DEER RESEARCH

2013

A resumé of 33 years’ contribution to knowledge of deer production, health and biology
Massey University
Deer Research Group

1979-2013

- Expertise and facilities
- Research vision
- Outputs and industry impact/adoption
- Publications

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MISSION STATEMENT

To undertake quality research consistent with the needs of the New Zealand Deer Industry and to advance scientific knowledge of deer biology.
SECTION 1

RESEARCH EXPERTISE AND FACILITIES

• Areas of expertise
• Research facilities
• Research strengths
• Principal researchers and specialities
• Current research projects
• Extension of research
• Significant achievements
AREAS OF EXPERTISE AVAILABLE AT MASSEY

- Health and Diseases
- Nutrition
- Management and Production
- Metabolism
- Clinical Medicine, Virology, Bacteriology
- Animal Remedy Evaluation
- Welfare
- Behaviour
- Forage Species and Management
- Grazing Ecology
- Meat Science – Quality
- Bioactive Compounds
- Pharmacology
- Epidemiology
- Marketing and Business
- Extension

RESEARCH FACILITIES

Deer Research Unit
The Massey University Deer Research Unit is twenty-six hectares of prime land adjacent to campus. It is intensively sub-divided, and contains approximately 200 red deer for a breeding and finishing operation. It is designed primarily for animal health, grazing and management studies, and undergraduate veterinary and agricultural student teaching. A new purpose-built research and teaching facility was constructed early in 2005.

Deer Research Building
A substantial, versatile building on the Deer Research Unit capable of housing up to 12 metabolism cages for individual nutritional studies or pens for other research requiring housing is used for experiments requiring housing. This facility is adaptable for pens for various indoor group studies.

Estendart Ltd (A research services company owned by IVABS, Massey University)
An approximately three-hectare unit with handling facility, used primarily for commercial contract research into products for deer health.

Veterinary Large Animal Surgery, Hospital and Isolation Facilities
Used for research needing surgical procedures or isolation facilities.

Specialist laboratories/Centres on campus available for deer research
- Clinical biochemistry, haematology, Parasitology, Microbiology/immunology/Virology
- Histology, histopathology, immuno-histochemistry and electron microscopy
- Molecular Biology, DNA sequencing
- Soils
- Meat Science
- Plant Science
- Endocrinology, Pharmacology
- Separation Science (Bioactive compounds)
- Diagnostic pathology including NZ Veterinary Pathology, a commercial veterinary diagnostic laboratory, which is on-site
- Nutrition and feed evaluation science
- Centres:
  - EpiCentre: an OIE approved centre (Epidemiology and data analysis)
  - Animal Welfare Science and Bioethics Centre (an OIE collaborating Centre)
RESEARCH STRENGTHS

Independent
University researchers are non-aligned and are independent of commercial interest.

Track Record
Thirty four years involvement with deer research

Staff Profile
Senior researchers are highly qualified, nationally and internationally recognised scientists who have a high profile within the New Zealand deer industry and internationally, and are abreast with all major deer industry issues.

Multi-disciplinary approach
Research projects have input by researchers with a range of veterinary, animal science, agricultural science and extension expertise, and regular interdisciplinary liaison occurs with all projects.

Available expertise
Research leaders have access to academic expertise in all disciplines through the University.

Location
The University is in a prime agricultural locality and is adjacent to Crown Research Institutes, including AgResearch Grasslands and the Hopkirk Institute with whom collaborative research takes place, and Veterinary Diagnostic Laboratories.

Consulting and Services
Researchers are involved with providing veterinary, production and management consulting services direct to farmers, deer industry stakeholders, and to international agencies.

Extension Activity
Researchers are actively involved in presenting and publishing information direct to the deer industry and to the scientific and professional communities.

National collaboration
Researchers have collaborative research links with all deer research groups throughout New Zealand.

Industry collaboration
Researchers have collaborative research programmes in association with Agricultural and Veterinary industry bodies and companies.

Human Capability Development
Academic staff are training the deer scientists, consultants and veterinarians of the future through undergraduate student involvement in research projects and post-graduate deer projects.

International Links
Staff have close links with several international organisations and individuals in Canada, USA, Australia, Chile, Argentina, China and Mexico.
PRINCIPAL RESEARCHERS, RESEARCH COLLABORATORS, AND SPECIALITIES

Peter Wilson BVSc, PhD, MANZCVSc
Professor, Deer Health and Production
Institute of Veterinary, Animal and Biomedical Sciences (IVABS).
Deer health, diseases, production, reproduction and welfare. Registered Veterinary Deer Specialist

Tom Barry BSc, PhD, DSc
Emeritus Professor, IVABS.
Basic and applied nutrition, digestion and growth. Development of grazing systems.

Cord Heuer, B Vet Med, PhD
Professor, IVABS, Veterinary Epidemiology.

Bill Pomroy BVSc, PhD, MANZCVSc
Professor, IVABS, Veterinary Parasitologist.

Laryssa Howe, PhD
Senior lecturer, Immunologist

Julie Collins-Emerson BSc (Hons), PhD
Molecular Biology/diagnostics

Other University personnel involved in recent and/or present deer research include:
Dr Craig Johnson, Veterinary anaesthetist/pain physiologist
Professor Kevin Stafford, Animal Behaviour and Welfare
Professor David Mellor (Stress, Welfare, Director Animal Welfare & Bioethics Centre)
Professor Roger Morris, (Veterinary Epidemiology)
Associate Professor Roger Purchas (Meat Science)
Dr Peter Kemp (Agronomy)
Dr Julie Collins-Emmerson, Microbiologist
Assoc Professor Alan Murray, Immunologist
Dr Jackie Benschop, Epidemiologist

Collaboration with other NZ scientists
Dr Geoff Asher, AgResearch Invermay. Reproduction
Dr Colin Mackintosh, AgResearch Invermay, Health and diseases
Dr Ian Sutherland, AgResearch Hopkirk, Parasitology
Wlodek Stanislawek, MPI Wallaceville, Virology diagnostics
Dr Neville Grace, AgResearch Grasslands, Trace elements

INTERNATIONAL COLLABORATION

Members of the Deer Research Group have collaborated with deer researchers at The University of Saskatchewan, Saskatoon, Canada, The College of Chinese Medicine Material, Changchun, PR China, the University of Queensland, Brisbane, Australia, Colorado State University USA, The National University, Mexico and the University of Buenos Aires, Argentina
**RECENT AND CURRENT RESEARCH PROJECTS**

**Nutrition**

Evaluation of a range of forage species for deer growth and production to produce quality venison to suit market needs. This project includes evaluation of the establishment, management, nutritive value and persistence of alternative pasture species as well as impacts of forage species on deer health and well-being. Brassicas, herbs legumes and browse are under evaluation currently.

**Whole Farm Production System Evaluation (Deer Herd Health and Production Profiling)**

A holistic approach to evaluation of key factors associated with optimum deer herd health, management, production, reproduction and financial outcomes.

**Digestive physiology**

Evaluation of the mechanism and efficiency of digestion of various feedstuffs in deer.

**New diseases**

Investigation of the epidemiology and control of newly diagnosed diseases such as a haemolytic disease associated with erythrocytic inclusion bodies, bacterial infections such as *Bartonella* spp, and eye lesions associated with cervine herpesvirus in farmed deer herds.

**Welfare**

Evaluation of factors which affect the health and wellbeing of farmed deer. Evaluation of analgesia of the pedicle and antler. This resulted in best practice for analgesia of the velvet antler. An additional study concerns the factors contributing to the death of stags under xylazine sedation for the purpose of antler removal.

**Internal parasites**

Evaluation of aspects of parasite control and prevention in deer with special reference to the role of plant secondary compounds including condensed tannins in legumes and sesquiterpene lactones in chicory. Subclinical internal parasitism investigations are about to commence.

Developments of grazing systems using plant secondary compounds to control parasites as alternatives to regular anthelmintic drenching.

Investigation of diagnostic criteria for lung and gastrointestinal parasitism.

Evaluation of anthelmintic efficacy.

Currently: PhD project into inter-species grazing aspects of gastrointestinal and lung parasite control, pathogenicity of various species of parasites in deer, speciating parasites of deer

**Trace elements and minerals**

Evaluation of the role of trace elements in deer production, and methods of control and prevention of deficiency-mediated disease and loss of production. Several projects have been undertaken including evaluation of forages to supply trace elements, the metabolism of copper, distribution of copper oxide wire particles, efficacy of new product formulations, role of fertilizer copper, and the mineral composition of deer. Investigations of selenium, cobalt and iodine have been undertaken.
Leptospirosis
Evaluation of the epidemiology and control of leptospirosis in farmed deer herds. This project providing data for an industry strategy to protect both deer and humans from this disease. It established the regional prevalence on farms, the seasonal infection pattern, the efficacy of vaccination in reducing shedding of organisms in urine, and provided preliminary data on growth and reproduction limiting effects of leptospirosis in deer.

A second PhD project confirmed growth and reproduction effects, the efficacy of vaccination in preventing production losses, preliminary data on the epidemiology of leptospirosis in mixed species farms, and demonstrated the presence of leptospires in the reproductive tract of deer early in gestation. This project also validated a PCR for diagnosis in urine and kidney samples.

A third PhD project involved further evaluation of inter-specie grazing with deer, and multi-species leptospirosis, along with demonstrating the high risk of infection in deer slaughter premise workers

Current work is investigating the role of leptospires in abortion

Johne’s Disease
A 6-year epidemiological study of Deer Johne’s Disease (2 PhD candidates) was aimed at understanding the major risk factors for the expression of disease, to enable management recommendations for deer farmers. Projects identified the farm and animal infection and disease prevalence and incidence, infection rate in deer at slaughter, the prediction of infection by mesenteric lymph node characteristics at slaughter, the efficiency of meat inspectors in detecting JD-like lesions, the efficacy of vaccination in young deer, the effect of vaccination of cross-reactivity with the Tb test, validation of the Paralisa test in low clinical disease incidence deer herds.

Further multi-species studies have shown strain type distribution, evaluated the role of sheep in reducing the risk of clinical disease in deer, Modelled the spread of disease between farms by movement of livestock, developed a model for evaluating the role of various potential control measures for deer herds.

Brucella ovis
This PhD study investigated the epidemiology and control of B. ovis in deer

Methane
A study of methane production from farmed deer with particular reference to nutritional factors, physiology and microbial populations in a comparative species context. This PhD study is also looking at means of reducing methane emissions.

Fetal wastage
This current project is investigating the prevalence and incidence of abortion in deer herds, and identification of potential infectious and non-infectious causes. It involves development and validation of tests for various pathogens, and work toward identifying solutions including vaccination for Toxoplasma.
EXTENSION OF RESEARCH

Members of the Massey team are actively involved in transfer of technology and research findings to the farmer and conducting on-farm investigation of health and production problems, to advance knowledge to enhance productivity. The group works closely with the Deer Industry organisations, and the Veterinary Association Deer Special Interest Group.

The group has a long history of presentations at various international deer conferences.

SIGNIFICANT ACHIEVEMENTS

- The development of 12-month venison production systems, effects of pasture height, pasture types including perennial ryegrass/clover, annual ryegrass, red clover, sulla, lotus and chicory. These studies have shown the potential of deer to achieve target weights to suit market requirements.

- Deer herd health and production profiling: Establishment of a significant database of farm management and performance variables for evaluation of major production limiting factors. Benchmarking data and models for optimum health, growth, reproduction and velvet production.

- Reproduction: Elucidation of mating behaviour of farmed deer and evaluation of ultrasonographic techniques for pregnancy diagnosis and foetal ageing.

- Identification and quantification of abortion in yearling and adult hinds.

- Evaluation of the seasonal biology of sambar deer in a farming environment.

- Animal remedy evaluation: Data from Massey has resulted in the licensing of vaccines, anthelmintics, copper and selenium preparations, antibiotics, a tickicide, tranquillisers, and melatonin.

- Parasitology: Development of a model for study of sub-clinical internal parasitism in weaner deer. Identification of new species of parasites in deer. Identification of the role of sheep and cattle in the transmission and control of internal parasites of deer

- Digestive physiology of deer: Elucidation of seasonal digestive patterns and food intake of farmed deer, and understanding differences in digestion between feeds that promote different levels of deer production.

- Tuberculosis: Elucidating the mechanisms and risk factors for the transmission of Tb from possums to deer, and further defining the pathophysiology of infection in deer, and quantifying the risk that feral deer pose to the persistence of Tb in wildlife populations.

- Identification of the optimum method for analgesia of the velvet antler. This has been adopted as “Best Practice” by industry through the NVSB programme

- Evaluation of various local analgesics and combinations for velvet antler removal and post-velveting pain control.

- Demonstration that a high pressure ring proposed for velvet antler analgesia is likely to be a noxious stimulus in its own right, contributing to its non-approval by NAWAC.
• Establishment of the noxiousness and efficacy of alow-pressure rubber band for analgesia of the antler of spiker deer. This resulted in its approval by NAWAC.

• Evaluation of the role of rubber rings for the prevention of antler growth in Red and Fallow deer. This resulted in NAWAC approval in fallow deer.

• Identification and characterisation of a number of new diseases of deer including Brucella ovis, enzootic ataxia, osteochondrosis, chronic MCF, a haemolytic disease, cervine herpesvirus.

• Elucidation of the epidemiology, diagnosis, control and prevention of Brucella ovis in farmed deer.

• Development of the national Johne’s Disease surveillance database, now managed by Johne’s Management Limited on behalf of industry

• Establishment of trace element reference ranges for diagnosis of adequacy and animal health and production risk

• Publications: The Massey University deer research effort has resulted in 210 reviewed scientific papers, three textbook chapters, 361 conference proceedings and more than 30 general articles being published, in addition to 15 industry reports, 15 PhD, 15 Masterate and 5 honours theses, 2 videos and 1 book.
SECTION 2

RESEARCH VISION

- Preamble
- “Internal” research imperatives
- “External” research imperatives
- Proposal for future research

1. PREAMBLE

The purpose of this section is to outline the preferred deer research and research funding environments within the principal areas of competence of the Massey University Deer Research Group and associates available for industry research needs of the future.

The guiding principle will be to maintain a flexible and dynamic deer research group that is responsive to industry needs and research opportunities.
2. “INTERNAL” RESEARCH IMPERATIVES

Within the University the Deer Research Group will strive to fulfil the following principles:

1. Scholarly research integrated with teaching
   - Postgraduate training is seen as a vital contribution by Massey University Deer Research to the deer industry and society in general. This will develop the scientific skills and knowledge of researchers for the future needs of the deer industry and society, nationally and internationally, at the same time as producing research outputs to meet the current needs of the industry;
   - Undergraduate students from a range of disciplines including veterinary, agricultural and science students, will be trained by academic staff with a strong and active involvement in deer science, to provide the professionals needed to support the industry of the future;

2. The primary focus will be on applied research, i.e.: developing solutions to existing, foreseen and potential problems facing the deer industry, thereby enhancing the sustainability of the industry and maintaining the improving profitability to the producer.

3. An additional focus will be to undertake fundamental research. It is acknowledged that the University has a unique role and responsibility in undertaking academic research to advance fundamental knowledge of the biology of deer and deer production systems.

4. The Deer Research Group will undertake research in a scientifically, academically and commercially ethical manner. The group will strive to maintain an appropriate balance between industry-based, commercial and pure research activity. This will be manifest by publishing research outputs in the scientific literature, presentation to scientific audiences and to producer audiences through several media, with discretion which addresses the needs of individual research funders and stability of the deer industry.

The academic arm of the Deer Research Group is uniquely placed to preserve independence through the availability of the Estendart Centre within the Institute of Veterinary, Animal and Biomedical Sciences, which is dedicated to providing directly commercial research services to private and industry agencies. This allows Massey University academic researchers generally to remain non-aligned directly to commercial interests.

5. Achieving a volume of research activity and funding that justifies maintaining a critical mass of academic and scientific expertise, and which justifies the continued operation of the Massey University Deer Research Unit and facilities.

6. To initiate independent research as appropriate in addition to providing for the identified specific research needs of the industry.
The Massey University Deer Research Group would prefer to operate in an environment that adopts and practices the following principles and processes.

- A primarily collaborative rather than competitive industry research philosophy.

Research areas determined as contributing collectively to the industry good should be undertaken in a collaborative, rather than competitive, environment. However, it is acknowledged that for some areas and projects commercial sensitivities will predominate and that competition and confidentiality will exist. Thus, an appropriate blend of collaborative and competitive research provision is anticipated.

This approach would be based on:

- collaboration and cooperation between both public and private research funders and providers where at all feasible;
- identification of research strengths of each research provider by an appropriate industry structure;
- avoidance of economically wasteful duplication of resources and expertise;
- pooling of scientific expertise to achieve the best outcome for the industry’s collective research needs;
- encouraging a free flow of knowledge between scientists to enhance knowledge, skills, understanding and job satisfaction of all deer researchers;
- promotion of multi-disciplinary and multi-institute research programmes;
- pooling of scientific resources in a neutral way to assist and determination of research priorities within the deer industry.

- An open and accountable research funding system for those research funds collected from producers and processors by compulsory levy.

- A formal process for coordinating, promoting and funding deer research. This would be envisaged as a joint initiative involving producers, processors, marketers, research providers and private industry to produce the most appropriate outcomes, while accepting the right of individual parties to operate independently where appropriate.
4. MASSEY UNIVERSITY DEER RESEARCH GROUP
PROPOSALS FOR FUTURE RESEARCH FOR
THE DEER INDUSTRY

The Group will employ existing and future multidisciplinary skills available within the University and in collaborating organisations to contribute to a range of current and future research areas which is believed will yield dividends for the deer industry.

These will be oriented largely towards sustainable and profitable production systems to meet market needs.

1. **Refining and adding value to present production systems**
   
   This integrates new or existing technology into farming systems, e.g.: the use of ultrasound for pregnancy profiling, promotion of holistic principles for improving production, epidemiological investigation of production losses such as mortalities, peri-natal losses etc.

2. **Creating a better understanding of the role of subclinical and clinical disease on the economics of deer farming**

   There is a dearth of robust data on clinical and subclinical disease rates and mortalities on deer farms. Such information is fundamental to development of risk management plans at the farm level, understanding the value proposition of various animal health measures, and providing industry with a clear direction for research priorities in the animal health arena. Development of a model as a tool for economic evaluation of animal health measures at the farm level.

3. **Enhancing food and occupational safety perceptions by developing farming systems to reduce or eliminate chemical usage and the risk of zoonotic or potentially zoonotic disease**

   To develop a better understanding of the epidemiology of infectious disease and therefore disease control programmes, e.g.: leptospirosis, Johne’s disease, tuberculosis, yersiniosis.

   To define management systems that reduce risk to humans. Research should produce technology to reduce the prevalence of these diseases and internal and external parasites requiring chemical control, thus lowering the risk of chemical residues in deer products.

4. **Developing management systems to enhance reproductive efficiency**

   Application of epidemiological tools such as case control and observational studies employing advanced statistical techniques to identify possible causes of variation in production levels, e.g.: lower fertility and poorer calf survival in first calving hinds. Applying improved nutrition and other practices to overcome these limitations. Continuation of research into fetal wastage and its control.

5. **Investigating environmental, management and animal behavioural factors contributing to improved animal well-being and productivity**

   Observational and behavioural studies where links between behaviours and production may be identified. Evaluation of management practices that enhance productivity and deer well-being, including reducing the risk of injuries, which are currently likely the largest source of wastage on deer farms. This will require further studies into methods of quantifying welfare of farmed deer. Improvement of the overall well-being of deer by establishing an understanding of the “whole of life” experiences of deer, and factors that contribute to or detract from optimum well-being.
6. **Defining and devising systems to reduce the impact deer have on the environment (soil, water, pastures, vegetation)**

- Observational and case-control studies of factors contributing to environmental impact of deer, and analysis by advanced statistical tools;
- Intervention study testing the effect of various factors determined by the above, on commercial deer farms.

7. **Developing farming systems to improve the well-being of deer through maintenance of optimum health, particularly for trace elements, parasite control and infectious diseases**

- This objective is linked to objectives above with respect to the role of forage species and nutrition in parasite and trace element management;
- Evaluation of new animal remedies to help provide solutions to disease and parasite control;
- Evaluation of existing animal remedies used or of potential use in deer production systems to enable their registration with the Agricultural Compounds Unit defining product safety and food safety specifications;
- Further holistic valuation of seasonal changes in trace elements, their metabolism, and the effectiveness of various supplementation techniques;
- Critical analysis of existing usage of trace elements with a view to refining decision making about expenditure on trace elements.
- Refinement of trace element reference ranges (particularly Selenium, cobalt and Iodine) to enhance the veterinarian’s ability to diagnose trace element deficiencies and improve the efficiency of monitoring and therefore the cost effectiveness of supplementation programmes;
- Evaluation of existing and new technologies for disease control, e.g.: improving knowledge of vaccine efficacy (yersinia, leptospirosis, Johne’s disease), tick control;
- Evaluation of teeth wear, its effect on deer health, well-being and farm management and economics.
- Evaluation of culling decisions and causes, including the role of longevity in enhancing the profitability of deer farming by extending the generation interval for breeding animals.

8. **Optimising the well-being of deer by developing the best methods for elimination of pain and distress during routine management practices**

- Investigation of post-operative pain control following antler removal.

Investigation of the deer welfare, health and productivity effects of supplemental oxygen to animals sedated with Xylazine or other alpha-2 agonist drugs known to result in hypoxia.

9. **Investigation of the epidemiology and production effects of diseases**

- Johne’s disease, leptospirosis, Cervine Herpesvirus-1, etc. to provide fundamental knowledge and data for industry-sponsored disease control programmes;
- Evaluation of suspect exotic disease, e.g.: suspected tick-borne haemolytic disorder;
- Investigation and description of recently diagnosed disease, e.g.: Cervine herpesvirus
- Investigation of the role of subclinical infection with Yersinia, and the role of vaccination in mitigating losses if shown
- Evaluation of the epidemiology and production effects of Malignant Catarrhal Fever (MCF) virus using PCR technology.
- Evaluation of the subclinical effects of Toxoplasma on growth of young deer.

10. **Johne’s Disease**

Utilise data collected by JML to analyse trends associate with suspect JD.

Evaluate *Mycobacterium avium* subsp. *paratuberculosis* in venison, and evaluate a risk management mechanism utilising the JML surveillance database system. This would involve stratification of farms, and animals by lesion status, analysing meat from animals in various strata, and the potential role of the current lymph node abnormality marker as a surrogate or predictor of infection in meat. This would help protect the industry in the event that MAP becomes established as a cause of Crohn’s disease in humans.

11. **Deer Research Group will continue to initiate fundamental research into the biology of deer as opportunities arise.**
SECTION 3

RESEARCH OUTPUTS

• Research project areas
• Study titles
• Principal outcomes
• Industry impact/adoption
## MASSEY UNIVERSITY DEER RESEARCH OUTPUTS

Deer research projects, outputs and their influence on, and uptake by the New Zealand deer industry, 1979-2005*

* Research highlights are presented, this is not an exhaustive list

<table>
<thead>
<tr>
<th>Research area</th>
<th>Study title</th>
<th>Principal outcome(s)</th>
<th>Industry impact/adoption</th>
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</thead>
<tbody>
<tr>
<td>1. ANIMAL REMEDIES</td>
<td>1. Bayticol</td>
<td>Description of the efficacy of Bayticol for control of ticks in deer</td>
<td>Bayticol licenced for use on deer as the principal tool for tick control by deer farmers</td>
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<td></td>
<td>2. Copper</td>
<td>Evaluation of the effectiveness of two copper needle products</td>
<td>Two copper needle products licenced for use in deer.</td>
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<td>Pilot evaluation of a new copper formulation</td>
<td>Resulted in commercial development for further study and licence</td>
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<td>Evaluation of the role of copper sulphate applied as a fertilizer for copper supplementation</td>
<td>Results indicated standard dose rates were inadequate. New formulation standards are being developed</td>
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<td>Evaluation of the role of molybdenum on copper metabolism</td>
<td>Data indicated Mo significantly reduces Cu absorption indicating the relevance of Mo measurement in aiding the diagnosis and management of Cu deficiencies</td>
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<td></td>
<td>Evaluation of the role of Molybdenum on the absorption of Cu from CuO wire supplementation</td>
<td>Copper absorption was significantly depressed in animals fed diet high in molybdenum, suggesting that this form of supplementation will be less efficacious in high dietary Mo situations</td>
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<td></td>
<td>Evaluation of the distribution of copper oxide wire particles in the gastrointestinal tract of deer</td>
<td>Data shows most particles are retained in the rumen as a reservoir for slow passage to the abomasum where dissolution for absorption occurs</td>
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<td>3. Clostridial vaccine</td>
<td>Demonstration of low antibody responses to clostridial vaccine</td>
<td>Showed manufacturer that more work was required before product can be licenced</td>
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<td>4. Detomidine</td>
<td>Demonstrated effectiveness as a tranquillising and chemical immobilising drug for farmed deer</td>
<td>Product not licenced for commercial reasons but technical information available for veterinarians for discretionary use</td>
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<td>5. Fentazin</td>
<td>Demonstration of the efficacy of fentazin compared with xylazine for sedation and analgesia</td>
<td>Provided veterinarians with greater detail on the physiological and pharmacological properties of these drugs and drug combinations, to allow better decision making in the choice of sedative agent</td>
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<tr>
<td>6. Leptospiral vaccine</td>
<td>Demonstration of serological responses to a leptospiral vaccine.</td>
<td>Two leptospiral vaccines licenced for use in deer and available for deer farmer use</td>
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<td>7. Melatonin (“Regulin”)</td>
<td>Demonstration of the efficacy of melatonin in advancing the breeding season in commercial deer herds</td>
<td>Industry has the means of reducing risk of transmission of leptospirosis to all people associated with farmed deer. This has significant OSH implications</td>
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<td>8. Terramycin</td>
<td>Demonstration that oxytetracycline is metabolised more rapidly in deer than in other species</td>
<td>Availability of a tool for advancing the breeding season. Demonstration that early rutting stags can be used to advance the breeding season. Some farmers have used this technology</td>
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<td>9. Valium</td>
<td>Valium produced sedation but inadequate for routine use on farmed deer</td>
<td>Terramycin “LA” licenced for use in deer providing veterinarians with more secure options for antibiotic treatment for control, treatment and prevention of disease</td>
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<td>10. Evaluation of Chloroprocaine</td>
<td>Confirmation that this local anaesthetic has the same efficacy as the presently licensed Lignocaine hydrochloride</td>
<td>Industry has an alternative to lignocaine, to avoid residue issues, if or when the Food safety Authority no longer approves the use of lignocaine for velvet removal because of unwanted residues. This research allowed industry to work with commercial partners to commence licensing and commercialisation processes.</td>
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<tr>
<td>10. Evaluation of “Silirum” a vaccine for Johne’s disease</td>
<td>The vaccine is safe in deer, and a dose rate of half the cattle dose rate is adequate to develop immunity. The vaccine reduced the clinical disease rate by 60%. The proportion of deer shedding was not reduced in vaccinated animals. Vaccinated deer had a higher rate of reactivity to the Tb skin test in yearlings but reactivity could be diagnosed as non-specific using current ancillary tests. It appears that cross-reactivity decreases with time.</td>
<td>“Silirum” has been licensed for use in deer in New Zealand</td>
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2. DISEASES

The following diseases have been evaluated and reported in the veterinary literature

1. **Brucella ovis**
   Better understanding of the epidemiology, transmission and pathogenesis of *Brucella ovis*, and understanding of the efficacy of various tests to detect infection in deer
   Veterinarians have better information for advising clients on diagnosis, control and eradication. Data showed most stags self-cure, obviating the need to cull valuable animals

2. **Enzootic ataxia**
   First description of the clinical syndrome and pathology of this copper deficiency disease in farmed deer in New Zealand
   Providing information for veterinarians for the diagnosis, treatment, control and prevention of this disease
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<tr>
<td>3. Keratoconjunctivitis (pinkeye)</td>
<td>First description of this eye disease and its treatment and control Preliminary investigation of the cause of keratitis</td>
<td>Information has allowed veterinarians to better understand this disease and means of diagnosis, control and prevention Demonstration of cHV-1 in the eyes of deer</td>
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<tr>
<td>4. Leptospirosis</td>
<td>Definition of serological status of deer in a regional pilot study to provide the industry with an evaluation of the risk of this disease. Data on the epidemiology and transmission on-farm: identification of timing of infection and serovars National seroprevalence, showing ~80% of farms and about 50% of deer were positive. Seroprevalence of Hardjoovis was about 75% of farms and Pomona about 20% of farms. Demonstration of reduced growth due to infection with leptospirosis (range up to 6.4kg liveweight at 12 months of age). Range was prevalence-dependent Demonstration of reduced weaning percentage (mean 5%, range up to 10%) Determination of efficacy of a leptospiral vaccine, showing a 44% reduction in urine shedding in infected deer, 100% protection against shedding in challenged deer, protection against growth and reproduction limiting effects of leptospirosis Identification of leptospires in the reproductive tract of</td>
<td>Alerted the deer industry to the potential importance of leptospirosis, assisting determination of research priorities Provided veterinarians with knowledge of the prevalence of this disease and the human risk Leptospirosis was confirmed as a disease nationwide, demonstrating that national rather than regional or individual farm approach to disease was relevant. This data was used to heighten awareness of this disease across industry Indicated that leptospirosis was a cause of subclinical production loss Leptospirosis is a disease condition that should be considered when sub-optimum reproductive performance is experienced. Vaccination is confirmed as a tool for prevention of the subclinical effects of leptospirosis, and protection of humans from infection via urine.</td>
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<tr>
<td>Research area</td>
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<td>Principal outcome(s)</td>
<td>Industry impact/adoptions</td>
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<td>hinds</td>
<td>Development and validation of a PCR for diagnosis from urine and kidney tissue from deer</td>
<td>A validated tool for further research investigation of leptospirosis</td>
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<td></td>
<td></td>
<td>Establishment of cross-species transmission of leptospirosis</td>
<td>Control of leptospirosis on deer farms needs to consider the organism in other classes of livestock</td>
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<td></td>
<td>Cost-effectiveness and decision-making about leptospirosis vaccination</td>
<td>A decision-making tree for vaccination decisions</td>
</tr>
<tr>
<td>5.</td>
<td>Malignant catarhal fever – chronic manifestation</td>
<td>First description of a chronic form of malignant catarhal fever</td>
<td>Allows veterinarians better knowledge to diagnose this important disease</td>
</tr>
<tr>
<td>6.</td>
<td>Osteochondrosis (copper deficiency)</td>
<td>Description of the epidemiology of this condition and its association with copper</td>
<td>Veterinarians and farmers now have a significantly better understanding of causes of lameness in young deer, aiding diagnosis, control, treatment and prevention. Prevention of economic wastage</td>
</tr>
<tr>
<td>7.</td>
<td>Red urine on red clover</td>
<td>Description of a phenomena of red urine on deer grazing red clover</td>
<td>Allows veterinarians to better understand the differential diagnosis of red urine which can potentially be a serious condition for farmed deer</td>
</tr>
<tr>
<td>8.</td>
<td>Theileria-like organism (Suspected new disease)</td>
<td>Investigation of a suspected new protozoal intravascular haemolysing disease of deer for MAF Regulatory Authority</td>
<td>Alerted MAF and NCDI of possible cause of haemoglobinuria and jaundice of carcasses seen subsequently. Further study was done by NCDI. The investigation will continue when more cases occur</td>
</tr>
<tr>
<td>9.</td>
<td>Tuberculosis (several studies)</td>
<td>Description of the relationship between possums and deer as a risk for Tb transmission The first demonstration of natural transmission of Tb from possums to deer Demonstration by natural infection of the importance of</td>
<td>Demonstration of the risk that possums and other wildlife species present to deer and better defining the impact of infection in deer. This data has aided veterinarians, the Animal Health Board and those involved with the Tb eradication programme to evaluate risk and assist the diagnosis of Tb, and providing guidance for management decisions to reduce the prevalence of Tb. The risk of feral deer has assisted the Animal Health Board to establish appropriate</td>
</tr>
<tr>
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<td>the tonsil as the primary route of entry</td>
<td>national strategies for eradication or control of Tb in feral wildlife species</td>
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<td></td>
<td>Description of the pathogenesis of Tb infection in deer</td>
<td>The project on management decisions should provide deer farmers with management means of reducing the risk of exposure of deer to infected possums and wildlife species</td>
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<td>Evaluation of the risk of feral deer in maintaining Tb in feral wildlife populations</td>
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<td></td>
<td>Impact of management decisions on farm to reduce the risk of domestic deer being infected from feral wildlife (study in progress)</td>
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<td></td>
<td>Review of the role of genetics/selection of resistant deer to reduce Tb incidence</td>
<td>Influenced research investment decisions</td>
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<td>10. Yersiniosis</td>
<td>Demonstration that there appears to be a genetic difference in immunological responses to vaccines</td>
<td>This study has prompted further research into the efficacy of vaccination programmes and susceptibility (study in progress)</td>
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<td></td>
<td>Evaluation of factors affecting the efficacy of vaccines</td>
<td>Data showed multiple vaccines given at one time did not interfere with efficacy, meaning that farmers can give more than one vaccine together</td>
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<tr>
<td>11. Cervine herpesvirus</td>
<td>The first isolation of this virus from eyes with lesions, and possible association with infertility</td>
<td>Demonstrated the need for further research (funding proposal submitted)</td>
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<tr>
<td>12. Johne’s disease</td>
<td>Incidence of clinical disease has been established.</td>
<td>Industry now knows JD is a low incidence disease, but infection is of high prevalence.</td>
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<td>Animal and environmental risk factors for clinical JD have been identified</td>
<td>Irrigation and inter-grazing with cattle are risk factors for clinical JD. Grazing with sheep reduces the risk of JD.</td>
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<td>The validity of Lymph node characteristics for estimation of the presence of MAP for national surveillance has been established</td>
<td>Development of the National Deer Johne’s Disease surveillance database: now passed on to the industry, and managed by Johne’s Management Limited.</td>
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<td>The accuracy of meat inspector determination of lymph</td>
<td>Development of training programmes and routine up-skilling of meat inspectors for</td>
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<td>node abnormalities has been determined</td>
<td>the JML surveillance database</td>
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<td>Evaluation of the histopathology of JD in deer, particularly in enlarged lymph nodes.</td>
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<td>Establishment of the individual animal and herd-level prevalence of infection with MAP</td>
<td>Industry awareness of the herd prevalence, guiding decisions about the rationale for farm status declarations.</td>
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<td>Independent evaluation of the sensitivity and specificity of the Paralisa test in low clinical disease herds</td>
<td>Sensitivity of 19% and specificity of 92 - 94% provides veterinarians with better data upon which to interpret use of tests for JD control</td>
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<td>Modelling of key factors for control of JD in deer showing grazing with sheep and identification and culling of high shedders are main means of reducing clinical JD, but that progress is long-term</td>
<td>Veterinarians have a model available to predict the effects of using these tools</td>
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<td>“Silirum” vaccination (see Animal Remedies section above)</td>
<td>Vaccine licensed for use in deer</td>
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<td>Investigation of the growth and reproduction effects of JD in deer showing no detectable causal effect using the method adopted</td>
<td>Requirement for further research into production effects before vets and farmers can be confident that growth and reproduction effects can be used in modelling the financial impact of JD on deer farms</td>
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<td>Strain typing shows 95% of deer MAP isolates are cattle strain</td>
<td>Cross-grazing with sheep is low risk for clinical disease in deer</td>
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<td>Strain typing shows some similarities between isolates from deer and dairy cattle, though some deer-specific strains exist</td>
<td>Cross-grazing with dairy cattle may represent a high risk for deer JD</td>
</tr>
</tbody>
</table>

3. EXTENSION PROJECTS

1. DeerMaster Project, South Canterbury/North

Identification of deer farm productivity in Canterbury. Application of technology to improve farm performance. Farmer seminars and field days to extend knowledge
<table>
<thead>
<tr>
<th>Research area</th>
<th>Study title</th>
<th>Principal outcome(s)</th>
<th>Industry impact/adoPTION</th>
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<tr>
<td></td>
<td>Otago Deer Farmers’ Association (PRW Scientific Adviser)</td>
<td>Implementation of factors to increase productivity</td>
<td>Altered fencing to improve weaning by 3-4%</td>
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<td></td>
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<td>On-farm clinical trials on trace elements, parasitism and calving management</td>
<td>Impact of parasites of adult deer need further study. i.e. helps determination of research priority</td>
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<td>Data presented to vets to help farmers improve production</td>
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<td></td>
<td>2. Richmond Wrightson Deer Performance Project, Hawkes Bay (PRW Scientific Adviser)</td>
<td>Demonstration of productivity improvements by adoption of assessing technology</td>
<td>Conference and several field days demonstrating management techniques and outcomes attended by up to 350 deer farmers each.</td>
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<td>On-farm clinical trials are being conducted in both studies to help fill the gaps in knowledge required for herd production outcomes (In progress)</td>
<td>Presentations to Veterinary Association deer conferences</td>
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<td></td>
<td>3. Genetic improvement</td>
<td>Explanation of genetic principles to provide a sound basis for herd improvement programme</td>
<td>Long term improvement of future deer farms, to make informed decisions on breeding and selection which will enhance the efficiency of deer production systems in future</td>
</tr>
<tr>
<td>4. FOOD SAFETY</td>
<td>1. Yersinia contamination of venison carcasses</td>
<td>Virtually no risk of carcass contamination with this organism</td>
<td>Adopted by industry to enhance food safety image of venison</td>
</tr>
<tr>
<td>5. HEALTH PRODUCTION PROFILING</td>
<td>2. A 4-year observational study employing epidemiological techniques</td>
<td>The first accurate description of growth, reproduction, antler production and health on commercial deer farms</td>
<td>Provide baseline data for industry planning, e.g. reproductive performance, animal growth</td>
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<td>The first description of current deer farm management practices and processes</td>
<td>Provided the basis focus for deer herd extension projects (see projects 3.1 and 3.2 above)</td>
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<td>First description of individual animal characteristics related to production outcomes</td>
<td>Benchmark figures available for all deer farmers</td>
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<td>Development of putative management models for achievement of optimum production and health outcomes</td>
<td>BCS system widely adopted on-farm and for research</td>
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<td>Development, publication and adoption of a body condition scoring chart and system</td>
<td>Models for productivity have been adopted and proven to increase productivity, e.g. reproduction 10-20%</td>
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<tr>
<td>3.</td>
<td>Characterisation of variation in adult live weights and velvet antler weights</td>
<td>Forms the basis for developing deer genetic evaluation procedures</td>
<td>Provides framework for the comparison of deer breeding strategies</td>
</tr>
<tr>
<td>6. NUTRITION/</td>
<td>1. Effect of pasture height on deer growth and venison production</td>
<td>Pastures grazed at 10 cm produced better deer growth than those grazed at 5 cm</td>
<td>Adopted to produce killable weights by 1 year instead of 2 years</td>
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<tr>
<td>METABOLISM</td>
<td></td>
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<td>The chicory work is being adopted by the industry now, especially as a specialist crop in dry areas</td>
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<td></td>
<td>2. Inputs of red clover and chicory during autumn and spring to increase venison production by one year of age</td>
<td>Inputs of the specialist crops increased deer growth by up to 47% and dramatically increased venison production by one year of age. Biggest responses in elk x red hybrids</td>
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<td>3. Inputs of red clover and chicory during summer to increase calf weaning weight</td>
<td>Calf growth during summer increased by approx. 25% and weaning weight by 6 kg</td>
<td>Being adopted in drier areas and intense finishing operations</td>
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<td>4. Digestion of forage diets by deer</td>
<td>Showed that alternative forages such as and chicory can break down faster in the rumen than perennial ryegrass, accounting for their higher feed intake and digestibility</td>
<td>Being adopted in drier areas</td>
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<td>5. Nutrition of sambar deer (in collaboration with AgResearch)</td>
<td>Sambar deer shown to have less seasonal growth than red deer and to use nutrients more efficiently. Hybridisation between red and sambar deer was not successful</td>
<td>None at this stage</td>
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<tr>
<td>6. Forages and trace elements</td>
<td>Identification of significant improvement in the trace element status on alternative forages such as Chicory and Plantain</td>
<td>Veterinarians and farmers can incorporate different forages into management of trace element deficiencies</td>
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<td>7. Trace elements from farmed and feral deer</td>
<td>Demonstration of the higher liver content of important trace elements in feral deer</td>
<td>Proposal that alternative forages can be used for management of trace element deficiencies</td>
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<tr>
<td>8. Forages and internal parasitism</td>
<td>Alternative forages such as chicory and sulla can reduce internal parasite numbers, and minimise the effect of subclinical parasite burdens</td>
<td>Incorporation into low chemical parasite control programmes, toward sustainable deer production systems</td>
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<tr>
<td>7. EXTERNAL PARASITES</td>
<td>Investigation of the epidemiology and control of ticks</td>
<td>Demonstration of the effectiveness of Bayticol in controlling ticks</td>
<td>Bayticol licenced as an aid for tick control</td>
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<td>Defining the epidemiology of tick infestations in deer and methods of control and prevention</td>
<td>Provision of veterinarians and farmers with a full understanding of the impact of ticks on deer and the adoption of various control strategies. Widely adopted in tick-prone areas</td>
</tr>
<tr>
<td>8. INTERNAL PARASITES</td>
<td>Identification of the major gastrointestinal parasites of deer</td>
<td>Description of the major internal parasites of deer</td>
<td>Veterinarians have a better understanding of the diagnosis, treatment, control and prevention of internal parasitism in deer</td>
</tr>
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<td></td>
<td>Subclinical model of parasitism used to test effect of forage species and evaluate diagnostic criteria</td>
<td>Greater understanding of limitation of current diagnostics for subclinical parasitism. Condensed tannins identified for natural control potential.</td>
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<td>Development of a model for study of internal parasitism in deer</td>
<td>Demonstration that chemicals in certain pasture species can reduce internal parasite burdens</td>
<td>These studies indicate the potential for natural means of parasite control as an alternative to anthelmintic drenching, providing stimulus for further research (research continuing on developing low anthelmintic grazing systems)</td>
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<td>Natural methods for</td>
<td>Relationships between control practices and parasitism,</td>
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<td>parasite control</td>
<td>Survey of parasite control methods and effectiveness</td>
<td>first presentation of diagnostic indices of parasitism, Description of current practices</td>
<td>Data now available to help veterinarians interpret diagnostic measures of parasitism</td>
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<td>Albendazole is efficacious against the major internal parasites of deer</td>
<td>Indicated need to focus on parasites of deer other than weaners</td>
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<td>Different efficacies were demonstrated</td>
<td>Assistance with label claim</td>
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<td>Efficacy of various new-generation anthelmintics</td>
<td>Efficacy of ivermectin and cydectin not optimal</td>
<td>Farmers and veterinarians have more knowledge of the properties of anthelmintics, to enable better decisions about parasite control</td>
</tr>
<tr>
<td></td>
<td>Forages for internal parasite control</td>
<td>Chicory and sulla reduce parasite burdens in deer, along with reducing the impact of parasites, through better nutrition</td>
<td>First indication of sub-optimum efficacy of some conventionally used anthelmintics</td>
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<td>Condensed Tannins in alternative forages reduce larval uptake and excretion</td>
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<td></td>
<td>Epidemiology of internal parasites</td>
<td>Demonstration that growth reduction due to internal parasites can occur by mid-January</td>
<td>Early adoption of anthelmintic application may increase productivity</td>
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<td>Molecular identification of the range of parasites in deer on mixed-species farms</td>
<td>Some parasites of deer are common with those of sheep and cattle</td>
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<td>Pen trials have shown that the uptake of sheep–origin gastrointestinal worm larvae in deer is significantly lower than in sheep</td>
<td>Cross-grazing with sheep may reduce internal worm burdens in deer.</td>
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<td>Identification of new parasites Trichostrongylus askivali and a deer-specific species of Oesophagostomum, with evidence</td>
<td>Consideration of additional parasites and the potential impact of a parasite species hitherto regarded as benign need to be considered when investigating production</td>
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<td>of pathological effect of the latter</td>
<td>effects related to parasitism</td>
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<tr>
<td>9. PHYSIOLOGY</td>
<td>1. Definition of blood haematological and biochemical parameters</td>
<td>Description of normal ranges for parameters of veterinary diagnostic significance</td>
<td>References ranges have been adopted by veterinary diagnostic laboratories to support veterinary practitioners in the field</td>
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<td>2. Teeth eruption</td>
<td>This study defined the pattern of teeth eruption patterns in red deer under farming conditions</td>
<td>This data allowed more accurate ageing of deer at deer slaughterhouses, which is of importance to the Cervena marketing strategy</td>
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<td>3. Antler nerve anatomy</td>
<td>Defined the major innervation for application of analgesics</td>
<td>Used as the standard for the national velveting scheme</td>
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<td>Used as the base reference by veterinarians for antler analgesia</td>
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<td>4. Electrical stunning</td>
<td>Determination of the appropriate slaughter stunning method</td>
<td>Widely adopted in deer slaughterhouses as the most humane method of slaughter</td>
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<td>5. Carcass composition</td>
<td>First definition of pre- and post-rut carcass composition</td>
<td>Highlighted the need for post-rut slaughter of stags to avoid fatness, and therefore poor quality image of venison</td>
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<td>6. The morphology of sambar deer stomachs</td>
<td>Further understanding of sambar deer physiology and nutrition</td>
<td>Basic Science</td>
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<td>7. The diet of sambar deer</td>
<td>Further understanding of sambar deer nutrition</td>
<td>Basic Science</td>
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<td>8. The seasonality of reticulo-rumenal motility in red deer</td>
<td>Further understanding of digestion in red deer</td>
<td>Basic Science</td>
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<tr>
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<tr>
<td>9.</td>
<td>The response of the forestomach of wild red deer in different seasons and dietary scenarios</td>
<td>Further understanding of wild red deer responses to adequate and poor nutrition</td>
<td>Basic Science</td>
</tr>
<tr>
<td>10. REPRODUCTION</td>
<td>Trans-rectal ultrasound scanning for pregnancy diagnosis and foetal ageing</td>
<td>The development of foetal aging equations. Accuracy of foetal ageing been defined in practice</td>
<td>Widespread adoption of ultrasound scanning and foetal ageing as a tool for management by commercial deer farmers</td>
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<td>Appropriate stages of gestation for scanning have been defined</td>
<td>Widespread adoption of this technique in extension projects to gather further information on commercial herd productivity</td>
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<td>A series of equations for foetal ageing have been developed and tested</td>
<td>Widespread utilisation in a research environment to evaluate the impact of reproductive strategies on conception outcomes</td>
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<td>A 130-page booklet and 20-minute video have been published and marketed</td>
<td>Early aging used as a tool for investigations of reproductive failure</td>
</tr>
<tr>
<td>11. Effect of melatonin implants on advanced breeding in commercial deer herds</td>
<td>Demonstration of a 30-day advancement in median conception date in commercial deer herds</td>
<td>Melatonin implant “Regulin” licenced for use in deer</td>
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<td>Demonstration of an 8-10 day advance in breeding due to stag rutting influences</td>
<td>Some farmers have adopted the induced stag effect to advanced breeding</td>
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<td>12. Fetal Wastage</td>
<td>Preliminary demonstration of mid-term abortion rates up to 16% in rising 2-year-old hinds on four farms</td>
<td>Industry awareness that abortion may be more prevalent than thought</td>
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<td>Demonstration of serological, PCR and pathological evidence that Toxoplasma may be one of the causes of abortion</td>
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<td>Quantification of the range of mid-term abortion rates on</td>
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<tr>
<td>Research area</td>
<td>Study title</td>
<td>Principal outcome(s)</td>
<td>Industry impact/adoption</td>
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<td>55 farms, indicating a mean</td>
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<td>Validation of an Elisa for diagnosis of Toxoplasma in deer</td>
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<td>11. TRACE ELEMENTS</td>
<td>1. Enzootic ataxia and osteochondrosis</td>
<td>See DISEASES above</td>
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<td></td>
<td>2. Several studies of the relationship between copper and growth</td>
<td>Better definition of the production responses to copper supplementation</td>
<td>Veterinarians provided with better information for copper deficiency diagnostic purposes</td>
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<td>Data has helped define reference ranges for copper</td>
<td>Contribution to farmer knowledge of the role of copper in production outcomes</td>
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<td></td>
<td>2. Copper and antler growth</td>
<td>No antler growth response was observed within the copper ranges measured</td>
<td>This study has better defined the “deficient” range for copper affecting velvet antler production</td>
</tr>
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<td></td>
<td>3. Survey of trace element usage</td>
<td>Observation of inappropriate and inadequate diagnosis in copper supplementation on many commercial deer farms</td>
<td>To alert veterinarians and farmers to the need for and value of copper monitoring and investigation</td>
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<td>Trace element monitoring is widely practised</td>
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<td>4. Selenium products and growth</td>
<td>Defined the safety and efficacy of a new formulation of long acting, injectable selenium</td>
<td>A potentially new selenium animal remedy for use in deer</td>
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<td>Defined a relationship between liver and copper selenium</td>
<td>Assisting refinement of reference ranges for selenium deficiency diagnosis</td>
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<td>Defined no growth rate response despite low levels</td>
<td>Confirmed value of liver vs. blood measurements for diagnosis of selenium deficiency</td>
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<td>Research area</td>
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<td>5. Relationship between liver and blood copper</td>
<td>Definition of the relationships between blood and liver copper concentrations</td>
<td>Adopted by veterinary practitioners to interpret the predictive value of blood and liver copper concentrations for veterinary diagnostic purposes</td>
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<td></td>
<td>6. Mineral requirements for deer</td>
<td>The dietary trace element and mineral requirements for deer have been identified. Of particular note is that the requirement for Copper is estimated to be 11 ppm.</td>
<td>Determination of copper sufficiency can be estimated by dietary measurement for Cu. Differentiation between primary and secondary Copper deficiency is now possible by measurement of cu in forages.</td>
</tr>
<tr>
<td>12. WELFARE/ANTLERS</td>
<td>1. Investigation of antler prevention</td>
<td>Defined the efficacy and welfare implications of rubber rings for preventing antler growth in young fallow deer</td>
<td>Adoption. Data provided the Animal Welfare Advisory Committee and deer industry with the means of developing a Code of Conduct for the use of rubber rings for prevention of antler growth in fallow deer</td>
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<td></td>
<td>2. Evaluation of local anaesthetic application techniques in spiker deer</td>
<td>Demonstration that a high dose ring block is the most effective, rapid and reliable method of local analgesia for the antler</td>
<td>Adoption. Data has alerted veterinarians to the most appropriate technique. Impact will be to improve the achievement of analgesia during velvet antler harvesting</td>
</tr>
<tr>
<td></td>
<td>3. Local anaesthetic application techniques</td>
<td>Confirmation that high dose ring block is the superior method for analgesia of the antler</td>
<td>Adoption of the best techniques as shown by this research will allow the industry to defend the process of velvet harvesting, and therefore protect a $50 million export industry from welfare concerns</td>
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<td>Data will be used by the National Velveting Standards Body to recommend refinement of the compliance standards within the National Velveting Scheme, and potentially modification of the approved techniques for velvet antler analgesia</td>
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<td>Research area</td>
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<td>in adult stags</td>
<td>Confirmation of the role of the auriculopalpebral nerve determined by the Chief Veterinary Officer under the AWAC Code Protection of the velvet industry as above</td>
<td>Two studies using advanced measures including electroencephalograms demonstrated that high pressure may be noxious to stags The data assisted the National Animal Welfare Advisory Committee to decline approval of this technique, and prompted that body to request a re-evaluation of a lower pressure system previously approved for young stags</td>
<td>Data used by AWAC to decide on the use of EI</td>
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<td>4.</td>
<td>Investigation of compression as a potential analgesic</td>
<td>Demonstration that electroimmobilization is no more aversive than crush restraint</td>
<td>Adoption of recommendations as “best Practice” for velvet antler removal, incorporated into the NVSB training manual</td>
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<td>5.</td>
<td>The use of electroimmobilization in red deer</td>
<td>Identification of key factors that contribute to optimum local analgesia</td>
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<td>6.</td>
<td>Investigation of reasons why local anaesthetic blocks of antler innervation are not always successful</td>
<td>No epidemiological factors were identified as risk factors for stag deaths Measurements show that hypoxia following Xylazine is severe in may animals, suggesting that oxygen supplementation to sedated deer may reduce mortality rate.</td>
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<td>7.</td>
<td>The cause of post-xylazine stag deaths</td>
<td>A range of tourniquets were not effective in eliminating the risk of residues in velvet antler, but the risk was reduced</td>
<td>Application of the tourniquet prior to administration of local anaesthetic is now standard practice.</td>
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<td>8.</td>
<td>Control of 2-6 xylidine residues in antler following lignocaine administration</td>
<td>Studies of the vascular supply to the antler demonstrated the nature of vasculature to the antler, helping to explain why a tourniquet is not reliably effective in eliminating</td>
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<td>Research area</td>
<td>Study title</td>
<td>Principal outcome(s)</td>
<td>Industry impact/adoptions</td>
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SECTION 4

PUBLICATIONS

• Peer reviewed journal publications
• Conference proceedings
• Honours theses
• Masterate theses
• Doctorate theses
• Books
1. Peer reviewed journal articles

1979-1984


1985-88


1989


Wilson, P.R., Bingham, C.M. (1990): Accuracy of pregnancy diagnosis and prediction of calving date in red deer. *The Veterinary Record* 126: 133-135.


1993


1994


Soetrisno, E., Barry, T.N., Wilson, P.R., Hodgson, J., & Purchas, R.W. (1994). Effects of grazing red clover (Trifolium pratense) or perennial ryegrass (Lolium perenne)/white clover (Trifolium repens) pastures upon growth and venison production from weaner red deer (Cervus elaphus). *New Zealand Journal of Agricultural Research* 37, 19-27.

1995


1996


1997


1998


1999


Hoskin, S.O., Barry, T.N., Wilson, P.R., Charleston, W.A.G. & Hodgson, J. (1999). Effects of reducing anthelmintic input upon growth and faecal egg and larvae counts in young farmed deer grazing chicory (Cichorium intybus) and perennial ryegrass (Lolium perenne)/white clover (Trifolium repens) pasture. Journal of Agricultural Science, Cambridge. 132, 335-345


2000


2001


2002


*2003*


2004


Wilson, PR, Clark, P, Parkinson, TJ. (2004) Undiagnosed haemolytic anaemia in young red deer. Surveillance. 31 (3) 5-7

2005


2006-14


MA Ayanegui-Alcérreca, PR Wilson, CG Mackintosh, JM Collins-Emerson, C Heuer, AC Midwinter, F Castillo-Alcala. Regional seroprevalence of leptospirosis on deer farms in New Zealand. New Zealand Veterinary Journal. 58, 184-9, 2010

Laven RA, Wilson PR. Comparison of concentrations of copper in plasma and serum from farmed red deer (Cervus elaphus). New Zealand Veterinary Journal 57, 166-169, 2009


RA Laven and PR Wilson Subclinical hepatopathy after copper supplementation in farmed red deer. New Zealand Veterinary Journal 59. 197-200, 2011


S Subharat, P R Wilson, C Heuer, J M Collins-Emerson. Longitudinal serological survey and herd-level risk factors for Leptospira serovars Hardjo-bovis and Pomona on deer farms with sheep and/or beef cattle. New Zealand Veterinary Journal. 61, 215-222, 2012


SL Smith, DM West, PR Wilson, GW de Lisle, MG Collett, C Heuer and JP Chambers The prevalence of disseminated Mycobacterium avium subsp. paratuberculosis infection in tissues of healthy ewes from a New Zealand farm with Johne’s disease present. NZVetJ 60, 41-44, 2012


L.A. Stringer, P.R. Wilson, C. Heuer, C.G. Mackintosh. A randomised controlled trial of Silirum® vaccine for control of paratuberculosis in farmed red deer. Veterinary Record. 2013. Accepted


2. CONFERENCE PAPERS (Non-peer reviewed conference proceedings)

1978


1979


1981


1984


1985


1986

Wilson, P.R. (1986). Tuberculosis case reports: use of CCT in herds with CT reactors. New Zealand Veterinary Association Deer Branch Course Proceedings. No. 3. 89-95.


1987


Wilson, P.R. (1987). Deer herd health and productivity management: Data collection and assessment. New Zealand Veterinary Association Deer Branch Course Proceedings. No. 4. 54-68.

1988


1989

Deer Branch New Zealand Veterinary Association Course No. 6. 36-53.

Deer Branch Course No. 6. 54-65.

Association Deer Branch Course No. 6. 104-117.

1990

Deer Branch NZVA. 183-195.


1991


1992


1993


1994


1995


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1998


1999


2000


2001


2002


2003


2004 – 2014


64


Castillo-Alcala F, Wilson PR, Pomroy WE Hoskin SO. Anthelmintic use and internal parasite control in farmed deer in New Zealand IN: Advances in Deer Biology. Proceedings of the 6th International Deer Biology Congress, Prague, August 7-11. 72 ABSTR 2006


Wilson PR, Castillo-Alcala F, Grace ND. Recent advances in understanding therapy with copper oxide wire particles in New Zealand farmed deer. IN: Advances in Deer Biology. Proceedings of the 6th International Deer Biology Congress, Prague, August 7-11. 76 ABSTR 2006

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Wilson PR. DEER RANCHING CHALLENGES IN NEW ZEALAND. Proceedings of the North American Veterinary Conference, Orlando Florida 2010,pp 312-314


WILSON PR. CERVID TUBERCULOSIS – A GLOBAL ISSUE WITH LOCAL SOLUTIONS. PROCEEDINGS OF THE NORTH AMERICAN VETERINARY CONFERENCE ORLANDO FLORIDA 2010,PP 315-219


Jackie Benschop, Anou Dreyfus, Fang Fang, Julie Collins-Emerson, Peter Wilson, and Cord Heuer UPDATE ON LEPTOSPIROSIS RESEARCH IN NEW ZEALAND: THE HUMAN-ANIMAL INTERFACE Epidemiology Society, NZVA conference proceedings, 2011.


Wilson, PR, Heuer C, Subharat, S, Ayanegui-Alcerreca, MA, Collins-Emerson, J. Vaccination of farmed deer against leptospirosis: Risk-based, public health and economic approaches to decision-making. IN: Proceedings of the International Leptospirosis society Conference No 7, Merida, Mexico, M15, 2011. ABSTR


Verdugo C, Jones G, Johnson W, Wilson PR, Heuer C. A Bayesian assessment of the dependence of infection prevalence and clinical incidence of paratuberculosis on joint grazing of sheep, beef


KK Patel¹, PR Wilson¹, GW Asher², L Howe¹, C Heuer¹ Preliminary results from a study of reproductive wastage in deer. NZVA conference proceedings 2013.


Marquetoux N., Stevenson M., Wilson P. and Heuer C. Molecular epidemiology for paratuberculosis: use of strain typing data to inform the transmission of Mycobacterium avium paratuberculosis between farms via livestock movements. *International Paratuberculosis conference Palm Italy June 2014*


**Honours dissertations**

Hoskin S.O. (1993). The digestion, rumen fermentation and chewing behaviour of red deer fed fresh chicory and perennial ryegrass. (B Agr Sc)

Howse A.J. (1994). Digestion and chewing efficiency of young sambar deer and red deer consuming a low quality roughage. (B Agr Sci)


Old, A. (1999). The sustainability of the biophysical resources in deer farming systems in Hawkes Bay (B appl Sci)


**Masterate theses**

Dudley M.F.R. (1983). The sexual and social behaviour of red deer hinds (*Cervus elaphus*) during the rut. (MSc)

Anderson M.V. (1985). Studies of some aspect of gastrointestinal nematodes (*Dictyocaulus viviparus*) of farmed red deer. (MVSc)


Congrene J.M. (1990). The effect of serum cortisol and ultimate pH of farmed red deer exposed to routine water sprinkling prior to slaughter. (M Tech)


Bosi E. (1992). Public health aspects of *Yersinia pseudotuberculosis* in deer and venison. (MVSc)


Lentle R. (1994). The use of anatomical features of the stomach to investigate the nutritional status of deer populations. MSc


Bartels M.M. (2002). Studies of local anaesthetics for velvet antler analgesia. MSc
Swainson N.M. (2004). Methane emissions from farmed red deer. MSc

PhD theses
Ataja A.M. (1990) Venison production from weaner red deer stags grazing moata annual ryegrass or perennial ryegrass pastures.
Semiadi G. (1993). The domestication and nutrition of sambar deer (Cervus unicolor): a comparative study with red deer (Cervus elaphus)
Kusmartono (1996). Nutritive value of chicory (Chicorum entybus) as a special purpose forage for deer production.
Ayanegui-Alcerreca MA. (2006)Epidemiology and control of Leptospirosis in Farmed Deer in New Zealand
Subharat S. (2010) Epidemiology, diagnosis and vaccination control of leptospirosis in farmed deer in New Zealand
Hunnam J. (2011) The epidemiology of Johne's disease in New Zealand farmed deer, including validation of abattoir-based surveillance
Dreyfus, A. (2013) Leptospirosis in humans and pastoral livestock in New Zealand

Books
Revol B Wilson PR (1990) Rectal ultrasonography in red deer. Massey University