 50% Bos indicus blood in controlling cattle ticks. In some articles, particularly Corlis and Sutherland (1976) which examines dipping crossbreds in central Queensland and Bums et al (1977) which examines dipping crossbreds in south-east Queensland, the cost of applying chemical acaricides to control the tick was not justified for the small liveweight gain. Holroyd et al. (1988) found that tick control was justified on the grounds that lower levels of tick infestation would improve fertility and increase weaning weights.

C. Pasture Spelling

The alternative to removing cattle ticks from cattle is to keep the cattle from the cattle ticks. Spelling pastures prevents the larval ticks from feeding. This method is particularly effective in summer when larvae die rapidly (Powell and Reid, 1982).

Pasture spelling requires considerable management planning and requires good fencing and excess capacity. Elder (1980) in a survey found that 42% of producers engaged in pasture spelling for an average period of six weeks. While pasture spelling may not be feasible as a primary form of control it is a useful means of supplementing a strategic dipping program in reducing tick populations.

D. TickGARD® Cattle Tick Vaccine

A recent development in cattle tick control technology has been the introduction of a cattle tick vaccine, TickGARD®. This vaccine, (not to be confused with tick fever vaccine described below) was developed through collaborative research between the Commonwealth Scientific and Industrial Research Organisation (C.S.I.R.O) and the Hoechst group.

The cattle tick vaccine works by continuously damaging ticks for two to three months rather than instantly killing ticks which is the case with dipping (QLD Dairyfarmer 1992: 10). TickGARD® is formulated from a protein found in the gut of the cattle tick. Cattle that are vaccinated produce antibodies against this protein. When ticks feed on the vaccinated cattle the antibodies attack the tick's gut and damage it. As a result fewer ticks are able to reach adulthood and there is a reduction in both the amount of eggs laid and the amount of eggs that hatch. Even the larvae coming from the eggs that do hatch will be less viable (Pockley, 1994).

As this product is still in its initial stages in the marketplace it is too early to perceive what its eventual effect will be. Hoeschst who are marketing the product are recommending that the product be used in conjunction with a strategic dipping program, so as to reduce a property’s long term tick population.

While the existence of this new and innovative bio-technology is exciting, the product is limited by the amount of properties in the ‘ticky’ part of Queensland that will find the product useful as an additional measure in their control strategies. For example, even with reduced fertility rates of ticks, properties in country that are very favourable to cattle ticks, will still have large infestations. In these areas only the magnitude of a large tick population will be reduced. In areas with very low tick infestations, the cost of the vaccine is unlikely to be justified compared to alternative control measures. However, this aside, the project represents a major non-chemical weapon against the cattle-tick and is a long term tick population management technique.

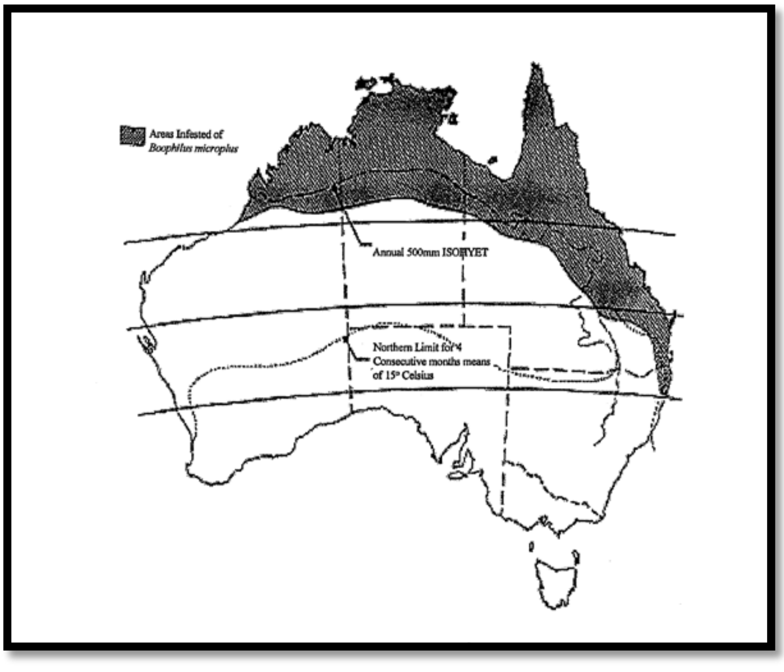
The major indirect effect of the cattle tick, tick fever, can be controlled by reducing cattle tick populations, selecting cattle that have a natural resistance to tick fever (high Zebu blood content) and/ or through the use of tick fever vaccines produced by the Queensland Department of Primary Industry at the Tick Fever Research Centre at Wacol. Tick fever vaccines come in three forms, Monovalent or ‘single germ’ vaccine containing *Babesia bovis*, Bivalent or ‘two germ’ containing *Babesia bovis* and *Anaplasma centrale* (a mild parasite that immunises cattle against *Anaplasma marginale*) and Trivalent which contains all three blood parasites (Mahoney, 1994)..

The amount of tick fever vaccine bought by a producer will often depend on the consistency of tick populations on their property. Producers with constant cattle tick populations are less likely to purchase vaccine as their stock will have acquired considerable tick fever resistance. A producer who is only occasionally tick infested will be more likely to suffer large losses from an outbreak of tick fever and will reduce his/ her exposure to this risk by vaccinating the herd.

Previous estimates of the cost of control such as the Cattle Tick Commission have stated that the major component of costs is in the application of the chemicals, in particular the cost of mustering stock. For example, Batholomew and Davis (1993) estimate that mustering accounts for (1994 dollars) $13.3 million of a total cattle tick control cost of $27 million.

5. The Role of the Government in Tick Control in Queensland

Boophilus microplus is thought to have arrived in Australia with 12 Brahman cattle brought from Java to Darwin in 1872 (Stewart et al, 1981, p.305). It then gradually spread across Northern Australia where the climate suited its development. Figure 4 shows the distribution of *Boophilus microplus* in Australia.



Source: Based on Cattle Tick Control Commission (1973, p.42)

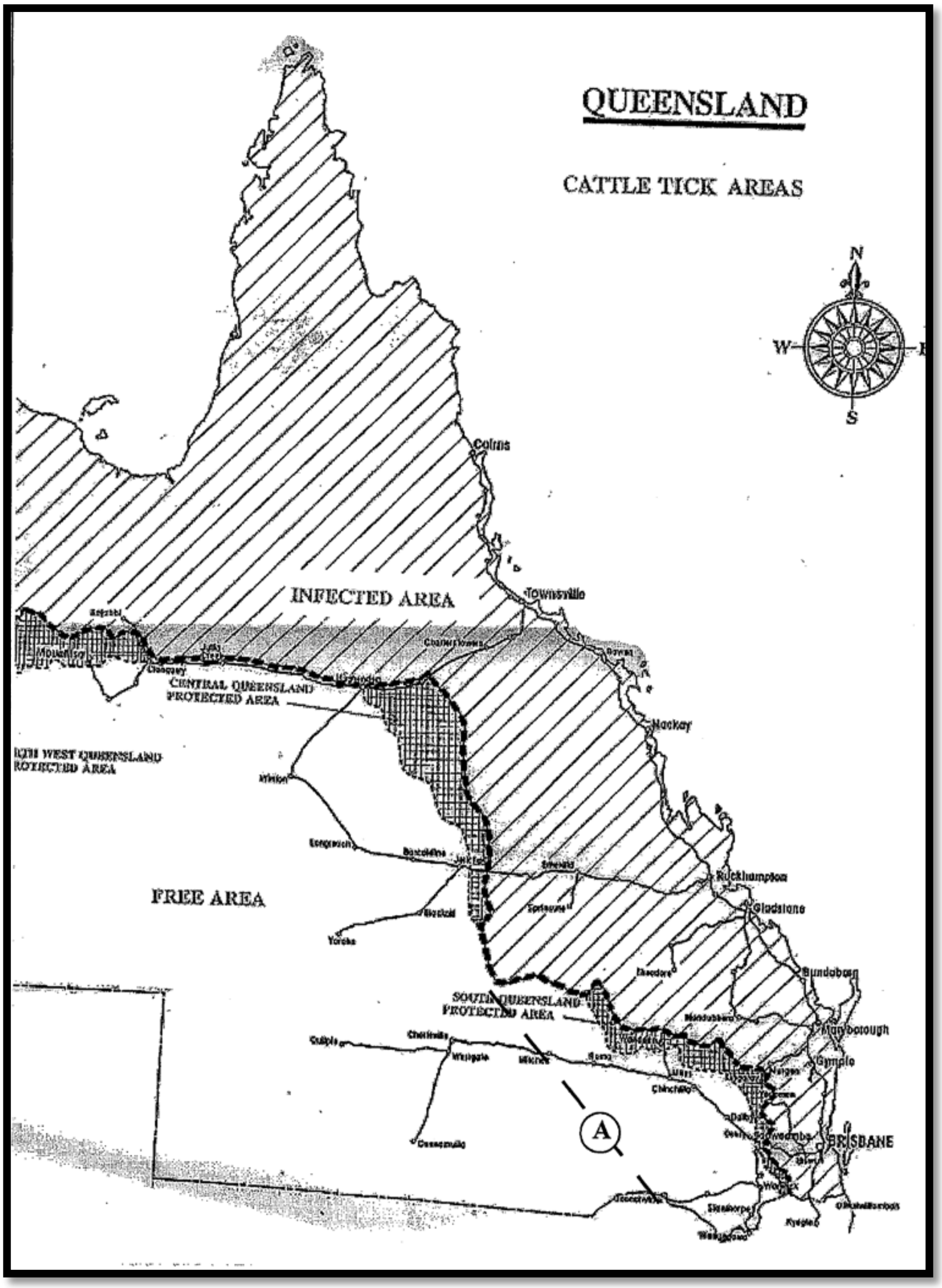
Figure 4 Distribution of *Boophilus microplus* in Australia - *Boophilus microplus* is present in Northern Western Australia, the Northern Territory, Queensland and Northern New South Wales. As it is a tropical pest, its distribution is limited by cold weather and low rainfall.

> "In the north, tick distribution is limited by dryness (less than 500mm of rain) and in the South by winter temperatures (more than four months with mean temperatures of less than 16°C)". (Cattle Tick Control Commission, 1973, p 7)

In Queensland, the spread of the cattle-tick and the favourable conditions for its existence, have meant that there have been few options but to 'live with the tick'. The Government's role historically has been to protect properties within the tick-free area from tick- infestations. To this extent, *Boophilus microplus* is confined to an 'enzootic' area by the controlled movement of cattle and the climatic conditions which limit the ticks natural spread (Stewart et al, 1981). The tick-line was established by the Stock Act of 1915, with only minor changes occurring to this boundary since its inception.

Figure 5 shows the tick-line, which divides Queensland into tick-free, tick-infested (diagonal lines) and protected areas (hatched). The protected areas are climatically marginal for tick populations although outbreaks may occur with the right seasonal conditions and act as buffer zones between the tick free and tick infested areas. The regulation of movement relates to restrictions placed on cattle moving from the tick- infested area of the State to either the protected or free areas.[2]

The infested area comprises approximately 920,000 km^2 and the cattle population within the area exceeds six million.



Source: DPI Information Sheet (1992)

Figure 5: Queensland tick infected, protected and tick free areas – The tick line was established by the Stock Act 1915 and divides Queensland in to tick-free, tick infested and protected areas. The protected areas act as a buffer zone. The line marked A shows the extra area the tick is likely to infest if the tick-line is removed.

6. Examination of the Challenges and Issues Relating to Current Government Regulations and Possible Alternative Government Policies

As mentioned above, the origin of the present tick control regulation stance dates back to the entry of the cattle tick into Queensland at the turn of the century. While the costs of the cattle tick to the industry and Government have been estimated, there has been no real economic evaluation of the overall net benefit of the current tick regulation. In quantifying the value of the present tick line, there is a need to develop possible alternative strategies against which comparisons can be made.[3] Two previously raised alternative strategies at the extreme ends of the scale are the removal of Government regulations (and therefore the tick line) or the eradication/partial eradication of *Boophilus microplus* from Queensland.

In examining the present tick line and these alternative strategies, several issues and in some cases unknowns, need to be considered in order to accurately quantify the optimum long term strategy. This point has been made by Knott (1979, p.67-68),

> "Government policies need reappraisal in the light of new knowledge concerning the breeding of tick resistant cattle, the availability of a reliable and safe tick fever vaccine and the problem of pesticide residues in meat. However, before rational decisions can be made, cost-benefit studies will need to be undertaken as this field has biological, political and sociological interfaces. Also research needs to be undertaken into the dynamics of tick populations west of the Great Dividing Range in Queensland."

6.1 Issues to be Addressed in an Economic Evaluation of the Current and Alternative Government Regulations Towards Boophilus microplus

A. Spread of the Cattle Tick in the Absence of the Tick-Line

In determining the benefits of the existing tick-line, the most important factor is how much area within the tick-free zone, *Boophilus microplus* is likely to occupy on a sporadic or long-term basis. As mentioned in Section 5, the spread of *Boophilus microplus* is limited by dry and cold conditions, Wilkerson (1970), Sutherst et al. (1988a). Glanville (Unpublished Report) estimates that ticks may be able to survive as far west as a line from Goondiwindi in the South through to Mitchell, shown by line **A** shown in Figure 5. If ticks were able to survive within this area, then approximately 1.5 million extra beef cattle would be affected and 50,000 dairy cattle. This would involve a significant cost to producers particularly in providing immunity from tick fever for producers in this region.

B. Breed Changes

If the tick-line was removed and *Boophilus microplus* sustained long-term population levels in the areas mentioned by Glanville, then it must be ascertained how this would affect the breed structure of cattle herds in the tick free areas of Queensland. A reasonable assumption is that producers currently in the tick-free area, with *Bos taurus* breeds would increase the content of *Bos indicus* blood in their herds in order to provide greater natural resistance to their stock. The question in an economic analysis is how much worse off is a producer of *Bos taurus* cattle in the present tick-free area if breed changes are necessary due to changes in the tick line?

There are two issues that have to be resolved to answer this question:

i) Evaluate the extra information and inconvenience costs to the producer. The producer will incur some significant information and inconvenience costs in changing breeds, as well as the physical costs involved in buying new bulls and gradually incorporating the different breed's blood into the herd. The producer may also have to adapt his property management techniques and principles for a business plan for the changed herd.

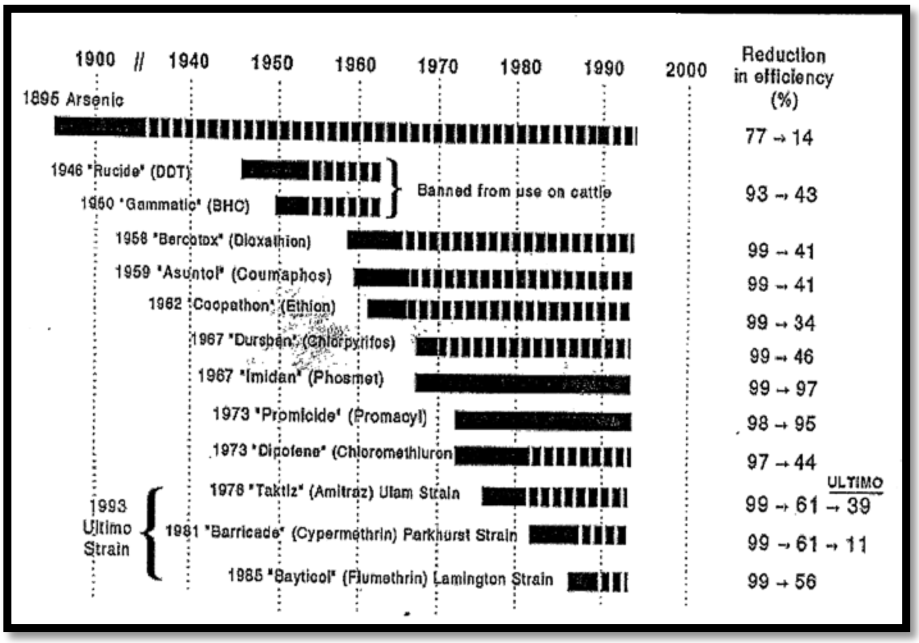
ii) Evaluate the difference between breeds with regard to yield and price. If we assume that the producer is currently using the optimum breed of cattle for that particular property, then any change in breed should result in either a lower yield, or a lower price for the cattle.

The opposite side of the question of breed optimally is important when examining the possible benefits from tick eradication. If producers in the tick-infested area have chosen *Bos indicus* cattle solely for its resistance to cattle ticks, then would they incorporate more *Bos taurus* cattle if *Boophilus microplus* is eradicated?

The issues in relation to breed choice are made more important with a domestic and international beef market that is becoming more heterogeneous. The cattle and production systems employed must reflect the demands of customers, for example, some producers in order to gain premium prices in the Japan beef market have experimented with breeds and production systems that produce a high level of 'marbling' in meat[4] (Queensland Country Life 1994, June 9). If it is shown that meat from *Bos taurus* breed cattle is more in demand than meat from *Bos indicus* breeds, then there are likely to be greater benefits involved in tick eradication.

C. Loss of Chemical Control Methods

Figure 6 shows how *Boophilus microplus* has gradually become resistant to major acaricides since arsenic was used as a control measure in 1895. As the effectiveness of a major pesticide declined, a new chemical has always been utilised in tick control. However, the research and development costs of new pesticides are a major barrier in the development of new chemical measures.



Source: DPI Information Sheet (1993)

Figure 6: Resistance to chemicals by *Boophilus microplus*

In the absence of any major chemical alternatives in the future, a situation exists as to how to most effectively utilise the current stock of chemicals to maintain their potency. Hueth and Regev (1974) have stated that the issue of insect resistance is similar to the economics of exhaustive resources in which the aim is to find the optimal benefits from the resource over different time frames.

The dairy industry is the most likely to be severely affected by a loss of the current chemical measures as replacement chemicals may involve long milk withholding periods, making them impractical for the dairy industry (Queensland Dairyfarmer, 1992).

The question needs to be asked of what is the most effective use of the current stock of chemicals. Should the remaining chemicals be utilised in an eradication campaign or should all producers in Queensland accept the inevitable end to chemical control methods, (and therefore no real means of continuing the tick-line) and adopt non-chemical forms of tick control?

D. Chemical Residuals and Market Exclusion

Aside from the problems with insect resistance, the industry's reliance on pesticides is being challenged by the problem of chemical residues in meat.

Applications of pesticides too close to slaughter can lead to chemical residuals in the meat. Residual violations in Japan in 1987 due to DDT, in the United States in 1993 (Condon and Nasson, 1994), problems relating to organochlorine products and the chlorfluazuron residual problem in 1994[5] have highlighted the real possibility of exclusion from key markets such as the United States and Japan for all Australian beef (Queensland Country Life, 1994; Wright, 1994).

Australia's continuance of exports and the prices received are dependent on the perception of Australian beef as high quality and free from toxins. Occurrence of residues of chemicals in Australian meat sent to key export markets would threaten both the price received and raise the possibility of exclusion from some markets.

To address meat residual problems, the cattle industry and the Queensland Government are working with a range of measures to control chemical residual problems. Withholding periods before cattle can be slaughtered have been enforced and examination of the residual levels of different chemicals by the Meat Research Council (MRC) continues to occur. The industry bodies and government have encouraged the use of highly tick resistant cattle so that little or no chemicals are used. Regulations relating to the movement of cattle from ticky areas have also been changed so that repeated tick treatments are no longer required in some circumstances when crossing the tick-line.

E. Treatment of other Pest Species

While *Boophilus microplus* is a major problem to cattle producers in Queensland, there are other economically significant external parasites. Biting and sucking lice, chorioptic and sarcoptic mange mites, and particularly buffalo flies (*Haematobia irritans exigu*) are often present simultaneously on cattle and need to be treated. Many of the more popular chemical treatments are utilised because of their ability to control several pests simultaneously (Stubbs et al., 1982). Davis (1996) reviews in much greater depth the control of multiple pest species.

A major benefit to producers from tick eradication is the savings in not having to engage in tick control. If the producer still has to treat cattle regardless of whether *Boophilus microplus* is present, then the advantages of tick control are greatly reduced. Equally, if producers in tick free areas are currently treating cattle for non-tick pests, and ticks are able to be controlled by the same methods currently employed to control these pests, then the benefits accruing to producers in the tick-free area may not be as great.

F. Other Factors

Two other complicating factors should be considered in developing an economic analysis of strategies for tick-control in Queensland. Argentina, a major potential competitor for key beef markets is currently undertaking a campaign for eradication of foot and mouth disease as well as *Boophilus microplus*. Once declared foot and mouth free, Argentina will be a major competitor for Australia in supplying markets such as Korea, Japan and the United States. This represents an important issue for Australia's entire beef industry, increasing the need for greater productivity and efficiency. Eradication of *Boophilus microplus* would be one means of improving producer productivity.

Finally, an examination of alternative tick control regulations should be considered in light of what is technically feasible. Eradication, for example can only be achieved if a number of conditions are achieved, such as full stock musters, complete producer cooperation and the removal of feral animals and occasional hosts[6] (Cattle Tick Control Commission 1973). Dahlsten et al. (1989) observe that with any eradication policy the ease of which eradication is achievable and the likelihood of the pest recolonising or being reintroduced into an area must be considered.

7. Conclusion

This paper has outlined the status of the cattle-tick in Queensland, the means by which it is controlled, the current Government regulations towards the cattle tick, it has also identified the issues that have to be addressed in developing an economic analysis of the current tick line and alternative regulatory stances.

LeVeen (1989) writes

> "Cost-benefit analyses, based on incomplete data and on certain critical values, must emphasise immediate benefits over long-term and less well understood costs. For this reason, they can be used to justify policies desired by powerful groups. Unfortunately, be public often accepts the figures resulting from this approach, so such analysis tends to obscure the real issues and to rationalise bad policy."

Leveen, finds that the valuing of uncertain and intangible values prevents cost-benefit analysis from being an effective technique for evaluating alternative pest control policies and can even be 'more dangerous than helpful'.

The methodology involved in developing cost-benefit analysis for large scale pest control projects will need to be refined to incorporate uncertain and intangible values more successfully. In the case of evaluating alternative tick control strategies, while there are uncertainties, these can be quantified with reasonable confidence provided there is sufficient data. Many of the factors mentioned above may not have much effect at all, however a quantified solution, particularly on issues such as the possible market advantage accruing to those in the tick-free region of the State, will address many areas of debate in the cattle industry.

8. Notes

1. The measures shown in this paper include only the major form of controls utilised in Australia. Other countries such as Nigeria, utilise methods such as bush burning, hand de-ticking and biological control through natural predators (Fasanmi & Onyima, 1992).

2. Until recent changes to movement regulations, all cattle moving from the ticky to the

tick-free part of the State had to be treated at clearing dips.

3. However the New South Wales situation has been economically evaluated by Johnston and Mason (1976) who also examined alternative control strategies such as eradication.

4. Marbling occurs when a high level of fat is spread throughout the meat.

5. The chlorfluazuron residual problem was caused by cattle being fed cotton trash which had been treated by the chemical Helix (Hansen, 1995)

6. Deer and horses are occasional hosts as well as the camel (Kennedy & Green, 1993).

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