MEAT & LIVESTOCK AUSTRALIA

on farm

# TICK CONTROL IN BEEF CATTLE

## *A workshop on current practice and future research directions*

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Animal Health and Welfare

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# PREAMBLE

Meat and Livestock Australia (MLA) conducted a *Tick Control in Beef Cattle* workshop in Brisbane on October 29, 2002. Over 50 researchers, scientists and industry representatives attended the workshop to consider existing tick control strategies and to discuss options for future research and development in the control of this parasite.

The meeting reviewed a number of aspects of cattle tick control including the incidence, avoidance and management of acaricide resistance. Currently there are only three classes of compounds that are effective against all strains of cattle tick, namely the macrocyclic lactones (MLs), fluazuron and the anti-tick vaccine Tickgard®. A further two chemical classes, the amidines and synthetic pyrethroids, are also effective for cattle tick control in regions where the parasite has not developed resistance to the respective chemicals. However, single and multichemical resistant tick strains have evolved in some regions and emerging resistance to existing chemicals is likely to limit the lifespan of current chemical control measures. Strategies to rapidly detect emerging resistance, or to predict its likelihood during the development of new chemicals, appear to be important to prolong the effectiveness of chemical controls.

The use of MLs in the control of cattle ticks was reviewed, as was the use of the recently re-released TickGard® vaccine. This vaccine is currently not widely used in the northern beef industry mainly due to the high frequency of treatments required. However the vaccine appears to have potential for wider use in tick control programs in conjunction with other control measures. Studies conducted at the time the vaccine was first launched, indicated that fewer treatments were necessary than is currently recommended, thereby increasing the attractiveness of this option.

Pasture management strategies to control tick numbers in paddocks was reviewed and appears to offer potential for inclusion in future control recommendations, particularly in view of increasing chemical costs and tick resistance. A balance must however be achieved between pasture management to reduce tick numbers and pasture management for optimum cattle productivity. A six-week spelling period appears to significantly reduce the numbers of tick larvae on pasture without affecting the quality of tropical pastures.

Experiences from tick control programs in the Queensland dairy industry were presented and highlighted a range of issues associated with the communication, implementation and rate of adoption of such programs. The experiences and outcomes from the dairy program should be carefully considered by the beef industry prior to promotion of best practice cattle tick control programs to this sector of the industry. The key issue presented was the need for a simple and effective program that is easily communicated.

The changing face of cattle tick regulation, particularly in Queensland, was discussed, as was the use of tick fever vaccines for the control of tick borne diseases. Significantly, there is a move to "privatisation" of the delivery of services at clearance sites along the tick line and the use of tick control staff for a range of other activity including animal welfare functions. An imbalance exists where producers that benefit from the regulatory control of ticks (those in the tick free areas) do not necessarily pay for that benefit.

The morning session of the workshop concluded with a presentation on current best practice recommendations for cattle tick control in beef cattle. A workshop session was held to review the combined use of pasture management, vaccination and chemicals to achieve sustainable tick control in endemic areas and to eradicate ticks on individual properties, with a view to reducing chemical usage and delaying the development of resistance to existing chemicals.

Control programs that exist for beef cattle are largely adequate at this time. The combination of resistant genotypes of cattle and the slower (apparently) emergence of resistance to acaricide on farms with beef cattle (compared to dairy) has resulted in a range of options still being available. These options are under some threat. There is a quoted trend in the reduction in the proportion of resistant (Bos indicus) genotypes due to market pressures. There is also continuing emergence of resistance by ticks to acaricide, most notably on some tick clearance sites in central Queensland. The rate at which these threats will be generally realised is uncertain. An important message was the need to identify and communicate the economic rationale for beef cattle producers to invest in voluntary tick control strategies, as the major driver in tick control is primarily the current regulatory requirements.

The afternoon session of the workshop turned the group's attention to the future of tick control over the next 25 years. Presentations were delivered on host resistance and other immunological approaches to tick control, biocontrol measures, pheromone-based control measures and the potential for the development of new pharmacological solutions.

The development of gene markers for tick resistance in cattle received strong endorsement from industry, as did improvements in anti-tick vaccines. The hunt for these markers may prove elusive but was seen as a long-term sustainable way to manage ticks.

The development of biological and pheromone control options also offer hope for the future. Research is currently progressing on the use of a fungal pathogen for cattle tick control.

Genomic information on ticks suggests that there are a large number of potential targets for new acaricide chemicals, however unlike nematodes and insects, molecular genetic tools and assays for tick target validation are still undeveloped due to the smaller market potential for acaracides. It was suggested that in the short term, new validated targets are more likely to come from basic research on tick toxins, biological pathways and mode of action work for new insecticidal compounds that also have acaricidal action.

## Outcomes

The major outcomes generated from the meeting were identified as:

1. A need to identify the economic rationale for tick control and treatment in beef cattle, given that the current primary driver for control is regulatory. Previous cost-benefit analyses have been based on genotypes that were more *Bos taurus* than *Bos indicus* and further work may be needed to identify the effect of cattle ticks on the productivity of cattle genotypes currently used by northern Australian producers. In 1995 cattle ticks were estimated to cost Queensland growers $41 million in tick control (chemicals, labour and dip repair and maintenance) and a further $91 million due to meat production losses from tick worry and mortalities due to tick fever[1]. Similar figures are not available for other tick prone areas of Australia.
2. A need to develop risk management strategies for the Queensland tick line in order to free-up trade in the face of increasingly ineffective knockdown chemical treatments.
3. A need to develop improved recommendations for the use of the anti-tick vaccine as a tool in cattle tick control and to improve the uptake of this product in the northern cattle industry.
4. A need for better definition of acaricide resistance in northern Australia perhaps by means of a structured survey.
5. A need to address the current stringency of NRA registration requirements for new acaricides. The current requirement for greater than 98% efficacy may limit the development and commercialisation of new acaricides that possess a lower level of efficacy. However these products may still provide valuable tools for tick control in the cattle industries. The possibility of a joint submission by MLA and AVCARE to the NRA should be considered and selected pharmaceutical companies may be approached to ascertain the barriers to registration of new actives eg Fipronil.
6. A need to review current cattle tick extension programs to assess the adoption of extension messages and to identify extension personnel and their training status. Short-term pasture management strategies may also be included in future extension messages.
7. Future potential research directions identified include:
   (a) Methods to detect the development of early resistance to chemicals in the field and to predict the development of resistance in new chemicals at an early stage of development
   (b) Identification of gene markers for selecting resistant sires
   (c) Identification of new targets for chemical screening
   (d) Biocontrol and pheromone options appear to be currently under utilised – is their scope for defining other options?
   (e) Improving the efficacy of the available anti-tick vaccine

[1] McLeod RS (1995) *International Journal for Parasitology* 25 (11):1363-1367

# TICK CONTROL IN THE DAIRY INDUSTRY – PROGRAMS, OUTCOMES AND LESSONS FOR THE BEEF INDUSTRY

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## Background

In 1992, cattle ticks (*Boophilus microplus*) resistant to synthetic pyrethroid and amidine dip and spray acaricides were identified on a beef property in Central Queensland. This strain of resistant ticks was designated Ultimo, after the district where they were found. The only available products effective against these ticks were those from the macrocyclic lactone (ML) class, including ivermectin. At the time these ticks were identified, no MLs were available for lactating dairy cows whose milk was intended for human consumption. This discovery caused considerable concern within the dairy industry and the Queensland Dairyfarmers Organisation (QDO) applied to the Department of Primary Industries (DPI) and the Dairy Research and Development Corporation (DRDC, Dairy Research Corporation or DRC, as it was then) to accelerate the process of eradication of cattle ticks from Queensland and to commit more resources to research into tick control.

The problem of controlling cattle tick in the Queensland dairy industry is complex and further complicated by the history of tick control in the State. Approximately 75% of all Queensland dairy farms lie within an area where the cattle tick has been endemic for about a hundred years. The other 25% or so lie to the west of this area, mostly on the Darling Downs. This area is protected from the incursion of cattle tick by regulations on the movement of cattle as well as by a less favourable climate for tick infestation.

The history of cattle tick control in Queensland has been one of containment and eradication on the boundaries of the endemic area, and intensive control elsewhere. Containment and eradication strategies have been traditionally seen as the domain of the public sector, while strategies of control within the endemic area have been seen as the responsibility of the individual land-holder. This dichotomy is reflected in the current pattern of high levels of public spending on movement controls, inspection and eradication relative to control of ticks within the endemic area. It is also reflected in the training and approaches of government officers involved in tick control. Attempts to manage previous crises, such as the widespread occurrence of organophosphorus resistance in the late 1960s, have generally been by containment and eradication. Staff have been trained to detect tick infestation and to promote the elimination of infestations in travelling stock. In general, there is little tolerance of any amount of cattle tick infestation.

Significant effort and funding were invested, however, in the development and promotion of breeds of cattle that are adapted to the northern Australian climate and resistant to cattle tick infestation. The DPI was heavily committed to the development of the Australian Friesian Sahiwal (AFS) breed of dairy cattle, and CSIRO likewise committed considerable resources to the development of the Australian Milking Zebu (AMZ) breed. The genetic base of both of these breeds has been, in one way or another, disposed of by the public sector, and although semen from both these breeds of tick resistant cattle is still available, it is difficult to source and is from a very limited gene pool. Certainly there has been very little if any genetic gain in milk production since the breeds were first made available. Premature attempts to commercialise the AFS breed resulted in a reputation for poor temperament, poor milk let-down and truncated lactations. Not surprisingly, their adoption by dairy farmers has been very limited. The QDO was a robust critic of the AFS breed, encouraging the DPI to divest its breeding stock and any involvement with the breed. Members of the QDO Council were of the opinion that resistant breeds of cattle were not the answer to the immediacy and severity of the threat posed by multiple acaricide resistance.

QDO Council believed that the most sensible response was to accelerate the eradication of the cattle tick from the state. While the voluntary eradication of the cattle tick was and is encouraged, the conditions under which eradication programs are to be supported by the State are very clearly described in the Acts and Regulations. Voluntary eradication programs will only be supported where a group of producers, whose properties are contiguous and adjoin the tick-free zone, apply to the State to be declared a Cattle Tick Eradication Area. The application must be considered by DPI officers, in consultation with an advisory body composed of industry stakeholders and scientists. It is an important condition that any group applying for declaration must have the support of the majority of landholders within the area proposed. It is also critical that the proposed area adjoins the Cattle Tick Free or Protected Area. With these preconditions, State-supported eradication is impossible on most dairy farms in the State within the foreseeable future. Without legislative support, regional eradication schemes are doomed to fail, because of the inability to prevent influx of infested cattle and the inability to enforce eradication on non-co-operator properties within an eradication area.

In spite of the forgoing, Councillors and Executive of the QDO were hopeful that the legislation could be modified to support the development of isolated tick eradication cells within the Tick Infected Area. At about the same time as the diagnosis of the Ultimo strain of cattle tick, a vaccine against the cattle tick was approaching commercial release. TickGARD had been developed by scientists in CSIRO and an offshoot company Biotech Australia and was released in 1994. The possibility of eradicating the cattle tick from dairy-farming districts with the assistance of the vaccine was advocated by the QDO. TickCON, a control programme for cattle ticks was developed by QDO, in consultation with DPI officers, CSIRO scientists and Hoechst Roussel Vet, licence holders of the tick vaccine. In 1994 and 1995 this programme was vigorously promoted by QDO to its membership, and attempts were made to organise TickCON groups that could act as quasi eradication groups. Properly implemented, the TickCON programme was expected to result in eradication of ticks from those farms that used it.

## The TickCON Program

The research project DAQ151, funded by the DRDC, commenced in 1996. The title of the project, negotiated between DRDC and DPI, was *Evaluation, development and application of integrated pest management strategies for cattle tick on northern Australian dairy farms.* Approximately $67,000 per year was committed by the DRDC to the project over three years, and half the time of one senior research scientist was committed by the DPI. It is clear from the title of the project that the emphasis of the project was on the development of sustainable control strategies for dairy farmers within the cattle tick-infected area. It was considered by the DRDC that attention should be paid during the project to the extension of research results and to the support of the existing TickCON project. The project leader for the research project was considered to be the DPI coordinator for the TickCON program

The essence of the TickCON program was to treat all cattle on all dairy farms with an acaricide on six occasions at three-week intervals, commencing on a given day in spring. This was combined with prescribed dates for vaccination against ticks using the TickGARD vaccine and vaccination of calves against tick fever. Farmers could therefore be reminded of dipping dates via notices sent out on the milk tankers. TickCON calendars with the recommended treatment dates were developed by QDO and DPI each year and distributed to all dairy farmers in the state. DPI and QDO recommended the installation of efficient spray races or plunge dips for tick control in place of widely used hand sprays. Many field days were held at which the benefits of the high level of tick control achievable through the strategic TickCON program were promoted.

Some concerns were expressed about the possible risk of detectable residues of acaricides in bulk milk if all cows in southeastern Queensland were treated on the same date and the dairy processors obtained a small set of data to allay these concerns. These data were never made public.

## *Dairy TickCON Calendars*

The TickCON calendar, produced each year, and distributed it to all QDO members, prescribed strategic treatment times for chemical dipping and vaccination against cattle tick. Calendars also included a limited set of recommendations to optimise tick control. From 1994 to 1995, the calendars had only a single set of recommended dates. In 1996, to cater to differences in the timing of the spring rise in different regions, the calendar had optional dates for far north and central Queensland. By 1997, it was clear that there was a need to cater to different expectations for tick control and the calendar for 1997/98 was designed as a paper-based decision support system, for four climatic regions and for three levels of control, either with vaccination with TickGARD*PLUS*, or without it. Thus, there were 20 different programs on the poster, and the farmer was expected to mark treatment dates on the calendar before the commencement of the tick season.

We undertook a telephone survey of 30 farmers randomly selected from the tick-infested area of the state to determine whether they received the 1997/98 calendar, whether they read and examined it, whether they used it, and whether they considered it to be of any value. Although the calendar was distributed in *The Queensland Dairyfarmer*, delivered to all farmers, only 19/30 farmers claimed to have received it, only 9/30 farmers read or examined the calendar, and only 2/30 actually used it as intended.

Because of the poor use of the 1997/98 calendar, and in response to the Extension Workshops of 1998, the TickCON extension group compiled a simpler, cheaper version printed both sides of an A4 sheet for 1998/99. A different sheet was distributed to farmers in each region. The front page included general information, and the reverse side had example calendars for high and low tick infestations. There was no follow-up to determine the effectiveness of these calendars.

## *Problems with TickCON*

With a view to improving the uptake of TickCON recommendations, the limitations and problems with TickCON were widely discussed at a number of meetings with farmers, scientists, dairy processors and advisers. The following are some of the more consistent issues.

1. What was the real aim of the program? Eradication was never going to be feasible on the majority of properties. Is there any point in pursuing such a high level of control if eradication is not a realistic goal? On some farms (perhaps the majority) the program would likely accelerate the development of resistance against acaricides by reducing the proportion of ticks in refugia and by increasing the number of acaricide treatments.

2. "The program did not work for me." Many farmers who used the program according to recommendations still had ticks on their cows. Most farmers thought that the TickCON program was supposed to be an eradication program, effective over one year. Under ideal circumstances, the program should eliminate ticks from most farms, however, 60% of dairy farmers used hand-spraying methods for applying acaricides, 25% used spray races and 17% used plunge dips. In most cases, the facilities and methods used fell short of recommendations.

3. Most farmers were not really interested. Only 6% of farmers used the full program in 1996/97. A further 6% used the program but without using TickGARD. Farmers ranked buffalo fly as a more immediate problem than ticks. Most farmers do have access to an acaricide that effectively controls ticks and do not see the risk of resistance against all acaricides as an immediate cost. This is in spite of the fact that the use of MLs will increase the cost of controlling ticks by a factor between five and ten, and that the use of MLs in strategic tick control programs is likely to lead to the rapid development of resistance by gastrointestinal parasites to MLs.

4. Interdependence of properties. Many farmers saw no point in using an intensive control program if neighbouring properties continued to present a high risk of reinfestation.

5. Present levels of resistance to the acaricides that are suitable for application in spray races or plunge dips, together with their high price of installation act against any extension campaign to encourage farmers to upgrade facilities. It is unlikely that resistance-testing methods in place today can predict the useful lifespan of a given acaricide on a farm where resistance is not already evident as dipping failure.

## Dairy Tick Control Liaison Committee

In an attempt to formalise an extension program for tick control in the dairy industry, an industry advisory committee, chaired by a QDO councillor, and with farmer, processor and DPI representatives was convened. The aim of this group was to co-ordinate extension and research activities in the field of tick control beyond the life of the funded project DAQ151. Unfortunately, this major aim was not achieved and the group, which had been active for a year, did not meet after the conclusion of the project DAQ151.

## Problems with Extension

A large proportion of the extension effort of the original TickCON program was directed at motivating farmers to apply the TickCON program to their own farms. Most of the conventional recommendations for tick control arise from programmes designed to result in eradication of ticks rather than sustainable control. However, not all of the extension recommendations could be supported by evidence and on close consideration of the program, the author concluded that the only messages for dairy farmers in the tick-infested areas of Queensland that could confidently be applied to all producers were:

1. Vaccinate all calves against tick fever.

2. Always use chemicals as directed on the label. Failure to do so is illegal and increases the risk of toxicity and residue problems.

3. Use the least number of treatments necessary by using a strategic program (i.e. in spring, usually at 21 day intervals for short-acting chemicals). And by making use of aids to control such as TickGARD, resistant breeds and pasture spelling where possible.

4. Keep resistant ticks out by treating all incoming cattle with a macrocyclic lactone product (e.g. moxidectin). (Even this treatment has not been confirmed to be effective and should be tested scientifically, although the theory behind it is very sound)

Several of the widely held tenets of tick control extension programmes are not supported by evidence or are likely to accelerate the development of resistance. These include:

1. Install a spray race or plunge dip rather than use hand-sprays.
    a. Hand sprays are likely to present a greater risk in terms of occupational health and safety, although there has been no study to determine levels of exposure arising from the different application methods.
    b. The installation will be rendered useless within one or two seasons if resistance to the dipping chemicals is already present at a low level when it is built. This might be the case for three to four years before resistance is identified by low kill rates.
    c. The higher efficiency of application by plunge dip or spray race and resulting higher level of control is likely to result in more rapid selection for resistance to acaricides.
2. Treat all groups of animals on a farm on the same day.
    a. This approach is necessary to achieve eradication but will certainly reduce the number of ticks in refugia and will accelerate the development of resistance under most circumstances.
    b. Different groups tend to have different levels of exposure to ticks. In many cases the milking cows don't carry as many ticks as dry cows and heifers.
3. Treat all animals in a group.
    a. As for 2. This issue is likely to be more important in herds where expensive endectocides are being used for tick control.

## Conclusion

Promotion of best practice for the control of ticks requires careful consideration. There are many large deficiencies in our knowledge that will act against the communication of simple messages to farmers. However, within the framework of our limited knowledge, the basic requirements include:

1. A simple, clear, undisputed and achievable aim. TickCON did not have this. The aim might be to delay the development of resistance, to limit the possibility of residue violations, or to eradicate ticks within a defined area with legislative support.

2. A strong evidence base for extension recommendations or clear statement as to where the basis of

recommendations crosses over from evidence into theory.

3. A suite of practical recommendations that can be readily implemented, that do not result in marginal losses and for which there are recognised performance indicators.

4. Continuing projects or the establishment of effective structures to ensure continuity of activity.

# REGULATION OF TICK CONTROL - CURRENT & FUTURE TRENDS

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## Maintain a tick "free" area

Both Government and industry currently support the policy of maintaining a tick free area.

In Qld $3.5 million per annum is spent on tick services.

## Industry has a high aversion to "risk"

Industry generally has a high aversion to risk and this influences the decision making process. The 'NIL' risk attitude of industry (and some DPI staff) affects the cost of clearing stock into the tick free area.

This attitude also contributes to the unnecessary use of acaricides and increases the risk of chemical contamination.

## Political considerations

Governments and Departments are often hesitant to make politically tough or sensitive decisions. The influence of different sectors of industry either side of the tick line has considerable effect on policy. A change of government could completely refocus the direction of the tick project.

## Subsidisation of tick services

The cost of providing tick inspection services will be placed onto the user of the services.

The major beneficiary of the tick free area is the producer that lives within the free area (particularly those within climatic parameters where ticks could survive in the area) and yet they contribute very little directly to the maintenance of the tick line.

The mechanics of how the service will be provided will continue to be reviewed by government. Alternative service providers and additional services such as on property or off line clearance and seven day services are required by industry.

## Reliance on chemical clearance

The "nil" risk approach to tick clearances has led to the over dependence on chemical clearance and there is a low acceptance of alternative clearing strategies.

## Minor use of "Risk" management options

Prescribed roads, low risk stock, approved meatworks, approved feedlots, controlled feedlots, low risk saleyards and meatworks. Except for horses and show stock these only account for a very small proportion of livestock movements.

# Future Trends

## No conventional acaricides for clearance

There is a high probability of continued development of acaricide resistance to conventional chemicals.

High cost of developing chemicals and the low likelihood of new knockdown chemicals in the near future.

## High cost to maintain tick free area

Overall priorities for animal health services will mean that government costs associated with the maintenance of the tick free area will be redirected to industry.

There is the likelihood of increased tick incursions due to resistance and the use of less effective knockdown chemicals.

## Increased cost to clear stock

The redirection of costs, lack of conventional acaricides and new mechanisms for clearing stock across tick lines will inevitably increase the costs to move stock, unless risk management or QA systems are allowed.

## Greater use of "Risk" management

The potential exists for some sections of industry to self regulate their stock movements across the tick line.

Industry may need to take greater responsibility for management of the tick problem, particularly through a QA approach.

Minimisation of inspection and use of chemicals through risk assessment should be encouraged.

1. Risk from point of origin
2. Risk at destination
3. Treatment protocols
4. Environmental factors affecting level of Risk!

## Will there be a tick free area?

Changing circumstances may preclude maintenance of the tick line in the long term - it may be technically and economically impossible to maintain.

## Will producers be able to live with ticks?

Changes may make it impossible to maintain a tick free area and producers will have to be able to manage ticks through vaccination and live with ticks.

## Will ticks be eradicated?

The total opposite may occur whereby technical advances with vaccines and biotechnology may make it feasible to eradicate ticks completely.

Although a tick line may be needed as any eradication progressed.

# TICK*GARD*®*PLUS* – What Can It Do For The Beef Industry?

**MATT PLAYFORD**

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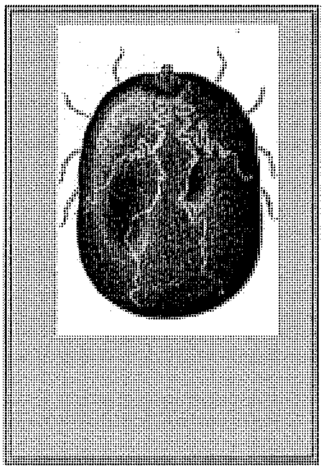
## Tick*GARD* ®*PLUS*

**For use in cattle as an aid in the control of the cattle tick (*Boophilus microplus*) by reducing the build up of cattle tick larvae on pasture.**



**THE CATTLE TICK**

The cattle tick is the most serious external parasite of cattle in Australia, causing great economic losses to the beef & dairy cattle industry.

## Tick Control

### Chemical

- Dips & Sprays (as regularly as every 21 days)
- Injectable & pour-on mectins (as regularly as every 21 days)
- Fluazuron p/on - tick development inhibitor – not in dairy cattle

## Non-Chemical

- Pasture rotation – need to leave pasture free of all stock for up to 9 months
- Genetic selection for tick resistant cattle
- Seasonal temperatures & humidity
- Locations away from flood waters to decrease spread & control with fires
- Fencing with controlled cattle movements & 100% musters
- Vaccine (Tick*GARD® PLUS*)

## Concerns

Continuing development of resistance in ticks with excessive chemical treatments. Similar problems in other ectoparasites and internal worms due to broad-spectrum treatments.

Chemical residues in domestic and overseas markets.

## How does TickGARD®PLUS work?

Rather than killing the tick outright, like conventional chemicals, the major effect is on the tick's reproduction. Consequently, the effects of vaccination are not likely to be noticed immediately after treatment.

The vaccine stimulates an immune response against a gut protein of the tick, resulting in an inability to feed properly, with damage to the tick and reduced egg-laying capacity.

DPI trials of the vaccine in dairy cattle have indicated that the vaccine reduces tick reproductive performance by 70 %.

Use of Tickgard Plus will reduce the number of conventional chemical tick treatments required to control tick populations, therefore delaying the onset of resistance to these products.

Tickgard plus is therefore long-term tick control.

## How is TickGARD®*PLUS* used?

Tick*GARD®PLUS* should be given every 8 - 12 weeks throughout the year, starting as soon as possible, preferably before the spring rise. Previously unvaccinated cattle will need a primer dose 1 month before the 1st injection.

DPI recommend 5 treatments per year every 10 weeks, beginning before the spring rise.

A 2 ml dose is given under the skin.

Tick*GARD®PLUS* comes in a 100 mL bottle (50 doses).

## TickGARD®PLUS LONG TERM TICK CONTROL

- ✓ NIL WITHHOLDING PERIOD
- ✓ REDUCES CHEMICAL USE
- ✓ EFFECTIVE AGAINT CHEMICAL RESISTANT TICKS

# THE USE OF MACROCYCLIC LACTONES IN THE CONTROL OF CATTLE TICKS IN BEEF CATTLE

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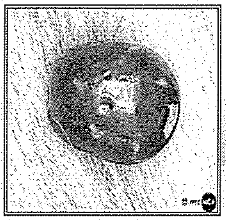
**The use of macrocyclic lactones in the control of cattle tick on beef cattle**

**Jo Bell.**
**Technical Manager- Rural Fort Dodge**



- **ML's, pharmacokinetics and mode of action**
- **Product Cydectin® and the expectations of efficacy against tick stages**
- **Considerations before using the ML's in a tick program**

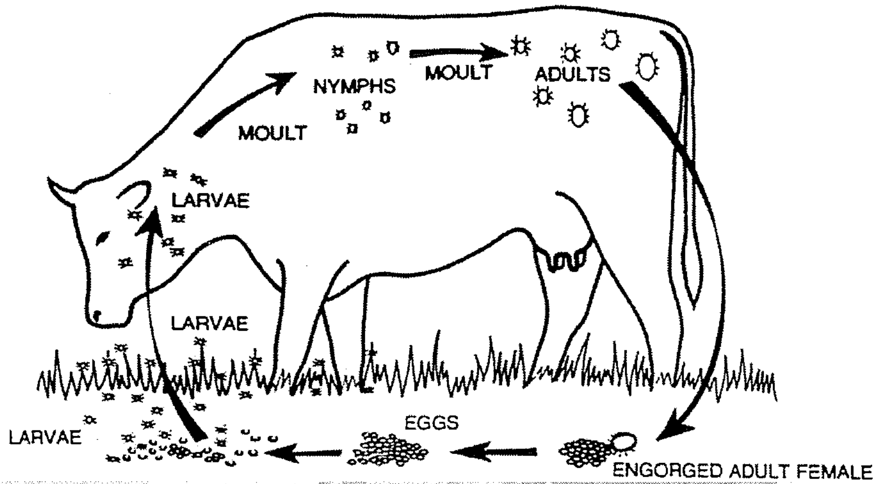
® Registered trademark

FORT DODGE®

- **ML's, pharmocokinetics and mode of action**
- **Action systemic, endo as well as ecto effects.**
- **Different pharmacokinetics of actives and formulations (Tmax, AUC's)**
- **Increase GABA binding and the flow of chloride ions into cells, produces hypopolarization of nerve membranes**
- **Signal transfer fails, paralysis then death**
- **<u>NOT ALL ML'S HAVE A CLAIM FOR FULL EFFICACY AGAINST CATTLE TICK</u>**

FORT DODGE®

## 2. Product Cydectin® and tick efficacy expectations.

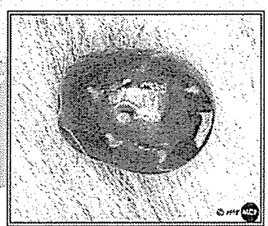



FORT DODGE®

## 2. Product Cydectin® and tick efficacy expectations.

**Engorged female ticks and male ticks**

- **3-4 days drop off (6-9d QDPI)**
- **May be slightly shorter with injectable**
- **First 2 days eggs may be still be viable**
- **2-21 days non viable eggs Pour-on, 2-28 days injectable.**
- **Retreat 21 days Pour-on will never have viable eggs**



FORT DODGE®

## 2. Product Cydectin® and tick efficacy expectations.

**Nymphs and larvae**

- Lymph feeders but are still affected
- Activity against larvae may not be 100%
- Reflected in a slight increase in adults at 12-14 days post treatment which will die within 2-3 days.
- Cattle are cleanest 5-11 days post treatment
- If held in tick free area will be clean 14-16 days post treatment

FORT DODGE®

## 2. Product Cydectin® and tick efficacy expectations.

**Held in Tick- Free area**

- Clean about 14-16 days post treatment

**Held in Ticky area**

No viable eggs after first 2-3 days

- Days 3-10: very low levels larvae
- Days 10-16: low levels larvae, nymphs and a few engorged dying females
- Days 16-21: low levels nymphs, odd dying engorged female
- Day 21( Pour-on), Day 28 ( injection): reduced efficacy

FORT DODGE®

## 3. Considerations before using an ML in a tick program

**Onset of action**

**Re-treatment intervals**

- Vary according to product
- EG Cydectin Pour-on interval of 21 days matches tick life cycle: implications in suppressing tick populations by eliminating the production of viable eggs (>98%) and therefore tick bourne disease.
- Reduce heavy tick burden, pretreat

**Witholding Periods**

- Cydectin Pour-on Nil ESI, Nil Witholding period

**Cost and Application method**

FORT DODGE®

# TICK FEVER – CURRENT USE OF VACCINES AND TRENDS FOR THE FUTURE

**RUSSELL BOCK**

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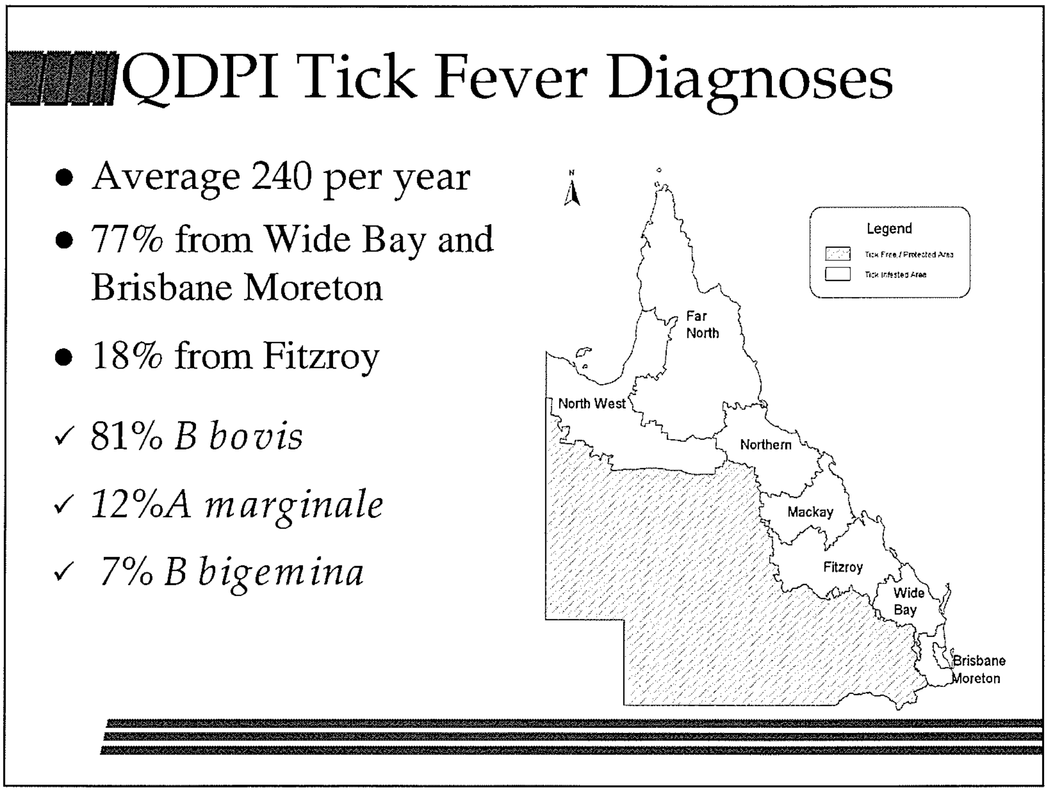
Tick fever is an important cattle disease in *B microplus* infested areas of Australia caused by infections of *Babesia bovis, Babesia bigemina* or *Anaplasma marginale.* It is also a potential threat to the live cattle export trade (de Castro, 1997). QDPI diagnostic laboratory records over the last 10 years show an average of 240 confirmed tick fever diagnoses per year with 90% coming from Brisbane Moreton, Wide Bay, and Fitzroy ABS regions but as 77% of respondents reporting outbreaks of tick fever in a 1999/00 survey did not have the outbreak confirmed, this is obviously an underestimate. *B bovis*, *A marginale* and *B bigemina* caused 81%, 12% and 7% of confirmed outbreaks, respectively over the 10 year period.




QDPI has produced live vaccines containing attenuated strains of *B bovis* and *B bigemina* as well as *A centrale* grown in splenectomised calves since 1964 (Callow et al., 1997). The predominant product initially was chilled monovalent *B bovis* vaccine, but in 2001/02 TFRC sold 870,045 doses made up of 38% chilled bivalent (*B bovis* and *A centrale*), 59% chilled trivalent (*B bovis, A centrale* and *B bigemina*) and 3% frozen trivalent vaccine. Vaccine sales are highest in the winter months when most weaner vaccinations are given and there is also regional variation in sales as shown in table 1.

**Table 1 Percentage of Chilled vaccine sales by region and valency in 2000/01**

| Region | Bivalent | Trivalent | Total |
|---|---|---|---|
| SE Qld | 20 | 29 | 25 |
| Central Qld | 62 | 41 | 50 |
| North Qld | 11 | 16 | 14 |
| Tick Free Area of Qld | 1 | 8 | 5 |
| Northern Territory | 1 | 4 | 3 |
| Western Australia | 5 | 2 | 4 |
| Other states | 0 | 0 | 0 |
| Total | 100 | 100 | 100 |

Use of tick fever vaccine in endemic parts of Australia is a risk management strategy based on the producers' perceived risk of exposure, the value and susceptibility of the stock involved and the owners' acceptance of the vaccine. For example the higher the *B indicus* content the less likely a producer is to use the vaccine. Only 58% of vaccine users surveyed in 1999/00 had more than 80% of their stock vaccinated at least once, but almost all users vaccinated cattle introduced from the *B microplus* free area.

**Table 2 Percentage of tick fever vaccine users in Queensland by ABS region for producers with more than 100 head of cattle**

| Survey | Region | | | | | | | All |
|---|---|---|---|---|---|---|---|---|
| | Brisbane Moreton | Wide Bay | Fitzroy | Mackay | Northern | Far North | North West | |
| 1999/00 survey (n = 382) | 73 | 64 | 53 | 38 | 28 | 25 | 27 | 51 |
| 1992 survey† (n = 205) | 71 | 59 | 42† | | 19 | 13 | 14 | 45 |

†Fitzroy and Mackay regions were combined as Central in the 1992 survey.

## Recommendations for use of tick fever vaccines in Australia

### *In endemic areas*

A single vaccination at 3 to 9 months of age should provide strong, lasting protection. At that age, the risk of vaccine reactions is minimal. There is no evidence that immunity wanes with time and revaccination is therefore unnecessary as a routine procedure (Bock and de Vos, 2001). Revaccination is advisable when there is uncertainty over the accuracy of previous records or procedures, to ensure all animals seroconvert (Table 3) or when there has been a change in the strains used in the vaccine (Bock and de Vos, 2001) especially for valuable stock.

**Table 3: Seroconversion of naïve weaner age calves following vaccination with trivalent tick fever vaccine (Bock and de Vos, 2001)**

| | Post vaccination seroconversion | | |
|---|---|---|---|
| Vaccine parasite | Number to seroconvert | Number seronegative | Percent seroconversion |
| *B bovis* | 359 | 0 | 100 |
| *B bigemina* | 354 | 5 | 98.6 |
| *A centrale* | 346 | 13 | 96.4 |

Trivalent vaccine is recommended for *Bos taurus* breeds, valuable animals such as stud cattle, and cattle originating from tick-free properties. Bivalent vaccine is most often used in *Bos indicus* and cross-bred cattle born in tick-infested areas.

### *In live cattle export trade*

Current measures vary depending on the requirements of the importing country, the origin of the cattle (endemic or non-endemic regions) and the type of cattle (breeders or cattle destined for feedlots). Where import requirements stipulate vaccination, it is usually to be done very shortly before export.

If the requirements were changed to allow vaccination at weaning age (6-9 months), it would provide adequate protection after export (Bock and de Vos, 2001) and would negate the need to muster and hold cattle some time before export. It would therefore reduce the risk of vaccine reactions en route. This would result in the delivery of a much more suitable animal. The main provisos will be an on-farm QA system, which will allow proper use of the vaccine and identification of immunised animals and acceptance by importing countries.

## The Future

The current live tick fever vaccine has shortcomings including a short shelf-life, transmissibility of *B bovis* vaccine strain, potential for co-transmission of infectious agents, animal welfare considerations, high cost of production and increasingly stringent national registration requirements. These limitations have led to continuing efforts to develop vaccines based on recombinant DNA technology, but limited research funding, variations in immune responsiveness (Court et al., 1998) and the need for repeat vaccinations mean that recombinants are a long way from commercial reality.

At QDPI, our focuses are:

- Optimised production methods for frozen vaccines to increase their viability and post thawing shelf life resulting in more cost effective production (i.e. through more efficient use of donor calf blood with lower pro-rata fixed costs and fewer vaccine batch failures).
- User friendly options for the presentation, storage and dissemination of the vaccines to field sites.

- A more protective Anaplasma vaccine based on a milder *A marginale* strain to provide better protection against challenge from the more virulent strains of *A marginale* especially overseas.

To improve biosecurity, by mid 2003 all calves used for vaccine production will be bred from an SPF herd held at Wacol and if the above research is successful we will move entirely to a frozen product over the next few years.

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# ACARICIDE RESISTANCE – CURRENT STATUS IN AUSTRALIA

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Historically the cattle tick *Boophilus microplus* has demonstrated its capacity to develop resistance to chemicals introduced for its control. Currently in Australia there are three classes of compounds that are effective against all strains of the cattle tick, namely the macrocyclic lactones class, fluazuron and the anti-tick vaccine Tickgard®. A further two classes of compounds: the amidine and synthetic pyrethroids (SP), are effective for the control of the cattle tick in regions determined as not having resistance to the respective chemical. The emergence of the Ultimo (resistant to amitraz, an amidine compound and SPs) strain of ticks in the early 1990's demonstrated the need for the accurate classification of the nature of resistance for specific regions followed by the implementation of an appropriate strategy for the use of an effective class of acaricides.

Detection of resistance has traditionally relied on the submission of field isolates of ticks for laboratory analysis using in vitro methods. Unfortunately this type of analysis usually occurs once a breakdown in control has been identified, not when resistance first was detectable. There is long time frame between emergence of resistance to a specific acaricide and loss of control, usually about 4 years. To prevent a loss of control of a specific acaricide requires that either frequent testing of field isolates is carried out to ensure the tick population is fully susceptible to the acaricide being used and/or the development of more sensitive methods for the detection of resistance.

The beef industry has a number of classes of acaricides available for the control of the cattle tick. Strategies that aim to minimize the emergence of resistance assist the industry by extending the efficacy of the existing classes of compounds for the control of the cattle tick. Further there is a need for structured process for the sampling of field populations of ticks to determine their resistance status and hence determine which class(es) of acaricide is appropriate to use. The absence of a strategy may result in the loss of efficacious chemicals for the control of the cattle tick without new compounds to replace the existing classes.

# ACARICIDE RESISTANCE CONTROL OF VARIOUS STRAINS

| | RESISTANT STRAINS | | | | |
|---|---|---|---|---|---|
| CHEMICAL | BIARRA MT ALFORD *(Organophosphates)* | ULAM *(Amitraz)* | LAMINGTON *(Bayticol)* | PARKHURST *(Barricade 'S' Bayticol Tixafly Blockade-S)* | ULTIMO *(OPs Amitraz Barricade 'S' Bayticol Tixafly Blockade-S)* |
| OPs | NO | NO | NO | NO | NO |
| AMITRAZ *(Taktic, Nu-tic, Amitik)* | YES | NO | YES | YES | NO |
| BARRICADE 'S' BLOCKADE-S | YES | YES | YES | NO | NO |
| BAYTICOL | YES | YES | NO | NO | NO |
| TIXAFLY* | YES | YES | YES | NO | NO |
| MACROCYCLIC LACTONES *(Cydectin, Ivomec*, Dectomax*)* | YES | YES | YES | YES | YES |
| TICK GROWTH REGULATOR *(Acatak*)* | YES | YES | YES | YES | YES |

* NOT REGISTERED FOR LACTATING DAIRY CATTLE

CREST & DPI LOGO

Kevin Duff, District Inspector of Stock, Beaudesert - 19 August 1998

# HISTORY OF ACARICIDES IN QUEENSLAND

| CHEMICAL | TRADE NAME | INTRODUCED | RESISTANCE | WITHDRAWN |
|---|---|---|---|---|
| Arsenic trioxide | Arsenic | 1895 | 1937 | 1986 |
| CHLORINATED HYDROCARBONS | | | | |
| DDT | Rucide | 1946 | 1953 | 1962 |
| BHC | Gammatik | 1950 | 1953 | 1962 |
| ORGANO PHOSPHATES | | | | |
| Bromophos ethyl (+ chlorfenvinphos) | Nexagan 'S' | 1967 | 1970 | |
| carbophenothion | Dagadip | 1958 | 1963 | 1968 |
| chlorpyrifos | Dursban | 1967 | 1970 | |
| coumaphos | Asuntol | 1959 | 1966 | |
| diazinon | Neocidol | 1955 | 1963 | 1967 |
| dioxathion | Bercotox, Delnav | 1958 | 1963 | 1982 |
| ethion | Coopathon | 1962 | 1966 | |
| phosmet | Prolate, Bophox | 1967 | | 1985 |
| CARBAMATES | | | | |
| carbaryl | Sevin | 1959 | 1963 | 1968 |
| promacyl | Promicide | 1974 | | 1990 |
| AMIDINES | | | | |
| amitraz | Taktic | 1975 | 1980 | |
| clenpyrin | Bimarit | 1972 | | 1983 |
| chloromethiuron | Dipofene 60 | 1973 | 1980 | 1987 |
| chlordimeform | Spike, Fundex | 1971 | | 1976 |
| cymiazole | Tifatol | 1979 | 1980 | 1986 |
| SYNTHETIC PYRETHROIDS | | | | |
| cyhalothrin | Grenade | 1982 | 1984 | 1997 |
| cypermethrin (+ chlorfenvinphos) | Barricade 'S' (Blockade-S) | 1981 | 1984 | |
| deltamethrin (+ethion) | Tixafly | 1981 | 1984 | |
| flumethrin | Bayticol | 1985 | 1986 | |

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Kevin Duff, District Inspector of Stock, Beaudesert - 19 August 1998

# ACARICIDE RESISTANCE AVOIDANCE AND MANAGEMENT IN THE CATTLE TICK, *BOOPHILUS MICROPLUS*.

**DAVID KEMP**

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**Best practice for tick control that avoids/delays resistance** to new acaricides has been discussed extensively in the last 40 years (Australia and worldwide). There has been little research funding for projects on optimum treatment strategies either for tick control or resistance avoidance (eg. chemical concentrations, rotation, refugia, etc) The strategy that has been supported to a limited extent has been reduced chemical use as a result of anti-tick vaccine or introduction of tick immune cattle. This will reduce the risk of acaricide resistance.

**Management of resistance**, once it has emerged, has received some research funding. For example, research on acaricide resistance detection in the period 1960s-1987. This resulted in advice to producers and Departments on what acaricides could still be used to overcome on-farm resistant strains. This extended the life of OP chemicals and to a lesser extent the SPs but did not delay emergence of resistance. Potentially it could extend the life of the amidines (which includes amitraz/taktic) and may well be useful for new groups of acaricides in the future.

What has also been learnt is that it is very difficult to get rid of resistance once it has emerged, it can only be "managed". Eradication of Biarra OP resistant ticks was not successful for various reasons and future attempts at eradication would need new information and careful consideration before being attempted. Eradication of amitraz resistant ticks may be more feasible because there is some information on the lack of biological competitiveness of these resistant ticks. This has not been reported for strains resistant to other groups of acaricides. The most obvious management tool after resistance has emerged is use of new acaricides and to a lesser extent, synergising old ones. This has been adopted but there have still been crises in the past when resistance "caught up" with the available acaricides and new chemicals became available only just in time. This may well happen in the future as introduction of new acaricides appears to be slowing down for reasons of residues and poor economic returns to companies for livestock acaricides (pesticides as a whole?).

**Recommendations on best practice for tick control that accommodates information we currently have on tick ecology, economics of control, residues and pesticide resistance:**

a) Use acaricides as recommended.

b) Use a strategic program (eg treatments starting in Spring) if possible.

c) Use tick resistant animals, where possible, to reduce number of acaricide treatments.

d) Use TickGARD*plus* vaccine and any other "biological" method for tick control that you think practical.

e) Do not bring ticks on to the property with newly purchased cattle or cattle straying from neighbours. They may be resistant ticks.

f) Get your ticks tested for resistance by QDPI when failure of control has occurred and acaricide application was known to be correct.

Many other recommendations have been made and some could be adopted. Unfortunately there is either no research or practical experience to support them, or there are reasons for not adopting them. These include:

Saturation or high acaricide concentration strategy, the alternative low concentration/low selection strategy, rotation, mixtures, refugia (leaving some susceptible, untreated ticks in the population to dilute out resistant ones), avoiding long acting acaricides, etc.

## The future of tick control to 2025 – what is needed to avoid and manage resistance?

It would be ideal to have no acaricide use by 2025. Past experience suggests that biological control (eg. tick immune cattle, tick vaccine) will be effective but will not eliminate chemical use. By 2025 it would certainly be surprising if new research had not provided new tools to improve on the present level of biological control (eg. methods for selection of immune cattle in different breeds, improved tick vaccine, new biologicals, etc.). Of course, accurate predictions are not easy and it is very likely that acaricides will still be in use 23 years from now. It is likely they will be needed for clearance at tick lines (particularly to prevent spread of Tick Bourne Diseases) where biologicals are unlikely to give rapid enough or high enough tick kill.

The following is a list of strategies that would help to prolong the life of useful acaricides. All of them need further research if they are to be effective by 2025.

1. DNA markers for selecting tick resistant cattle in any breed (discussed later by Peter Willadsen)

2. Improved TickGARD*plus* anti-tick vaccine (discussed later by Peter Willadsen)

3. New biocontrol methods (discussed later by Lex Turner)

4. Rapid acaricide resistance testing to detect resistance and to predict the threat of resistance emergence.

   (DNA based tests for acaricide resistance have been advocated for several years and research has been taken up by USDA in their Kerville laboratory. They have to date one gene for SP resistance which has potential in a diagnostic test. DNA based tests offer a 24h response time compared to the present 6 weeks and they could reduce costs by replacing expensive maintenance of tick strains on cattle, with DNA samples stored at –25°C. DNA based tests may also detect on-property emergence of resistant heterozygotes (1 resistant allele) in the tick population, an early warning that the particular acaricide in use should be stopped before full resistance emerges. The prediction of resistance emergence to new insecticides can be done with some success in the laboratory, before resistance has emerged in the field. Similar techniques could be applied to acaricide resistance both for first detection of resistance and possibly also determining which new acaricides are more probe to resistance selection, eg MLs compared to Acatak.)

5. The NRA needs new information to advise on registration of acaricides and Departments need this information to advise on best tick control practice and options.

   (The guidelines for acceptance of new acaricides have set a concentration that kills 98% of ticks on treated animals. More recently, registration has also been accepted where adequate seasonal control of ticks in the field has been demonstrated with a particular concentration of a new acaricide. Neither of these "concentrations" has been assessed for "resistance selection". Problems also arise with residues resulting from too frequent treatment with the same chemical in attempts to gain "adequate" control. Biologicals are unlikely to reach even 90% control but what is the accepted level for registration. What is a reasonable % control per treatment to give "economic" tick control for a tick season? What treatment "strategies" are likely to cause resistance? What combinations of biological and chemical control are best? What is the best seasonal tick control strategy that fits in with control of other parasites and most importantly, with production systems. These questions have been too complex for analysis in the past but this is no longer true.)

# PASTURE MANAGEMENT FOR TICK CONTROL


## LEX TURNER

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There are currently many pasture management strategies available to cattle producers to control ticks. Most strategies are not, and will not be fully utilised while simpler methods of tick control exist. The usefulness of these strategies needs to be regularly reassessed as consumer resistance to chemical usage increases and tick resistance to the present chemicals increases.

Extra promise is shown by some management strategies because analyses shows that disproportionately large changes in the on-host *Boophilus microplus* populations occur in response to small changes in larval mortality rates under some infestation levels. Unfortunately the limitations of many management strategies are not fully established and many factors need to be considered when developing pasture management strategies for any particular farm.

Strategies include:

- Increasing levels of nutrition
- Burning pasture
- Use of feedlot facilities
- Use of pasture species
- Intensive grazing
- Strategic cultivation
- Vacuum methods
- Night paddock management
- Pasture rotation, spelling

Some problems exist because pasture management to control ticks usually has conflicting benefits on productivity that is being achieved through pasture improvement. Many pasture management strategies become effective when the pasture cover is reduced to a level where the non-parasitic stages of the ticks are more exposed to harsh environmental conditions. This may not be beneficial to the pasture.

Pasture management has been used to control ticks on cattle in many countries. Often pasture management is used in conjunction with conventional chemical treatments. There are many factors that need to be considered to see if any of the pasture management systems are economic for a particular farm. A suitable system will vary depending on the level of tick control required, the level of herd resistance to ticks, the season conditions and the farm location.

Because of increasing chemical costs and tick resistance, pasture management should become an integral part of any tick control program wherever it can be applied. Unfortunately there are many factors that need to be considered before a program is initiated. The main issue for successful pasture management is to control tick numbers in the paddocks. Environmental conditions on the farm are important for tick survival. Relative humidity, rainfall and temperature alter developmental rates and survival of tick stages in the pasture.

# CURRENT BEST PRACTICE FOR CATTLE TICK CONTROL IN QUEENSLAND

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Efficient cattle tick control is a dynamic situation, requiring close consideration of a number of parameters.

- Geographical location (climate variations – seasonal incidence)
- Acaricide resistance status (susceptible – Parkhurst – Ulam – Ultimo)
- Type of production system (dairy, beef breeding, fattening)
- Cattle breed
- Registered chemicals available for various production systems
- Management of chemical application (dips, sprays, pour-ons, injectable)
- Property boundary security
- Property biosecurity
- Grazing management
- Withholding periods (nil → 4 months)

Efficient control programs should incorporate multiple strategies. There can be no "one size fits all" solution if maximum control is to be achieved with minimum chemical treatments.

Current cattle tick control options include:

- Conventional dipping and spraying
- Macrocyclic lactones (in pour-on and injectable forms)
- Tick growth regulator (Acatak pour-on)
- TickGARD*Plus* vaccine (injectable)
- Resistant cattle breeds
- Pasture spelling

The reliance on, and frequency of, chemical treatments should be minimised for several reasons:

- High frequency leads to faster resistance selection
- Increasing emergence / spread of known acaricide resistance
- Risk of new resistant strains developing
- Cost of chemicals
- Labour costs in repeat mustering / handling
- Chemical control options are currently diminishing

Control and eradication strategies are currently available for 3 geographical areas covering the Queensland cattle tick infected area.

- South east
- Central
- North and north west

While these strategies represent current best practice in tick control, they do rely heavily on correct implementation and monitoring by the producer.

# KEY ELEMENTS OF EFFECTIVE CATTLE TICK CONTROL


## KEVIN DUFF

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1. Knowledge of Boophilus microplus life cycle and climatic influence.

2. Determine acaricide resistance status of property.

3. Examine available chemical treatment options (registered claims, limitations, WHP / ESI and modes of action).

4. Manage chemical applications correctly - dip, sprayrace & hand spray concentrations and application. Pour-ons and injectables - calibration, weight and correct dosage.

5. Select appropriate breed of cattle - tick resistant V not so resistant.

6. Ensure property security - keep neighbouring stock and their ticks out.

7. Implement property biosecurity - introduce tick free stock only, treat with Macrocyclic Lactone on arrival and hold in yards for 4 days minimum - reduce risk of introducing acaricide resistant ticks.

8. Incorporate grazing management of paddocks - include strategic pasture spelling, chemical treatments and life cycle knowledge in decision making.

9. Aim for long term control with multiple strategies and minimal treatments - think about the ground population

10. Maintain constant vigilance - monitor stock closely - know your tick situation - adjust control options as needed - seek advice.

Queensland Government
Department of Primary Industries
**DPI Notes**

# Cattle Tick Control Strategies: South East Queensland

**Kevin Duff**, *Animal and Plant Health Service, and Members of State Tick Control Project Team*

## Economic impact

The cattle tick (*Boophilus microplus*) is a serious economic pest of the Queensland cattle industry. If left unchecked, this external parasite has the ability to significantly reduce cattle liveweight gain and milk production. This tick is also responsible for transmitting three blood-borne Tick Fever organisms, which cause sickness and death in cattle.

In addition to lost production, other major costs are incurred in controlling the tick:

- Treatment facilities
- Chemical controls
- Labour required for mustering and handling cattle.

Cattle ticks can be controlled to varying degrees with the use of resistant cattle breeds, strategic chemical treatments, the cattle tick vaccine (TickGARD$^{Plus}$), pasture spelling or combinations of these methods.

## Implementing a Strategic Program

Planned strategic treatment programs are an efficient means of limiting the impact of the cattle tick. For any program to be effective, it must take into consideration:

- Life cycle of the parasite
- Known population rises or fluctuations
- Climatic influences that affect the parasite's survival

An effective program requires a coordinated plan that will give maximum control with the least number of treatments.

The ultimate success of any treatment program will depend on:

- Using a chemical that will kill ticks in the locality eg. No chemical resistance present.
- Effectiveness of treatment facilities and equipment eg. Adequate wetting, correct dosage.
- Correct management of facilities and equipment eg. Calibration, chemical concentration.
- All cattle are treated (including calves where recommended).
- Recommended treatment intervals are strictly adhered to.

- Property security – stock proof fencing to prevent incoming tick infested stock.

## Control program options

### *Dairy cattle*

- Dip or spray - 6 treatments at 3 week intervals commencing in October.

- TickGARD*Plus* can be used in addition to dip or spray treatments. TickGARD*PLUS* treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

- TickGARD*Plus* as above plus 2 Cydectin Pour-On treatments at 3 week intervals starting October.

### *Beef cattle*

- Dip or spray - 6 treatments at 3 week intervals commencing October

- Acatak - 2 treatments at 12 week intervals commencing October

- TickGARD*Plus* treatments at 10 to 12 week intervals throughout the year. (*Primer required*)

- May use Ivomec, Cydectin or Dectomax at start of season in place of 1 dip or spray.

**Tick Fever vaccination is recommended.**

## Eradication program options

***It is most important for producers in Official Cattle Tick Eradication Areas (or on individual property eradication programs) to discuss treatments and the various available options with their local Inspector of Stock. Programs may be tailored to suit individual herds, local conditions and include strategies such as destocking and pasture spelling.***

### *Dairy cattle*

**No chemical resistance present**

- Dip or spray – minimum of 8 treatments at 3 week intervals - start 1st October

- TickGARD*Plus* can be used in addition to dip or spray treatments. TickGARD*PLUS* treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

**Ultimo resistance present**

- Cydectin Pour-On - 8 treatments at 3 week intervals commencing 1st October.

- TickGARD*Plus* can be used in addition to dip or spray treatments. TickGARD*PLUS* treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

### *Beef cattle*

**No chemical resistance present**

- Dip or spray – minimum of 8 treatments at 3 week intervals - start 1st October.

- Acatak - 3 treatments at 6 - 8 week intervals commencing 1st October or earlier if considered necessary.

- May incorporate strategic use of Ivomec, Cydectin or Dectomax into program.

- TickGARD*Plus* can be used in addition to dip or spray treatments. TickGARD*Plus* treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

**Ultimo resistance present**

- Acatak - 3 treatments at 6 - 8 week intervals commencing 1st October or earlier if considered necessary.
- TickGARD*Plus* treatments at 10 to 12 week intervals throughout the year. (*Primer required*)
- Incorporate strategic use of Ivomec, Cydectin or Dectomax into program.

**Tick Fever vaccination is recommended.**

## Pasture spelling period

If pasture spelling or destocking is to be used effectively to eradicate cattle ticks in South East Queensland, the paddock or property must remain free of all stock for a minimum period of 9 months, commencing 1st October through until 30th June. A small group of tick free sentinel or test cattle should be introduced at the completion of this period. After a period of 3-4 weeks, owners should examine these animals in order to gauge the effectiveness of the program.

**NB**: There are many factors that will impact on the success of destocking or spelling a paddock as a means of controlling cattle ticks.

- Destocked means "Remains free of all stock".
- Condition of the perimeter fencing – is it really stockproof?
- Increased pasture growth will result in pressure on the fencing from outside stock.

## Follow safety precautions

- ALWAYS READ THE LABEL CAREFULLY.
- OBSERVE ALL SAFETY REQUIREMENTS FOR THE HANDLING OF CHEMICALS AND THE DISPOSAL OF UNWANTED CHEMICALS AND CONTAINERS.
- Use products only as directed.

## Avoid chemical residues

- ***Read the Product Label.***
- Adhere to ***Withholding Periods (WHP)*** and ***Export Slaughter Intervals (ESI).***

  **A withholding period ***(WHP)*** is a domestic, legally binding requirement. It is the minimum period of time that must elapse between the treatment of an animal and the slaughter of that animal or collection of its milk for human consumption.

  **An export slaughter interval ***(ESI)*** is the recommended interval between the treatment of an animal with a veterinary chemical product and the slaughter of that animal for export into a market that has different statutory requirements for residues in meat to the Australian domestic market.

## Further information

Contact your local Stock Inspector for further advice. ■

Queensland Government
Department of Primary Industries
**DPI Notes**

# Cattle Tick Control Strategies: Central Queensland

***Kevin Duff,*** *Animal and Plant Health Service, and Members of State Tick Control Project Team*

## Economic impact

The cattle tick (*Boophilus microplus*) is a serious economic pest of the Queensland cattle industry. If left unchecked, this external parasite has the ability to significantly reduce cattle liveweight gain and milk production. This tick is also responsible for transmitting three blood-borne Tick Fever organisms, which cause sickness and death in cattle.

In addition to lost production, other major costs are incurred in controlling the tick:

- Treatment facilities
- Chemical controls
- Labour required for mustering and handling cattle.

Cattle ticks can be controlled to varying degrees with the use of resistant cattle breeds, strategic chemical treatments, the cattle tick vaccine (TickGARD*Plus*), pasture spelling or combinations of these methods.

## Implementing a Strategic Program

Planned strategic treatment programs are an efficient means of limiting the impact of the cattle tick. For any program to be effective, it must take into consideration:

- Life cycle of the parasite
- Known population rises or fluctuations
- Climatic influences that affect the parasite's survival

An effective program requires a coordinated plan that will give maximum control with the least number of treatments.

The ultimate success of any treatment program will depend on:

- Using a chemical that will kill ticks in the locality eg. No chemical resistance present.
- Effectiveness of treatment facilities and equipment eg. Adequate wetting, correct dosage.
- Correct management of facilities and equipment eg. Calibration, chemical concentration.
- All cattle are treated (including calves where recommended).
- Recommended treatment intervals are strictly adhered to.
- Property security – stock proof fencing to prevent incoming tick infested stock.

## Control program options

### Dairy cattle

- Dip or spray – 3 to 6 treatments starting mid September depending on season and tick population pressure.

- Include 1 to 2 dip or spray treatments in autumn or late summer if needed.

- May use Cydectin Pour-On at start of season in place of 1 dip or spray.

- TickGARD PLUS can be used in addition to other treatments. TickGARD PLUS treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

- ***DO NOT use Acatak on animals producing milk for human consumption***

### Beef cattle

- Acatak – 1 treatment mid September

  ***Monitor and inspect 8 to 10 weeks after treatment. Retreat with Acatak if warranted.*

- Where tick numbers are moderate to low – 4 treatments TickGARD PLUS at 12 week intervals starting mid September. *(Primer required)*

- May incorporate strategic use of Ivomec, Cydectin or Dectomax into program.

### West of Drummond Range – Beef Cattle

- Acatak – 1 treatment during October. Stock should be inspected in March (late summer) and the tick burden assessed. Substantial tick numbers at that time may warrant one further Acatak treatment. This may be required in summers when high rainfall is received.

- May incorporate strategic use of Ivomec, Cydectin or Dectomax into program.

**Tick Fever vaccination is recommended.**

## Eradication program options

***It is most important for producers in Official Cattle Tick Eradication Areas (or on individual property eradication programs) to discuss treatments and the various available options with their local Inspector of Stock. Programs may be tailored to suit individual herds, local conditions and include strategies such as destocking and pasture spelling.***

### Dairy cattle

- Dip or spray – minimum of 6 treatments at 3 week intervals commencing mid September.

- May use Cydectin Pour-On at start of season in place of 1 dip or spray.

- TickGARD PLUS can be used in addition to dip or spray treatments. TickGARD PLUS treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

- ***DO NOT use Acatak on animals producing milk for human consumption***

### Beef cattle

- Dip or spray – minimum of 6 treatments at 3 week intervals commencing mid September.
- Acatak – 2 treatments at 8 week interval commencing mid September.

- May use Ivomec, Cydectin or Dectomax at start of season in place of 1 dip or spray.
- TickGARD*PLUS* can be used in addition to other treatments. TickGARD*PLUS* treatments should be given at 10 to 12 week intervals throughout the year. *(Primer required)*

**Tick Fever vaccination is recommended.**

## Pasture spelling period

If pasture spelling or destocking is to be used effectively to eradicate cattle ticks in Central Queensland, the paddock or property must remain free of all stock for a minimum period of 24 weeks. A small group of tick free sentinel or test cattle should be introduced at the completion of this period. After a period of 3-4 weeks, owners should examine these animals in order to gauge the effectiveness of the program.

**NB**: There are many factors that will impact on the success of destocking or spelling a paddock as a means of controlling cattle ticks.

- Destocked means "Remains free of all stock".
- Condition of the perimeter fencing – is it really stockproof?
- Increased pasture growth will result in pressure on the fencing from outside stock.

## Follow safety precautions

- Always read the label carefully.
- Observe all safety requirements for the handling of chemicals and the disposal of unwanted chemicals and containers.
- Use products only as directed.

## Avoid chemical residues

- ***Read the Product Label.***
- Adhere to ***Withholding Periods (WHP)*** and ***Export Slaughter Intervals (ESI).***

  **A withholding period ***(WHP)*** is a domestic, legally binding requirement. It is the minimum period of time that must elapse between the treatment of an animal and the slaughter of that animal or collection of its milk for human consumption.

  **An export slaughter interval ***(ESI)*** is the recommended interval between the treatment of an animal with a veterinary chemical product and the slaughter of that animal for export into a market that has different statutory requirements for residues in meat to the Australian domestic market.

## Further information

Contact your local Stock Inspector for further advice. ■

Queensland Government
Department of Primary Industries
**DPI Notes**

# Cattle Tick Control Strategies: North and North West Queensland

***Kevin Duff,*** *Animal and Plant Health Service Members of State Tick Control Project Team*

## Economic impact

The cattle tick (*Boophilus microplus*) is a serious economic pest of the Queensland cattle industry. If left unchecked, this external parasite has the ability to significantly reduce cattle liveweight gain and milk production. This tick is also responsible for transmitting three blood-borne Tick Fever organisms, which cause sickness and death in cattle.

In addition to lost production, other major costs are incurred in controlling the tick:

- Treatment facilities
- Chemical controls
- Labour required for mustering and handling cattle.

Cattle ticks can be controlled to varying degrees with the use of resistant cattle breeds, strategic chemical treatments, the cattle tick vaccine (TickGARD$^{Plus}$), pasture spelling or combinations of these methods.

## Implementing a Strategic Program

Planned strategic treatment programs are an efficient means of limiting the impact of the cattle tick. For any program to be effective, it must take into consideration:

- Life cycle of the parasite
- Known population rises or fluctuations
- Climatic influences that affect the parasite's survival

An effective program requires a coordinated plan that will give maximum control with the least number of treatments.

The ultimate success of any treatment program will depend on:

- Using a chemical that will kill ticks in the locality eg. No chemical resistance present.
- Effectiveness of treatment facilities and equipment eg. Adequate wetting, correct dosage.
- Correct management of facilities and equipment eg. Calibration, chemical concentration.
- All cattle are treated (including calves where recommended).
- Recommended treatment intervals are strictly adhered to.
- Property security – stock proof fencing to prevent incoming tick infested stock.

## Control program options

*(<= less than) (>= more than)*

### *Dry tropical coast (Bowen to Burketown)*

***< 3/8 Zebu***

- 4 dips at 3 week intervals starting late March plus 2 dips in September *(Cattle of this type are not recommended for this environment).*

***3/8 - 5/8 Zebu***

- 2 to 4 dips at 3 week intervals starting late March
- 1 dip and TickGARD*Plus* treatments at 1st and 2nd round musters *(Primer required)*
- 1 Acatak treatment in late March

***>5/8 Zebu***

- Autumn dips if required

***Tick Fever vaccination is recommended.***

### *Dry inland (Charters Towers to Cloncurry north)*

***< 3/8 Zebu***

- 3 dips at 3 week intervals starting late March *(Cattle of this type are not recommended for this environment)*

***3/8 - 5/8 Zebu***

- 2-3 dips at 3 week intervals starting late March
- 1 dip and TickGARD *Plus* at 1st and 2nd round musters *(Primer required)*

***>5/8 Zebu***

- Autumn dips if required

***Tick Fever vaccination is recommended.***

### *Wet tropical coast (Ingham to Cooktown)*

***< 3/8 Zebu***

- *Cattle of this type are not recommended for this environment.*

***3/8 - 5/8 Zebu***

- 4 to 6 dips at 3 week intervals commencing in September followed by 3 TickGARD*Plus* vaccinations. The first vaccination is given at the time of the last dip treatment and repeated at 10 week intervals. The cattle should have already received a priming dose.
- 1 Acatak treatment in September

***> 5/8 Zebu***

- 2 to 3 dips at 3 week intervals starting November

***Tick Fever vaccination is recommended.***

### *Atherton Tablelands*

***< 3/8 Zebu***

- 6 dips at 3 week intervals starting October
- 3 dips at 3 week intervals commencing in October followed by 2 TickGARD$^{Plus}$ treatments. The first vaccination is given at the time of the last dip treatment and repeated 10 weeks later. The cattle should have already received a priming dose.
- 1 Acatak treatment in October (***not dairy cattle***)

***3/8- 5/8 Zebu***

- 3 to 4 dips at 3 week intervals starting October
- 1 dip and a TickGARD$^{Plus}$ vaccination in October followed by 2 further TickGARD$^{Plus}$ vaccinations at 10 week intervals. The cattle should have already received a priming dose.
- 1 Acatak treatment in October

***> 5/8 Zebu***

- Autumn dip if required

***Tick Fever vaccination is recommended.***

## Eradication program options

It is most important for producers in Official Cattle Tick Eradication Areas (or on individual property eradication programs) to discuss treatments and the various available options with their local Inspector of Stock. Programs may be tailored to suit individual herds, local conditions and include strategies such as destocking and pasture spelling.

### *Central and North Western cattle tick protected areas*

- 1 to 2 Acatak treatments at 8 week interval starting mid-September
- 4 to 6 dips at 3 week intervals starting mid-September

***Tick Fever vaccination is recommended.***

## Pasture spelling period

If pasture spelling or destocking is to be used effectively to eradicate cattle ticks in North or North Western Queensland, the paddock or property must remain free of all stock for a minimum period of 12 to 24 weeks, depending on the time of year and the individual situation. A group of tick free sentinel or test cattle should be introduced at the completion of this period. After 3 to 4 weeks, owners should then examine these animals in order to gauge the effectiveness of the program.

**NB**: There are many factors that will impact on the success of destocking or spelling a paddock as a means of controlling cattle ticks.

- Destocked means "Remains free of all stock".
- Condition of the perimeter fencing – is it really stockproof?
- Increased pasture growth will result in pressure on the fencing from outside stock.

## Follow safety precautions

- **ALWAYS READ THE LABEL CAREFULLY.**
- **OBSERVE ALL SAFETY REQUIREMENTS FOR THE HANDLING OF CHEMICALS AND THE DISPOSAL OF UNWANTED CHEMICALS AND CONTAINERS.**

- Use products only as directed.

## Avoid chemical residues

- ***Read the Product Label.***
- Adhere to ***Withholding Periods (WHP)*** and ***Export Slaughter Intervals (ESI).***

  **A withholding period ***(WHP)*** is a domestic, legally binding requirement. It is the minimum period of time that must elapse between the treatment of an animal and the slaughter of that animal or collection of its milk for human consumption.

  **An export slaughter interval ***(ESI)*** is the recommended interval between the treatment of an animal with a veterinary chemical product and the slaughter of that animal for export into a market that has different statutory requirements for residues in meat to the Australian domestic market.

## Further information

Contact your local Stock Inspector for further advice. ■

# THE FUTURE OF TICK CONTROL

# WHAT WILL IT LOOK LIKE IN 2025?

# HOST RESISTANCE AND OTHER IMMUNOLOGICAL APPROACHES TO TICK CONTROL

**PETER WILLADSEN**

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The use of acaricides for tick control is of concern to both farmers and the chemical industry. Farmers are concerned about chemical resistance and the potential impact of chemical residues on the marketability of meat both within Australia and more importantly, in export markets. In addition, it is obvious that each new class of acaricide tends to come with a substantially increased price tag. From the perspective of the chemical companies, the concerns are with the difficulty of finding new active compounds or new chemical classes from which the pesticides arise and the increasing costs of commercially synthesising highly complex molecules. These difficulties are exacerbated by the relatively small size of the acaricide market.

An excellent current example of these difficulties is the macrocyclic lactone class. These are highly efficacious, safe, broad spectrum antiparasitic compounds, the product of many years of R&D and a great deal of investment by the major pharma companies. However, there is already evidence for tick resistance to some members of this class in South America, and although the evidence is currently mostly anecdotal, it is certainly being taken seriously by the chemical companies.

These difficulties may pale into insignificance well before 2025. Consider the example of Denmark which is moving to a situation where anthelmintics cannot be used unless a veterinarian diagnoses a helminth infection; that is, these antiparasitic treatments cannot be used preventatively but only prophylactically. If in, for example, ten years time such measures are generally adopted for parasite control in our export markets, it would mean that chemical treatment for ticks may only be applied once an unacceptable level of tick infestation had been diagnosed. Our control of ticks and tick-borne diseases would then have to rely largely on a mixture of biological and immunological control.

## Genetics

Tick resistant breeds of cattle have had a major impact on the northern Australian industry. It is highly unlikely that the next two decades will see another revolution based on breed differences. Instead, further progress will depend on the identification of genetic markers for resistance. Ultimately we need to know as accurately as we can which genes are responsible for tick resistance and for the animal-to-animal and breed-to-breed variation in resistance. This is critical for two reasons. Firstly, if these genes are identified there is potential to design high throughput diagnostic tests for resistance that avoid the undesirable features of measuring resistance by counting parasite loads on tick infested cattle. Secondly, identification of the genes responsible for the resistance potentially allows the dissection of resistance from undesirable production characteristics which may lie in close but still distinct parts of the bovine genome; that is it will allow us to separate the tick resistance phenotype from other potentially undesirable phenotypes. Such work has begun in our own labs and is partly supported by the CRC for Cattle and Beef Quality. Currently it is a very small research effort.

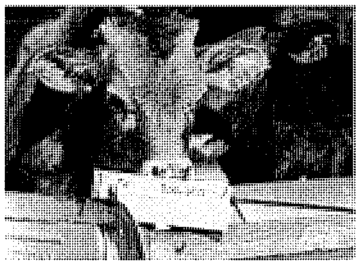
In addition, it is possible in principle to identify genes for resistance to tick borne disease. The feasibility of this has been demonstrated with at least one such disease but work on resistance to *Babesia* and *Anaplasma* has not yet begun.

## Vaccines

Vaccines are available for all four parasites of concern: *Babesia bovis, Babesia bigemina, Anaplasma marginale and Boophilus microplus*. While this is useful, none of the vaccines are ideal, suffering from a mixture of short shelf life, reactogenicity and, for several, inadequate efficacy. In order to achieve low cost, long shelf life and low reactogenicity it is desirable that all four vaccines be available as recombinant, defined antigen vaccines. To do this will require considerable effort to identify appropriate antigens and to optimise the immunology to produce a sustained effective response.

In the specific case of the anti-tick vaccines, greater efficacy is desirable. In particular, it would be very useful if the vaccine targeted the early larval attachment stages of the tick instead of the late adult stages and the egg laying process. A small and sporadic international interest in tick vaccines has led to the identification of a number of proteins showing some efficacy as recombinant antigens and at least one of these is reported to be effective against larval stages of another tick species (*Ixodes ricinus*). Such work is encouraging but very much in its early phase.

**Tick Vaccines**



1981 Research begun

1986 Antigen identified

1987 First recombinant antigen trials

1989 First field trials

1994 Product registered and marketed

1995 TickGARD Plus released: an improved vaccine

The vaccine will be re-released this year

A single antigen recombinant vaccine

A related product is manufactured in Cuba

**On-Farm Results: the 1996-1997 Season**

**Trial design**

- 26 Properties, all with beef cattle; primary vaccination in September, booster in October and in January if desired

**Results**

- All farms reported a reduction in chemical usage
- One quarter used no acaricide at all
- On average, a booster vaccination saved 2.4 acaricide dips
- Protective antibody persisted for > 16 weeks

**Acceptance**

- More than 90% of farmers would continue to use vaccine

Anecdotal evidence is that efficacy improves in subsequent years

Reduction in frequency of acaricide application should delay the emergence of resistance

## Retrospective Cuban experience with the tick vaccine

Manuel Rodriguez *et al.*

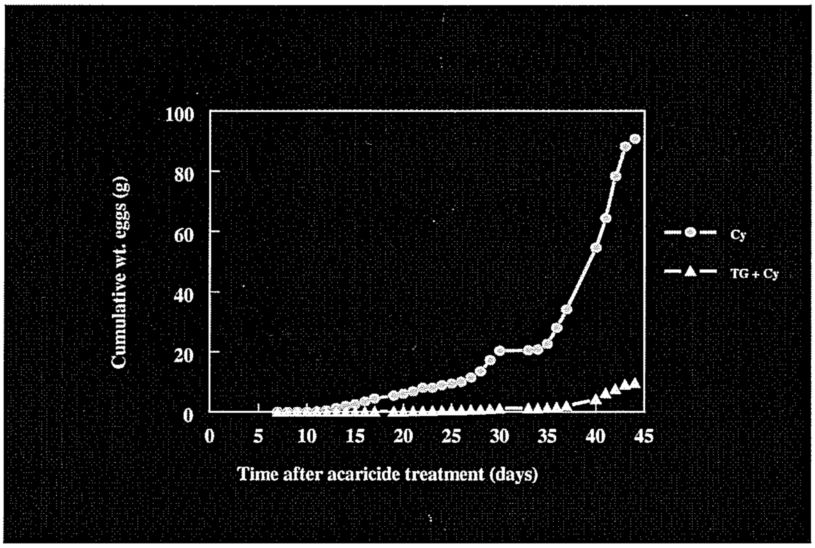
Based on the vaccination of 588573 Holstein and crossbred cattle over six years. The criterion of performance was the reduction in acaricide treatments (when tick numbers were judged to have got beyond tolerable levels)

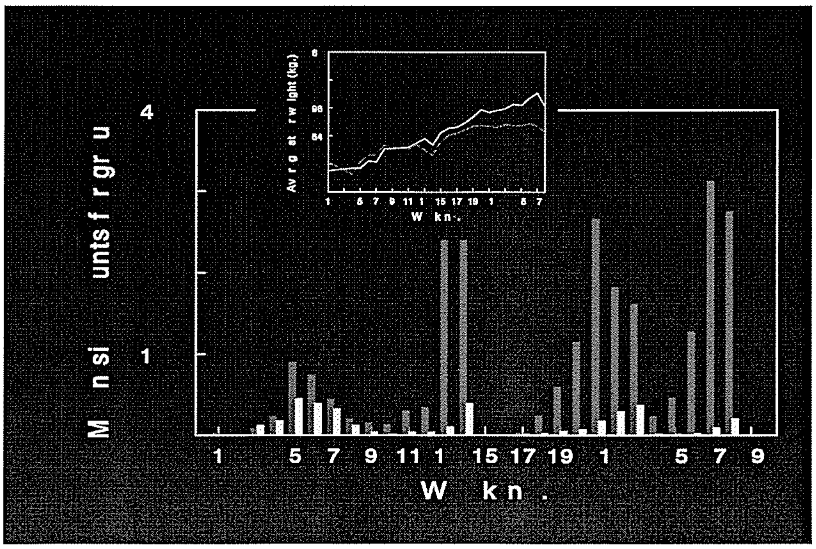
Mean period between treatments 7-14 days to 88-174 days

Mean treatments per year from 15-17 to 2.8

98% reduction in tick borne diseases over a six year period

National acaricide consumption reduced from 480 to 80 metric tons



## Genomes and the brave new world

The genomic revolution is gathering pace. It now seems highly likely that an international consortium to sequence the bovine genome will be successful within the next two years. CSIRO Livestock Industries is a small player in that international effort. While this is a tool rather than a solution, it should greatly facilitate attempts to identify markers for tick resistance as well as many other phenotypes of importance to the cattle industry. Other genomes of relevance are underway. The *Anaplasma marginale* genome has now been completed though it is not yet fully publicly available. This was funded by the United States Department of Agriculture and carried out in Washington State. Australia played no part. Several of the major sequencing centres are interested in doing the genome of *Babesia bovis* and it is likely that this too will happen within the next few years. Some sequence information has just become available (September 2002) funded entirely by a small grant from a Dutch University. Once again, Australia has made no contribution. These genomes will again be a tool facilitating the identification of antigens which may be important in future protective vaccines.

Ticks and TBDs must be viewed as part of on-farm cattle production and local and international marketing. In the area of research into the control of ticks and tick borne disease, Australia has lost the position of leadership it once enjoyed. It is in our interests to at least be a part of a small but growing international effort on these diseases if we are to maintain an international market edge by 2025.

# NEW PHARMACOLOGICAL SOLUTIONS TO TICK CONTROL

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## Market considerations

The global agricultural chemistry market has a value of USD 30 billion pa, 26% of which is spent on insecticides and acaricides. The global animal health market is worth USD 11 billion pa, 30% of which is for parasiticides. Cattle ectoparasiticides are worth USD 225 million and cattle tickicides are worth USD 70 million. The Australian market for cattle tickicides is A$ 10 million. The Australian cost for registering a new tickicide is about A$ 600,000. Therefore the financial incentives to find a new cattle acaricide are relatively minor and the regulatory costs can be a significant hurdle.

## Recent trends

No new dips have been introduced since the SPs were commercialised in the 1970s. The recent products are the MLs, fluazuron and vaccine. All are either pour-on or injection, have a systemic action, have a slow onset of action and are long lasting. Thankfully Australia's regulatory guidelines have permitted an informal 'aid in the control' claim and permitted season long field trials to demonstrate useful efficacy of these products in the field. The 98% efficacy hurdle is not the barrier to registration of useful products it is in some countries.

Lack of international uniformity on tissue residues is a contemporary issue, eg the withdrawal of Bayticol pour-on and must be a consequence of systemic modes of action.

## New products not in Australia

### Fipronil, Topline® Merial

1% at 1 mL/10 kg, pour-on formulation, 99.7 % efficacy, 6 - 8 weeks protection against re-infestation and not for use in dairy cattle. Resistance is rumoured in Latin America probably associated with significant misuse of the product and especially the AgChem formulation. It is not released in Australia perhaps for reasons associated with usage of the active ingredient (or analogues) in crops as the proportion of the ADI attributable to animal produce may be restrictively low and thereby could create WHP/MRL issues in animal tissues.

### New macrocyclic lactone delivery methods, Merial

**Ivomec Gold®** - long lasting injection formulation with 60-70 days efficacy in Latin America.

**Ivermectin intra-rumenal bolus** - pays out 12 mg ivermectin/day for 135 days which is equivalent to 120 – 30 ug/kg/day 100 to 400 kg animals. Twenty five and 50 ug ivermectin/kg/day are known to give >99% efficacy v cattle tick. Known to give > 99% efficacy v *B decoloratus.* Potential impact on dung fauna due to long payout.

Neither product claims to give eradication and there would be significant milk and meat WHPs if registered in Australia. Ticks resistant to ivermectin have been reported in Columbia and Brazil and anecdotally in Australia.

### Spinosad, Elanco

Launched in Brazil 2002, applied at 250 ppm as a spray. Novel mode of action and no cross-resistance.

Minimum OH&S, environmental issues and the molecule is a naturally occurring organic. The spray gives slow knockdown of adults and 2 – 4 weeks protection against re-infestation. Spinosad is ideal for use in a rotation strategy.

## New products

New acaricide chemistry has almost exclusively come from AgChem discovery efforts because of the huge markets available for crop insecticides. Animal health products have piggy backed on the AgChem regulatory efforts. New chemistry is likely to come from the same sources.

It is clear that existing insecticides and acaricides exploit only a tiny number of the potential molecular targets available. New chemistry will be the fruit of genomic and molecular biology-based approaches that allow the discovery of novel targets suited to high volume screening. These methods have the potential to accelerate insecticide discovery and have already provided new targets for screening.

New approaches specific for acaricides are being employed. Genomic information in ticks suggests a large number of potential targets for new acaricides. However in contrast to nematodes and insects, molecular genetic tools and assays for acarine target validation are still undeveloped. In the short term, new validated targets are likely to come from basic research on tick toxins, biological pathways, and mode of action work of new insecticidal compounds with acaricidal activity.

## Risks

- Further consolidation of the chemical industry and an even greater trend to only developing chemistry with huge market potential.
- Costs to identify and develop new products increase and there are increased regulatory pressures, costs and environmental hurdles.
- Resistance development by parasites to new targets.
- Intellectual property rights are not honoured around the world – eg Cuba's attitude to the tick vaccine patent.
- End users are not willing to pay for higher priced new chemistry.
- No guarantee that new insecticidal targets/activity will have good tick activity.

## 37 New Insecticides and 13 New Classes were Introduced In The 90's

| Products | Active Group (Class) |
|---|---|
| Emamectin-benzoate, Milbemectin | Avermectin |
| Flucycloxuron, Flufenoxuron, Lufenuron, Novaluron | Benzoylurea |
| Triazamate | Carbamate |
| Cadusafos, Chlorethoxyfos, Tebupirimphos | Organophosphate |
| Acrinathrin, Beta-cyfluthrin, Fenpropathrin, Zeta-cypermethrin, | Pyrethroid |
| Silafluofen | Non-ester pyrethroid |
| Methoxyfenozide, Tebufenozide, Chromafenozide, Halofenozide | Diacylhydrazine |
| Pyriproxifen | Juvenile hormone mimic |
| Etoxazole, Fenazaquin, Pyrimidifen | Miscellaneous |
| Imidacloprid , Acetamiprid, Thiamethoxam, Nitenpyram | Neonicotinoid |
| Indoxacarb | Oxadiazine |
| Tebufenpyrad, Fenpyroximate | Pyrazole |
| Chlorfenapyr | Pyrrole |
| Fipronil | Phenylpyrazole |
| Pyridaben | Pyridazinone |
| Pymetrozine | Pyridine |
| Spinosad | Spinosyn |
| Bifenazate | Carbazate |
| Diafenthiuron | Thiourea |

## Of the Top 13 New Insecticides Introduced in 1990s, 10 are from New Mechanistic Classes

| Compound | Year Introduced | Company | Mechanism (Target) |
|---|---|---|---|
| Imidacloprid | 94 | Bayer Crop Sci | nAchR |
| Fipronil | 93 | Bayer Crop Sci | GABA Cl |
| Spinosad | 97 | Dow AgroSci | nAchR |
| Acetamiprid | 96 | Nippon Soda | nAchR |
| Chlorfenapyr | 96 | BASF | Uncoupler Oxi. Phos. |
| Pyridaben | 90 | Nissan / BASF | Elec Trans Inhib |
| Thiamethoxam | 97 | Syngenta | nAchR |
| Diafenthiuron | 93 | Syngenta | Mitochon Resp Inhib |
| Indoxacarb | 98 | DuPont | Na Channel |
| Tebufenozide | 95 | Rohm and Haas | EcdyR Agonist |
| Lufenuron | 94 | Syngenta | Chitin Synth Inhib |
| Flufenoxuron | 93 | BASF | Chitin Synth Inhib |
| Betacyfluthrin | 91 | Bayer Crop Sci | Na Channel |

# BIOCONTROL OF TICKS

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## Predators

There are many predators of ticks. Many are not serious predators and do not impact on tick numbers. None of the predators are specific for ticks (except for the oxpecker) so their introduction as control possibilities is not recommended. Local predators should be conserved and augmented.

- Arthropods
  - Spiders
  - Mites
  - Bugs
  - Moths
  - Flies
  - Ants
  - Beetles
  - Other arthropods
- Amphibians
- Reptiles
- Birds
  - Oxpeckers
  - Cattle egrets
  - Domestic fowl
  - Others
- Mammals
- Other vertebrates

## Pathogens

- Viruses and virus-like particles
- Bacteria
- Protozoa
- Fungi
- Nematodes

Pathogens in these groups are capable of successfully killing ticks but have not been developed into commercial products. Further research is required before any of these options can be developed for use against ticks.

## Others

- Pheromones
- Release of sterile males

These options may have some promise in assisting tick control but would require more research to develop the ideas into effective methods.

- Another option is the manual removal of ticks, which has been reported to be used by 10% of small-scale cattle farmers in the central eastern cape province in South Africa – Good luck.

# PHEROMONE-BASED CONTROL MEASURES FOR CATTLE TICKS


## CHRIS MOORE

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Pheromones form part of an intra-specific communication system in animals and are a sub-class of semio- (signalling-) chemicals. They include the sex pheromones which are involved in mating, with those of insects being the most thoroughly studied, particularly those of moths classified as agricultural pests. Such studies address one or more of the following elements: the determination of the chemical structure of individual chemical components; chemical synthesis; the composition of species-specific blends of chemical components; biosynthesis; behaviour; the electrophysiology of response; the fabrication of devices which can be used to release pheromones in a natural way; field-testing.

In an agricultural context, the aim of pheromone research (and of semiochemical research in general) is the modification of the behaviour of a pest as a means of control. Lepidopteran (moth) pheromones have been used successfully as monitoring tools, where synthetic female pheromones lure males to traps. This enables population density to be estimated, followed by the precisely-timed application of pesticide once a particular threshold is reached. Attract-and-kill methods, where the attractant is combined with a pesticide, are an extension of this. The creation of a homogeneous atmosphere of pheromone which prevents a male finding a female (a point-source emitter) is the principle behind mating disruption methodology.

Pheromones of non-lepidopteran insects are more diverse in the range of behavioural responses they elicit and include those which lead to aggregation, or communicate alarm. With respect to ticks in particular, behavioural terms used include attraction, aggregation, attachment, mounting and assembly. A role for pheromones in the assembly of ticks, through arrestment of movement upon contact, has been identified in both hard and (particularly) soft ticks, with these pheromones being present in excreta.

The most recent of several US patents, "Tick pheromones and uses thereof" (US Patent 6,331,297. December 18, 2001) describes the use of an aggregation pheromone from tick excreta combined with a biocontrol agent (the fungus *Beauvaria bassiana*). Specifically targeted at Ixodes ticks, compounds identified "cause ticks to move towards and/or stay in contact with the compound once the ticks have encountered the compound."

An earlier patent (5,296,227. March 22, 1994) "Attractant decoy for controlling bont ticks" describes applications to the control of *Amblyomma* species males, females and nymphs using a polymer matrix (e.g. PVC) impregnated with pheromones and an acaricide. Tail-band applications on cattle are included. The essential role of carbon dioxide is acknowledged to the extent that off-animal decoys must include a source of this gas. o-nitrophenol, methyl salicylate and nonanoic acid are named as components of *Amblyomma variegatum* pheromone. The "attraction-aggregation-attachment" pheromone includes components with long-range (up to 30 metres) and short-range activity.

Publications relevant to the above patents include:


R.A.I. Norval *et al.* 1996. Efficacy of pheromone-acaricide-impregnated tail-tag decoys for controlling the bont tick, *Amblyomma hebraeum* (Acari: Ixodidae), on cattle in Zimbabwe. Exp. App. Acarol. 20, 31-46.

S.A. Allan and D.E. Sonenshine 2002. Evidence of an assembly pheromone in the black-legged deer tick, *Ixodes scapularis.* J. Chem. Ecol. 28, 15-27.


Some encouragement of the exploration of the potential for similar control strategies directed at cattle ticks in Australia, both from the natural biopesticide angle and the focused study of the target insect, might be found in the above information.