Breeding Strategies for Prioritising Health in Pedigree Dogs

Report for the Winston Churchill Memorial Trust

Dr Tom Lewis
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Cover picture: Dog statue at junction of King Street, Enmore Road and Australia Street in Newtown, Sydney
Introduction

The last 4 years has been a tumultuous time in the pedigree dog world. In August 2008 the documentary ‘Pedigree Dogs Exposed’ was aired on BBC1, highlighting many inherited diseases and conformational problems that affect pedigree dog breeds, and criticising the UK Kennel Club for not doing enough to promote the health and welfare of the 211 breeds it currently recognises and registers. The programme caused a public outcry, resulted in major sponsors and the BBC pulling out of the annual ‘Crufts’ dog show and engendered three major inquiries concerned with pedigree dog welfare (by the Royal Society for Prevention of Cruelty to Animals [RSPCA], the Associate Parliamentary Group for Animal Welfare [APGAW] and Professor Sir Patrick Bateson FRS). The same programme was aired in Australia just over a year later, provoking a similar reaction. Although some parties felt that they had been portrayed unfairly (and indeed Ofcom upheld some complaints, http://consumers.ofcom.org.uk/2009/12/pedigree-dogs-exposed/) the documentary succeeded in bringing the issues of health and welfare in pedigree dog breeds firmly to the public’s attention. There can be no doubting the gravity of these issues, but while much debate continues over who is to blame for the current situation, less public interest has been shown in delivering practical solutions to the current problems.

Genetically, the challenges facing pedigree dog breeders are the same as those facing livestock breeders, namely to achieve a satisfactory response to selection while maintaining sufficient genetic diversity within the breed, herd or population. It is simply the traits under selection that differ. For farmers and livestock breeders the selection objectives are to improve yields and efficiencies and to cut costs. For pedigree dog breeders primary selection objectives have often been defined by what is successful in the show ring. Thus, the interpretation of ‘breed standards’ has been all important and the ability of the breeder to identify a certain ‘type and temperament’ in a dog provide the raison d’être for the activity. However, pedigree dog breeders are increasingly attempting to consider health traits alongside those that they perceive will bring them success in the show ring. It is here, however, that some difficulties have arisen.

Effective artificial selection relies on the collection and collation of data pertaining to the objective traits, and genetic progress on the application of sufficient selective pressure to elicit a response. This equates to possessing the motivation for change and the degree of control to enact it. These are relatively easily achievable in livestock industries where there are relatively few individuals each controlling a large number of animals, and where collective improvement is quantitatively evaluated and financially rewarded. In the pedigree dog world, in contrast, the motivation to improve health is weaker since health traits are still sub-ordinate to ‘type’ traits in many overall objectives. Furthermore, the competitive nature of breeding and showing and the large number of individuals each controlling relatively few animals makes universal co-operation much harder to achieve. Improving selection for health in pedigree dogs therefore relies on fostering the motivation to include health in breeding objectives and in developing the opportunities for co-operation among breeders necessary to gather information and exert sufficient selective pressure throughout the breed population.

Motivation

For many dog breeders primary motivations include success in the show ring and the placing of puppies superfluous to their breeding strategies in good homes as pets. Ascertaining health status with respect to individual diseases is not an explicit requirement of dog show judges, although breed standards do state that dogs should
be ‘fit for function’. Potential pet owners might be expected to rank health highly among their concerns when buying a puppy, but are often ignorant of diseases most relevant to specific breeds and of tests available for which the results should be requested. Thus, in many cases the motivation to prioritise health in breeding strategies may be relatively weak. Nevertheless, many breeders do actively try to include health in their breeding strategies where they can. Breeders of pedigree dogs have enthusiastically embraced DNA testing for simple ‘Mendelian’ inherited diseases, such as progressive retinal atrophy (PRA), hereditary cataract, primary lens luxation (PLL) and canine hyperuricosuria. One of the main advantages of these DNA tests is their simplicity: breeders can determine whether a puppy is clear, affected or a carrier for such disease simply from using a buccal swab or taking a blood sample shortly after birth. The process is definitive and ‘self reliant’, and has resulted in some diseases being swiftly all but eradicated from some breeds (e.g. canine leukocyte adhesion deficiency [CLAD] in Irish Setters). Unfortunately many diseases afflicting pedigree dogs are known or thought to be complex; that is there is a scale of severity of affection driven by multiple genetic and environmental influences (for example canine hip dysplasia, and asthma, schizophrenia and cardiovascular disease in humans). In these cases there is no clear pattern of inheritance and animals do not fall into 3 distinct categories but must be viewed as possessing a genetic ‘risk’ of developing the disease. These characteristics of complex disease make it very difficult to accurately judge the disease risk in potential breeding animals. While many breeders do actively participate in screening schemes for such complex diseases, the manner in which the results have been used often reflects the individualist nature of dog breeding. The difficulties of tackling complex inherited disease have dented morale and, since costly screening often provides a poor indicator of the likelihood of developing the disease, have weakened the motivation to undertake screening or use results in selection objectives. Fortunately, methods do exist that use all data available to calculate simple to use and accurate indicators of genetic risk.

Co-operation
Given the number of pedigree dog breeds, breeders and apparent health issues the dog breeding world might be said to have shown a remarkable degree of co-operation to date. The oldest UK health screening scheme (run by the British Veterinary Association [BVA] and Kennel Club) for hip dysplasia was established in its current form 1984 and has evaluated the hips of well over 100,000 dogs. Furthermore, when a new genetic disease emerges breeders have often been very proactive in organising sample collection to assist researchers in the discovery of the relevant mutation and the development of a DNA test (e.g. Gordon Setters with PRA). However, there remains a strong element of individualism that leads some to refuse to participate in or publish the results of health testing and suspicion that centrally disseminated indicators of health will result in de facto restriction of personal judgement in breeding strategies.

The way forward
To enhance the motivation to prioritise health in pedigree dog breeding it is necessary to make it much easier to do. The enthusiastic uptake of DNA tests demonstrates that breeders are willing to include health in breeding decisions. However, complexity deters many, particularly pet buyers confronted with a myriad of new and esoteric information. Co-operation of breeders in submitting health information to a centralised body would enable the calculation and public dissemination of more accurate indicators of genetic risk of disease. This will achieve the goal of making it easier to prioritise health in breeding strategies and in turn encourage the motivation of co-operative efforts to select away from inherited disease to come to fruition.
Background

I joined the Animal Health Trust (AHT) in February 2008 on a 2 year contract funded by the UK Kennel Club to research the genetic parameters of complex genetic disease in Labrador Retrievers and Cavalier King Charles Spaniels. Later that year the Kennel Club and AHT announced the formation of the Kennel Club Genetics Centre at the Animal Health Trust (KCGCAHT), in which the Kennel Club committed to funding research into canine inherited disease at the AHT for a five year period. I was fortunate enough to be a part of this venture and my work continued and expanded to include researching complex disease in other breeds and calculating pedigree derived indicators of genetic diversity in all breeds.

The main aim of my work on canine complex inherited disease and population genetics is to allow health to more readily be considered in pedigree dog breeding via the development of publically available tools. This involves using all information available (both pedigree data and health test results) to calculate indicators of genetic risk of disease and genetic diversity (or inbreeding) and ensuring that they are utilisable by breeders. In 2010 the Kennel Club launched ‘Mate Select’, a web based tool that allows public access to these indicators and any health test results available. Currently Mate Select allows users to obtain the inbreeding coefficient for any individual Kennel Club registered dog, offspring of a hypothetical mating, and the average of each breed. It is anticipated that the Mate Select web tool will be augmented with a number of additional features, such as estimated breeding values (EBVs – an estimate of genetic risk of a particular disease), optimal contributions and other features that will allow breeders to easily take account of health in their breeding strategies.
Objectives

Australia is a world leader in the science of animal breeding and the application of state-of-the-art genetics in breeding schemes. My proposal involved visiting renowned researchers and breed organisations in Australia, to learn techniques, compare research, discuss initiatives, and canvas opinions relevant to prioritising health in pedigree dog breeding.

The objectives of my travel fellowship were quite distinct according to each of the places I visited. While at the University of New England in Armidale, NSW I was hoping to investigate the use of optimal breeding strategies that will maximise the response to selection while maintaining genetic diversity. At the Faculty of Veterinary Science at the University of Sydney my aims were to compare recent research and to discuss initiatives with an international perspective that might reduce the burden of inherited disease in pedigree dogs. I also planned to use my time in Australia to meet and talk to pedigree dog breeders about their experiences and perceptions of the use of health screening data and the pedigree dog breeding ‘industry’ in Australia. I compiled an anonymous questionnaire examining the economic aspects of puppy production that I hoped many of the breeders I met would be happy to complete. This would give an idea of the economic drivers of the industry and might show where educational efforts should be focussed to ensure health is adequately considered by both puppy vendors and purchasers.
The objective of my time at the University of New England (UNE) in Armidale was to investigate the development of optimal breeding strategies that will assist in selection against genetic diseases. As described in the introduction, the aim of any animal breeder is a satisfactory response to selection while maintaining sufficient genetic diversity within the herd or population. Individuals that display merit in a particular trait are often more closely related than a random sample, since the similarity of relatives is a fundamental principle of heredity. Thus genetic selection tends to result in ‘inbreeding’, which geneticists define as the mating of individuals more closely related than random mating of the background population. Inbreeding leads to higher incidences of both of a pair of genes being identical copies of an ancestral gene. This is desirable for genes influencing the traits under selection, but can have dire consequences if the ancestral copy is a ‘mutant’ (causing alteration or loss of protein function). Recent studies estimate that we all carry 150-200 such mutant genes, although fortunately usually only a single copy paired by a dominant ‘normal’ copy. Thus the greater the level of inbreeding, the greater the risk of producing progeny with a recessive genetic disorder, and overuse of one or a few breeding individuals can lead to the widespread emergence of genetic disease two or more generations on. Therefore it is important to balance selection and the rate of inbreeding, to effect genetic improvement while minimising the risk of emergence of a novel genetic disease, and to ensure that if such a disease does emerge that there is enough genetic diversity in the population to breed it out. Maximising the response to selection, while constraining the rate of inbreeding is known as ‘optimisation’.

Professor Brian Kinghorn is an internationally renowned expert on the optimisation of breeding schemes and has devised methods for optimal animal selection and mate allocation using an evolutionary algorithm. The evolutionary algorithm iteratively evaluates a solution (a list of matings) to the posed problem (maximising response with a constraint on inbreeding) using an objective function, adjusting the solutions using an optimisation component based on the ‘fitness’ of the current solution to the problem. The optimal solution is reached when the ‘fitness’ of solutions to the
problem asymptotes. Professor Kinghorn kindly made a copy of this programme available to me, and I spent a considerable amount of time learning how to use it, using data from Tibetan Terriers as an example, and conducting simple trials determining the possible reduction in genetic risk of hip dysplasia given certain constraints on inbreeding (figure 1). The visual output in figure 2 shows the constraints set by the user in the top left corner, the progress of the evolutionary algorithm in achieving optimality in the bottom left hand corner (the red line shows the ‘fitness’ of the solution within the possible boundary and given the constraint placed on co-ancestry or inbreeding), and the optimal solution on the right. This is a tremendously useful program that will assist my applied research into health in pedigree dog breeds by identifying best possible scenarios and comparing them to the actual selection decisions made by breeders. The simple trials conducted so far are encouraging in that they demonstrate that selection for improvement in hip scores results in progeny inbreeding well within current levels, suggesting that the inclusion of health in selection objectives need not lead to a concomitant rise in inbreeding. However, further research in other breeds is necessary.

Figure 1. Screenshot of the visual interface of the ‘MateSel’ optimisation program written by Professor Brian Kinghorn.

Professor Kinghorn availed another program to me for use in research that uses the results of DNA tests to calculate a genotype probability for all animals in the pedigree. This uses maximum likelihood to infer the probability that each individual in the pedigree has two normal copies of the gene, a normal and disease causing copy, or two disease causing copies. This information will be extremely useful in identifying the most ‘at risk’ dogs among those that have not undergone DNA testing, and potentially may be used in genetic analysis of breeds suffering multiple genetic diseases.
My aims in meeting with researchers at the Faculty of Veterinary Science at the University of Sydney were to compare recent research and to discuss initiatives with an international perspective that might reduce the burden of inherited disease in pedigree dogs. The faculty is a world leader in canine genetics research and I was fortunate enough to meet and enjoy lengthy discussions with Associate Professor Peter Thomson, postgraduate student Bethany Wilson, Professor Claire Wade and emeritus Professor Frank Nicholas. Professors Nicholas and Wade were the editors of a recent special issue of the Veterinary Journal which focussed on canine genetics. Professor Nicholas is also the author of “Introduction to Veterinary Genetics” and curator of the internet database of inherited animal diseases “Online Mendelian Inheritance in Animals”. Professor Wade is a trained quantitative geneticist who now focuses her research on canine and equine genomics and was part of the team that sequenced the canine genome while at the Broad Institute, Massachusetts. A/Professor Thomson is a statistician by training who is now at the forefront of veterinary genetics research and lectures in both statistics and genetics. Bethany Wilson is a vet currently researching for a PhD in the quantitative genetic analysis of hip dysplasia in Australian German Shepherd Dogs (GSD), under the supervision of Professors Thomson, Wade and Nicholas. The research into the genetics of hip dysplasia in Australian GSDs was of particular interest since I have been looking at the same disease but in UK Labrador Retrievers. My week at the Veterinary faculty provided ample opportunity to compare our analysis (the statistical models we used are subtly different) and results, which were broadly similar. The screening scheme for evaluation of hip condition is the same in the UK and Australia, although using different assessors in either country, meaning scores may be regarded as being of the same scale. The heritability (proportion of observable or phenotypic variation that is due to genetic variation) of hip score in the Australian GSDs was 0.30, compared to a value of 0.35 in UK Labrador Retrievers. Such divergence simply reflects differences, both genetic and environmental, between the two sample populations. Dr Wilson described an improving phenotypic and genetic trend in GSDs in Australia, most probably due to a breed club policy of compulsory
scoring and openness where both parents of puppies to be registered must be hip scored, and such scores are publicly available.

To date the calculation of genetic parameters of hip dysplasia by Dr Wilson, myself and other researchers has been limited by the pedigree data readily available, and so is undertaken on a country-by-country basis. My visit to the University of Sydney enabled discussions regarding a potential collaboration between the Animal Health Trust and the University of Sydney, to link the two sources of pedigree data for a single breed, where there is sufficient exchange of breeding stock between countries, and to attempt to estimate ‘cross-border’ genetic parameters. The EBVs, an estimated genetic propensity to hip dysplasia, calculated from such analysis would be more accurate than those calculated nationally due to the greater amount of information used in their computation. The accuracy of EBVs of popular sires would be particularly enhanced since they are more likely to have progeny scored in either country, which are currently unable to be included all together in UK or Australian evaluations. The higher echelon of pedigree dog breeding is increasingly a global affair, with the import and export of animals being commonplace. The breeders investing the money to import a dog are highly likely to participate in health testing and have a strong motivation to ensure the soundness of their dogs. Thus, potentially more accurate evaluations of genetic risk are likely to be of great interest. This collaboration represents a fantastic opportunity for the UK and Australian Kennel Authorities to be seen to be at the forefront of research into ‘global’ evaluations of the risks of inherited disease, and meeting with the researchers at the University of Sydney has been critical in advancing this ambition.
Meetings with Breeders from New South Wales and Western Australia

Over the eight weeks of the travel fellowship I was able to meet and talk to several breeders about their experiences and perceptions of the use of health screening data and the pedigree dog breeding ‘industry’ in Australia. All the breeders I met had at some time undertaken a prominent role in the pedigree dog breeding community, and many take an active role in promoting health, whether directly educating puppy buyers on the prevalent diseases in their breed or sitting on health and welfare committees. As such, their views, while not necessarily truly reflective of the larger community of dog breeders, do represent those with a long history of dog breeding and a strong moral desire to do the right thing for their animals.

All breeders I encountered screened their animals for health problems relevant to that breed. Most do so out of a sense of moral obligation, and most felt a degree of frustration that not all breeders tested as assiduously as they did. They felt that many breeders were financially motivated, yet public ignorance of the problems of inherited disease means health testing does not fetch the premium it ought to and so is viewed by some as an unnecessary cost. The breeders encountered had strong emotional bonds with the puppies they produced and were all keen to ensure that they went to good homes. All had turned away potential buyers on the basis that they felt they were unsuitable, and all were upfront about the health issues of their particular breed. Several breeders described how they were proud to attract ‘repeat buyers’, quite a feat given the infrequency with which people tend to buy a pet. They attributed this to their expertise and ‘after-sales’ role, whereby they offer to act as a ‘first port of call’ for new puppy owners who may often have queries that while important (for example questions regarding nutrition, behaviour and training) do not require veterinary intervention. Many breeders stated they like to keep in touch with purchasers, even if only to hear news of their former puppies. One breeder even described how she held ‘birthday parties’ for the dogs she had bred. While herself describing this as ‘nutty’, she explained that it allowed her to see the dogs annually and assess for herself their health and the general level of care being provided by the owners. Many breeders encountered also make use of ‘puppy contracts’, stipulating the level of care expected from the purchaser and the level of support provided by the vendor. In most
cases, these breeders offer to take the dog back if the owner can no longer look after it, for whatever reason. I got the impression that the breeders I encountered represented the higher echelon of pedigree dog breeders / puppy vendors. They offer considerable ‘added-value’ to the puppies they sell, in the form of health testing, appropriate socialisation and provision of an advisory role. While clearly not every purchaser may wish to opt for such a premium product, the general feeling was that ignorance of canine health and welfare hampered potential buyers from making fully informed decisions.

It was widely believed that the internet was and would continue to facilitate the self-education of potential puppy buyers prior to purchase enquiry. Some purchasers would inevitably opt for a cheaper product, but given informed decision making the principle of *caveat emptor* can be more stringently applied. Most breeders used the internet to advertise their puppies, and many had their own websites. However, it was felt that a single, ‘impartial’ trusted source of information on the practical considerations of dog ownership would be useful to potential owners.

![](image)

A ‘de Jong’ Border Collie.

The frustration with the intransigence of some breeders and ignorance of some buyers towards health testing was matched by dismay at the way such information is currently collated and used. There was considerable enthusiasm for the example set by Nordic countries, where it is much more common for health test results to be centrally collated and publication is often compulsory. Many breeders were positive about new measures such as the ‘Mate Select’ web pages provided by the UK Kennel Club and excited about the potential as a ‘one stop shop’ for genetic and health information. This was viewed as potentially being of great value to breeders and pet owners alike, and was seen as neatly supplementing the provision of general information previously described.
Most breeders questioned operated at a global level, importing and exporting dogs both inter-state and in and out of Australia. As a result it was generally considered that an international collaboration, collating health information and pedigree connections among major pedigree dog breeding countries, would be extremely useful. An international perspective, at least for the higher echelon of breeders, would improve the accuracy of indicators of genetic risk to disease and of genetic diversity within global populations. This would be of particular value for ‘rarer’ breeds where there are perhaps insufficient numbers nationally to maintain a viable population in the longer term. An example of an organisation conducting international genetic evaluations exists for dairy cattle (InterBull) and has been independently proposed for dogs by Professors John Woolliams and Claire Wade (potentially named InterDog). The anticipated collaboration between the Animal Health Trust and the University of Sydney to research and demonstrate the value of international EBVs for hip score would prove a vital first step in such an enterprise.

With grateful thanks for their input and assistance to Lee & Frank Pieterse, Jeanie Montford, Lyn Brand, Bernadette Merchant, Anne Moy, Judy & Ron de Jong, Shirley Fraser, Karen Hedberg, Hugh Gent, Janice Humphreys, Pam Campbell, Steve Warry, members of the governing council of Dogs West and members of the Cavalier King Charles Spaniel Club of New South Wales.
Results from the Breeders’ Questionnaire
A questionnaire was compiled attempting to ascertain the relevant factors that influence the market forces for pedigree puppies in Australia (appendix 1). A total of thirty-five questionnaires were completed, thirty three respondents indicating a single breed and 2 respondents indicating two breeds. All but one respondent indicated they viewed themselves as breeding dogs as a hobby. The survey was dominated by breeders of Cavalier King Charles Spaniels (CKCS) as I gave a seminar to the CKCS Breed Club of New South Wales: 20 responses were from CKCS breeders versus 16 for other breeds (one respondent bred both CKCS and Affenpinschers). A brief summary of the results from the questionnaires follows.

Demand
Current demand for puppies was rated as fairly high, with all respondents able to at least sell all their puppies eventually (see figure 2). However 14% (5 of 35) respondents indicated they had at some time been unable to sell all puppies from a litter. Furthermore, 26% (9 of 35) respondents indicated they had experienced a change in demand since the airing of ‘Pedigree Dogs Exposed’ in Australia in September 2009. In the event of being unable to sell all available puppies the majority of respondents indicated that they would keep them (63%), with 26% giving them to friends or family and just 7% using a re-homing organisation or donating to a working organisation. Eighty percent (28 of 35) of respondents advertised puppies and 94% (32 of 34) relied on word of mouth. Of those that advertise a huge proportion (81%) do so via the internet, with 15% advertising in the dog press or breed club journals, and just one respondent advertising in newspapers. No respondents advertised or sold to pet shops. All respondents (34 of 34) sold puppies privately as pets, and 32% (11 of 34) had sold puppies to other breeders. All respondents (35 of 35) reported to have turned a potential buyer away because they deemed them unsuitable. The majority (80%, 28 of 35) of respondents felt that buyers were sometimes informed about the health issues in their breed, but all (35 of 35) had attempted to highlight these issues with buyers.

Breeders’ assessment of the factors influencing demand among buyers indicated that, encouragingly, health was rated the second most influential factor (with colour first), and that show or field trial winning pedigree were considered the least important (figure 3). Price was the third most important concern, with type and temperament and immediate availability closely following.
Responses to Q19: current demand for puppies

Figure 2. Summary of responses to question 19: “What is your experience of current demand for puppies?”

Responses to Q20: factors influencing demand for puppies in potential buyers

Figure 3. Summary of responses to question 20: “Which factors do you feel, for better or worse, influence demand for puppies among potential buyers?”
Pricing
Thirty-five percent (12 of 34) respondents felt that health testing added a premium to their puppies, perhaps related to the influence of health on demand indicated by the responses in figure 3. Forty-five percent (15 of 33) respondents said if they were aware that another breeder was able to charge significantly more for puppies due to a specific reason, such as additional health tests or the provision of a puppy pack, they would consider doing the same. Furthermore, 80% (28 of 35) respondents indicated that the prices other breeders charge influences their own pricing. Thirty-one percent (11 of 35) stated that covering costs was an influence in pricing, and only 6% (2 of 35) that the demand for puppies from the previous litter influenced pricing of the next litter. This suggests that breeders are acutely aware of the ‘market value’ of puppies, although they may be less responsive individually to changes in demand.

Profit
The perception of respondents is that dog breeding is a hobby where the associated costs outweigh income from puppy sales. Sixty percent (20 of 33) of respondents indicated that they felt they made a financial loss, and a further 24% (8 of 33) stated that they broke even. Only 15% (5 of 33) felt they made a small financial gain, and no respondents indicated that dog breeding generated significant income (figure 4).

![Figure 4. Summary of responses to question 25: “Do you make a financial gain from breeding?”](image)

The average costs and profits per litter and per year derived from the questionnaire are shown in table 1 and indicate an average profit of AUD$1415 per litter, and of just over AUD$4000 per annum. Cavalier breeding appeared to be less profitable, possibly due to smaller mean litter size (3.83 vs. 5.25). Given the average value of AUD$1000 per puppy, a CKCS litter of equal litter size of non-CKCS breeds would
generate a mean profit of AUD$2136.67 per litter (more comparable with the mean of AUD$2158.33 per litter for non-CKCS breeds).

<table>
<thead>
<tr>
<th></th>
<th>All breeds mean respondents</th>
<th>CKCS only mean respondents</th>
<th>Non-CKCS only mean respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litters / year</td>
<td>2.55 (35/35)</td>
<td>2.15 (20/20)</td>
<td>3 (16/16)</td>
</tr>
<tr>
<td>Litter cost (AUD)</td>
<td>2301.79 (28/35)</td>
<td>2341.18 (17/20)</td>
<td>2304.17 (12/16)</td>
</tr>
<tr>
<td>Income / litter (AUD)</td>
<td>3695.31 (32/35)</td>
<td>3091.18 (17/20)</td>
<td>4284.38 (16/16)</td>
</tr>
<tr>
<td>Profit / litter (AUD)</td>
<td>1415.38 (26/35)</td>
<td>716.67 (15/20)</td>
<td>2158.33 (12/16)</td>
</tr>
<tr>
<td>Profit / year (AUD)</td>
<td>4057.69 (26/35)</td>
<td>1953.33 (15/20)</td>
<td>6325.00 (12/16)</td>
</tr>
</tbody>
</table>

Table 1. Summary of mean average costs and profit per litter and per year (including the response rate) for all breeds, CKCS only, and non-CKCS only.

However, there was considerable variation in the profits per year calculated from the costs and price figures obtained from respondents. A histogram of profit/loss per year is shown in figure 5. Thirty-one percent (8 of 26) respondents appeared to make no profit at all from dog breeding activities. Fifty percent (13 of 26) made a small annual profit of up AUD$6,000. Nineteen percent (5 of 26) respondents appeared to make profits in excess of AUD$10,000 per annum from puppy sales.

Figure 5. Distribution of profits/losses per litter from 26 respondents.

It appears that there is a slight discrepancy between the perception of profitability and estimates derived from information gathered from the questionnaire. It may be that many respondents, particularly CKCS breeders, did not fully include the costs associated with health testing in their assessment of costs of producing a litter. For CKCS, where screening for syringomyelia involves costly MRI scans, and other
breeds, such as those undergoing screening for hip dysplasia, these costs can be considerable. However, many breeders felt that such health testing added a premium to their puppies, and thought that potential buyers valued it too. Demand for puppies appears to be strong in Australia, and breeders appeared well informed of the market value for puppies of their breed. A caveat of the results garnered is that the respondents may not necessarily be truly reflective of the wider pedigree puppy selling ‘industry’. Most breeders questioned attached a high degree of value to the type of person to whom they sold their puppies; all had turned people away they judged to be unsuitable. It is likely that those breeders volunteering to talk to a researcher of inherited disease in pedigree dogs, or to attend a seminar on that topic, are responsible breeders already aware of the inherent problems and undertaking steps to tackle them. As such they probably represent a paragon of the industry. Most breeders questioned relayed anecdotes of less assiduous breeders who viewed selling puppies as much more of a commercial enterprise. Such a situation is probably similar in the UK, and the exercise of constructing, conducting and analysing this questionnaire should prove vital in an attempt to undertake a similar task on a larger scale in the UK.
Concluding remarks
My fellowship in Australia resulted in varied and valuable experiences. The work undertaken with Professor Kinghorn at the UNE was tremendously informative and educational, and I have learnt techniques that I will find invaluable in my future research. My week at the University of Sydney offered a fantastic chance to discuss with leading researchers in the field of canine genetics an international approach to facilitate consideration of health in pedigree dog breeding. A collaboration which will be instrumental in the development of these ideas has been agreed. Meeting breeders in Australia was the final part of my fellowship. This presented an opportunity to discuss the factors affecting demand and price of pedigree dog puppies in a country very similar to the UK, with useful and interesting results, particularly highlighting the power of the internet in education and advertising. It also gave me an insight into the advantages and problems an assembly of semi-autonomous registries faces in co-ordinating the optimal use of information for more effective selection for health. This will have enormous relevance to the nascent operation of an ‘InterDog’ type organisation.
Acknowledgments
This project would not have possible without the assistance and support of a number of people and organisations. My appreciation and gratitude are owed to the following:

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Finally, I would like to thank all at the Winston Churchill Memorial Trust for not only making this project possible, but for providing continued, valuable assistance throughout.
Appendix 1 – Dog Breeders Questionnaire:

**Dog Breeders Questionnaire**

This is an *anonymous questionnaire* the purpose of which is to gather background information from dog breeders about the current climate in which they are operating. I would be very grateful if you would take a few minutes to complete this and hand it in/leave it on your seat when completed.

1. Dog Breed:  

2. Would you describe yourself as breeding for a hobby or profession?  
   - [ ] Hobby  
   - [ ] Profession  

3. How many dogs do you own in total?  
   - [ ] Male  
   - [ ] Female  

4. How many breeding bitches do you own?  

5. How many breeding sires do you own?  

6. How many litters do you breed per year on average?  
   - [ ]  
   OR If you breed less than one litter a year do you breed every:  
     - [ ] 18 months  
     - [ ] 2 years  
     - [ ] 3 years  
     - [ ] 4 or more years  

7. How much do you estimate it costs to produce and rear a litter? *(including stud fees through to puppy registration and vaccination)*  
   - $  

8. What is the average number of puppies produced per litter?  

9. How many puppies from each litter do you keep on average?  

10. What do you do with the remainder? *(Please mark all that apply)*  
    - [ ] Sold as pets privately  
    - [ ] Sold as working dogs (field, assistance, sniffer, police etc)  
    - [ ] Sold as pets via pet shop  
    - [ ] Sold to other breeders  
    - [ ] Given to family and friends  
    - [ ] Donated as a working dog  
    - [ ] Euthanized  
    - [ ] Other (please specify):  

11. How do you arrive at the price for the puppies you sell? *(Please mark all that apply)*  
    - [ ] Cover costs  
    - [ ] Based on charges by other breeders  
    - [ ] Based on prices seen in adverts  
    - [ ] Demand for previous litters  
    - [ ] Other (please specify):  

12. Do you advertise?  
    - [ ] Yes  
    - [ ] No  

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FOR OFFICE USE ONLY.  
FID:  

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13. If you do advertise where do you do this?  (Please mark all that apply)
   □ Newspaper       □ Dog Press
   □ Internet        □ Pet Shops
   □ Other (please specify): ________________________________

14. Do you rely on word of mouth?  □ Yes  □ No

15. What was the average price of a puppy sold from the last litter you produced? \$ \_

16. Have you ever not managed to sell all your puppies?  □ Yes  □ No

17. If yes, what did you do with them?  (Please mark all that apply)
   □ Given to family and friends  □ Donated to working organisations (assistance, police, sniffer dog)
   □ Given to a rehoming organisation  □ Euthanize
   □ I kept them  □ Other (please specify): ________________________________

18. If the answer to question 17 was no, what would you do with the pups if you were ever not able to sell them?  (Please mark all that apply)
   □ Give them to family and friends  □ Donate them to working organisations
   □ Give them to a rehoming organisation  □ Euthanize them
   □ Keep them  □ Other (please specify): ________________________________

19. What is your experience of current demand for puppies?
   LOW  □ I couldn't give them away for free
   □ I manage to sell some of them
   □ Usually sell them all eventually
   □ Usually sell them all no problem

   HIGH  □ Could sell them several times over and can often chose between several potential buyers

20. Which factors do you feel, for better or worse, influence demand for puppies among potential buyers?  
   (Please rank as many of these as you feel apply in descending order of importance i.e. most important = 1)

   □ Immediate availability  □ Field Trial winning pedigree
   □ Health  □ Geographical location to buyer
   □ Socialized  □ Price
   □ Show winning pedigree  □ Colour
   □ Belong to accredited breeder scheme  □ Other - please specify: ________________________________
   □ Type and Temperament

21. Does demand for the last litter influence the price you seek for puppies the next litter?  □ Yes  □ No

22. What would be the minimum price you would sell puppies for?  (If you would give them away please indicate)  \$ \_

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23. What factors would lead you to consider breeding less often? (Please mark all that apply)

☐ Costs too high  ☐ Can't sell puppies
☐ Too bureaucratic  ☐ Other (please specify): ________________________________

24. If you were aware that another breeder was able to sell puppies for significantly more than you for a specific reason (such as additional health tests, or provision of a 'puppy buyer's pack') would you consider doing the same?  ☐ Yes  ☐ No

25. Do you make a financial gain from breeding?

LOSS  ☐ No, I make a significant loss but I bear all the costs because I enjoy it
☐ No, it partially offsets the cost
☐ I just about break even
☐ Yes, a little

GAIN  ☐ Yes, it provides significant income

26. How well informed do you feel potential buyers are about the health issues of pedigree dogs?

☐ Not at all
☐ Fairly/sometimes
☐ Very well informed

27. Do you make an effort to highlight to potential buyers the steps you take to ensure the puppies you produce are healthy?  ☐ Yes  ☐ No

28. Have you ever turned a potential buyer away?  ☐ Yes  ☐ No

29. If you answered yes, why? (Please mark all that apply)

☐ Judged unsuitable to own puppies  ☐ All puppies already sold
☐ Price offered was too low  ☐ Other (please specify): ________________________________

30. Do you feel that health testing adds a premium to the price you charge for your puppies?  ☐ Yes  ☐ No

31. Have you experienced any change in demand for puppies since the 'Pedigree Dogs Exposed' programme aired on TV?  ☐ Yes  ☐ No

Thank you! Please feel free to add any comments below:

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