Species-Specific Approaches Aid Effective Implementation of the Three Rs in Farm Animal Research

David J. Mellor [1], Paul H. Hemsworth [2], John L. Barnett [3], and I. Ross Young [4]

[1]Animal Welfare Science and Bioethics Centre, Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand; [2]Animal Welfare Science Centre, Melbourne School of Land and Environment, University of Melbourne, Parkville, Victoria, Australia; [3]Animal Welfare Science Centre and Department of Primary Industries, Victoria, Australia; [4]Department of Physiology, Monash University, Clayton, Victoria, Australia

Summary

Comprehensive, high quality standard operating procedures (SOPs) developed for individual species can provide guidance for novice researchers, inexperienced designated veterinarians, and lay members of animal ethics committees. Those with regulatory responsibilities for experimental animal facilities sometimes have greater experience with laboratory and companion animals than with farm animals, and this can result in attempts to apply unnecessary or inappropriate conditions to the management of farm animals before and during laboratory or field studies. Biologically, a rat is not a dog is not a pig is not a sheep. The purpose of this paper is to briefly outline, as an example, the development of a "Policy on the Care and Use of Sheep for Scientific Purposes Based on Good Practice" by Australian and New Zealand experts in sheep biology, behavior, experimentation, husbandry, and welfare, which led to the formulation of institutional SOPs for sheep. The areas covered include: teamwork and training; applying the code of practice; appropriateness of animals for the purpose, including their selection, acclimatization and training; minimizing stress; pain relief; facilities; confinement; movement of animals; and monitoring. This experience, together with the policy developed, provides guidance on the development of such SOPs.

Keywords: sheep care and use, policy development, standard operating procedures, refinement applications

1 Introduction

Biological functionality exhibits general similarities across mammalian species. This is the well-known scientific basis for using one species to model another, a strategy that has been extremely successful, as indicated, for example, by the substantial advances in the understanding of human biology that have been made during the last 100 years using a wide range of mammalian models. It is also well understood that, in other respects, a rat is not a dog is not a pig is not a sheep, and that the differences among them offer both an opportunity to choose the most appropriate species to model a particular phenomenon and a hindrance to the success of some of these choices because of the differences. On the other hand, understanding the key features of biological functionality that are unique to each species is essential to the development of species-specific management and care strategies in the veterinary arena and in the laboratory. This paper deals with the latter context.

Novice researchers, inexperienced designated veterinarians, and lay members of animal ethics committees obviously would benefit from guidance about special attributes of the biology of the species under study. Similar guidance, when provided to those with regulatory responsibilities for experimental animal facilities, who have greater experience with laboratory or companion animals than with farm animals, would help to ensure that requirements imposed on the management of farm animals before and during laboratory or field studies are both necessary and appropriate. Indeed, it was in response to concerns about the inadequacy of such guidance that, in 2005, a group of about 100 Australian and New Zealand experts in sheep biology, behavior, experimentation, husbandry, and welfare participated in a workshop to develop *a Policy on the Care and Use of Sheep for Scientific Purposes Based on Good Practice*[1]. The purpose was to facilitate the formulation of institutional standard operating procedures (SOPs) for sheep. The workshop was organized by Monash University and the Animal Welfare Science Centre, Melbourne, Australia. It consisted of moderated discussion of introductory presentations given by invited expert speakers. Key discussion points were noted and were later edited to develop a draft document, which was circulated to all attendees for comment before finalization. The present paper incorporates an edited version of this document with some additional and updated references.

[1] http://www.animalwelfare.net.au/comm/download/sheepcare.pdf (accessed 18.08.2011)

2 Workshop set-up

Workshop participants
The workshop moderators were D. J. Mellor (Animal Welfare Science and Bioethics Centre, Massey University, New Zealand) and P. H. Hemsworth (Animal Welfare Science Centre, University of Melbourne, Victoria), and the invited speakers were S. Atkinson (University of New England, NSW), J. L. Barnett (Animal Welfare Science Centre, Victoria), J. Culican (Howard Florey Institute, Victoria), A. D. Fisher (CSIRO Livestock Industries, NSW), R. J. Kilgour (Department of Agriculture, NSW), T. Kuchel (Institute of Medical and Veterinary Science, South Australia), and I. R. Young (Animal Welfare Science Centre, Monash University, Victoria).

Key focusing ideas
When proposing to use sheep in experiments it is necessary to keep the scientific purpose clearly in mind and to recognize that animal welfare "trade-offs" may be necessary in order to achieve the purpose. The magnitude of the "'trade-offs" that will be regarded as allowable will be weighed against the magnitude of the anticipated benefit(s), and it is the remit of members of Animal Ethics Committees (AECs), assisted by input from investigators, to evaluate this (Mellor and Reid, 1994). Clearly, there needs to be an ongoing focus on application of the Three Rs to minimize the risks to animal welfare. The policy outlined here was designed to facilitate this while recognizing that justifiable welfare compromise that remains after stringent application of the Three Rs still may be significant. Thus, it is acknowledged that sheep are used for experimental procedures that range from completely non-invasive to highly invasive, including behavioral, surgical, and pathological studies. These studies may involve the maintenance of sheep outdoors or in a wide variety of indoor accommodations and may be conducted over a range of periods from exceptionally short (e.g., minutes) to very long (e.g., several years).

Characterization of "good practice"
During the workshop, a series of principles was derived, together with explanatory details, as outlined below. However, it was recognized that an important factor underlying all of these was the promotion of positive conduct towards animals, i.e., "good practice." In 2004, the National Animal Welfare Advisory Committee in New Zealand characterized good practice as follows (see Mellor and Bayvel, 2008, p. 323), and the participants in the Workshop endorsed this characterization.

> *"Good practice" may be taken to mean a standard of care that has a general level of acceptance among knowledgeable practitioners and experts in the field, is based on good sense and sound judgement, is practical and thorough, has robust experiential or scientific foundations, and prevents unreasonable or unnecessary harm to, or promotes the interests of, the animals to which it is applied. Good practice exceeds the requirement to observe minimum standards and changes with the evolution of attitudes about animals and their care.*

3 Principles and explanatory details for investigators, laboratory veterinarians, and AEC members regarding the management, housing, and care of sheep

Principle 1 – Teamwork and training

Good welfare is everyone's responsibility and requires commitment to a cooperative team approach to maximize research and welfare outcomes. The team includes the researchers, the animal caretakers, and the AEC members.

The successful conduct of research using sheep requires a wide range of skills and knowledge specific to the species. This includes a good knowledge of their biology, behavior, and husbandry, as well as the special requirements pertaining to experimental techniques and procedures.

It is necessary for all personnel to be appropriately skilled and to regularly practice and maintain currency of their skills and knowledge. This may involve seeking expert advice from within the organization or elsewhere.

All team members should acknowledge the need for ongoing review of experimental and husbandry practices and implement changes that will improve animal welfare and research outcomes.

Explanatory details
- The expertise of all those involved, including the research team, field/animal care staff, and AEC members should be fully utilized to contribute to the development and review of SOPs, the conduct of research, and the care of animals.
- A respectful and constructive engagement between researchers and animal care staff is essential.
- Selection and training of personnel should be appropriate to achieve both the research outcomes and high standards of animal welfare.
- Training must ensure that personnel are competent in their tasks. Such training may be on-the-job, via courses, or working with an experienced practitioner, and it should encompass the needs of both new and experienced staff.
- Institutions should facilitate and maintain constructive working relationships within and across teams to maximize teamwork and achieve high standards of research and animal welfare.
- Where there is doubt about a practice and local expertise is insufficient, advice should be sought from an appropriate expert. AECs may wish to consider the use of animals for the acquisition of skills, including developing surgical techniques on cadavers, non-recovery surgery, and small-scale pilot studies.

Principle 2 – Applying codes of practice and relevant regulations

Researchers must provide clear and detailed protocols that fully justify the use of animals and the specified procedures. AECs should take into consideration any peer review of the scientific integrity of the project. Both parties need to effectively communicate with each other and be clear about their areas of responsibility.

Explanatory details

- All parties should inform themselves of their responsibilities under any code of practice and relevant regulations or legislation.
- If there is some uncertainty or disquiet regarding a proposed protocol within an institution, either by researchers or AEC members, communication between parties should be improved.
  - Suggestions include having researchers present at AEC meetings or one-on-one discussions between a nominated AEC member and the researcher to clarify the protocol and any areas of concern, and, if necessary, inputs from a mutually respected third party.
  - Good communication between researchers and community members is essential, and this aim may be assisted by public seminars and presentations to the AEC made by researchers.
- If there is uncertainty concerning the scientific value of a novel experimental approach, the appropriate number of animals per group required for statistical analysis, the impact of a procedure upon animal welfare, or the correct dose or duration of a particular experimental treatment, it is recommended that a pilot study be performed to obtain the necessary scientific information upon which to base further decisions.
- Pilot studies, where proposed, should be regarded as integral to the overall project, especially to enable assessment of the feasibility of the project and the potential for Refinement and Reduction. The pilot studies should be assessed by the AEC according to the usual criteria applied to project approval.

Principle 3 – Appropriateness of animals for the purpose including their selection, acclimatization, and training

Standard operating and selection procedures should be developed and put in place to ensure that animals are fit for the purpose.

All aspects of the use and management of sheep must suit the scientific purpose. This requires appropriate selection of sheep to minimize risks to animal welfare.

Consideration should also be given to all aspects of acclimatizing sheep to experimental conditions.

Explanatory details

- Researchers should consider and justify the choice of sheep as the most appropriate species for the purpose.
- There must be appropriate selection of particular sheep to minimize risks to animal welfare:
  - Physical and clinical examinations should be performed to a veterinary standard.
  - Worming and vaccination practices of the source farm should be evaluated.
  - The breed and class of sheep should be considered in relation to the purpose, including the age, physiological status, body condition, amount of wool, and condition of feet.
  - To accommodate the possibility that some animals may be rejected as unsuitable for experimentation and to provide for companion sheep (e.g., at the ends of rows of individually-housed sheep), allowance should be made for the inclusion of additional sheep.
    - Criteria for rejection would include both behavioral (e.g., will not settle within a specified period; will not feed within 2 days) and health (e.g., becomes sick) reasons.
    - Humane procedures must be developed to manage rejected animals.
    - Each animal should be identified individually to facilitate accurate record keeping. Temporary identification (e.g., stock spray marker, electronic tagging) or more permanent methods (e.g., double ear tagging, implanted microchip or electronic tag) should be selected as appropriate.
- Procedures should be in place to manage acclimatization of sheep to assist transition to experimental facilities and husbandry, such as pre-feeding of the laboratory diet in the field, some training for confinement (e.g., in sheep facilities, indoor pens, outdoor pens) and providing animals with experience of new social groups prior to moving.
- To both assist transition from field to laboratory and to maintain body condition, appropriate roughage should be included in the diet (e.g., feeding chaff or hay) which will maintain digestive function and normal levels of oral activity to reduce oral stereotypies and risks to welfare such as wool biting (Vasseur et al., 2006) and mouthing of cage bars.
- An appropriate period of acclimatization should be planned, bearing in mind the nature of the experiment. For example, sheep can be acclimatized to laboratory conditions within 3-6 weeks with appropriate positive handling (McNatty et al., 1972; Pearson and Mellor, 1976); previous experience of laboratory conditions may assist (Pearson and Mellor, 1976).
- Recognize that there can be a conflict in the selection criterion of minimized variation in body weight (for experimental purposes) and the time taken to establish a social hierarchy when such animals are grouped (acclimatization).
- Recognize that positive handling of sheep early in life can improve their subsequent behavior and minimize stress in response to humans and novel settings with humans present (Hemsworth and Coleman, 2010).
  - Sheep can be adapted to humans by early human contact, habituation (regular positive human contact, e.g., touching

or stroking of sheep by humans), and conditioning (associating humans with rewarding experiences, e.g., molasses).
- Trained sheep seem to like having their neck/chin stroked and head to head contact with humans. They seem to dislike stroking on the ventral abdomen and touching on top of the head.
- Because sheep appear to be able to discriminate between people, if possible, different personnel should conduct aversive and positive procedures and exposure to strangers should also be minimized.

– It is a matter of judgment by individual AECs whether it is appropriate to reuse sheep that have had previous experience of laboratory conditions versus using naïve sheep. Previous experience may assist in reducing the number of animals used (including rejected animals) and the time to acclimatize. Such benefits of Reduction of numbers used and Refinement procedures need to be balanced against the cumulative impacts on individual animals. Sheep do not perceive all procedures as unpleasant, and the nature of procedures, previous and envisaged, will be relevant to the decision.

Principle 4 – Minimizing stress
Those who use sheep for experimental purposes need to be aware of the potential sources of stress for their animals and take action to minimize related risks to their welfare.

Explanatory details

– Stress is the physiological response to an alteration of homeostasis, whether actual, threatened, or perceived. As an acute response to a limited challenge it can be adaptive, but prolonged stress can adversely affect animal welfare and may compromise the results of scientific studies. Those who use sheep should be aware of the responses of sheep to specific stressors and act to minimize the associated risks to animal welfare.

– As social isolation from other sheep is a potent stressor, animals should not be transported alone or held out of sight of other sheep. Whenever possible, the minimum group size should be three animals so that removal of one will not leave a single individual. Where the holding of a single animal cannot be avoided, a large mirror or a surrogate object (e.g., a cardboard box covered with a sheep skin) may lessen the stress of isolation.

– A range of stressors may attend the preparation for and the conduct and recovery from surgical procedures.
- The period of withdrawal of food and water prior to general anesthesia should be kept to a minimum to minimize the effects on energy metabolism and rumen microflora. While sheep may be kept off feed for a limited period to lessen the risk of rumen tympany (bloat), the rumen contents of sheep are more liquid than normal after a period of fasting and may constitute an increased risk of aspiration pneumonia.
- The need for and choice of premedication for surgical procedures should be carefully considered. While a reduction of anxiety is a principal objective of premedication, the drugs used may potentiate the effects of the anesthetic agents and induce ataxia, which can interfere with handling procedures and may be stressful in itself.
- As sheep find unfamiliar environments stressful, animals recovering from surgery should be returned to their home cage with familiar sheep nearby. During this period, animals should be protected from injury that may arise from uncoordinated movements by removal of unnecessary objects (food and water containers) and by using solid sides to the cage until motor coordination has returned. Disturbance should be minimized during recovery from surgery, but where human presence is necessary, familiar humans are preferred.

– All of these stress-minimization strategies represent Refinements.

Principle 5 – Pain relief
Every invasive procedure should be assessed regarding the necessity for, and the application of, pain relief.

Explanatory details

– Some invasive procedures, such as venipuncture and ear tagging, require no pain relief.

– The possibility that sedation and local or regional anesthesia can replace the routine use of general anesthesia should be considered.

– Longer-term surgery requires use of appropriate general anesthesia. Choice of induction and maintenance agents should be considered in each case.

– Pain relief is a sophisticated and advanced area of management, and expert advice should be sought to obtain sufficient, appropriate information and skills. Consideration should be given to the use of agents that act at several levels in the pain pathway and the timing of analgesic treatments. Reference should be made to suitable sources (e.g., Flecknell and Waterman-Pearson, 2000; Hellebrekers, 2000; Mathews, 2008; Mellor et al., 2008; Anonymous, 2009a).

– Sheep need to be closely observed for signs of pain, as they are relatively undemonstrative when in pain (Benson, 2004). In general, indices of pain are not specific to pain alone and can include:
- Jaw-grinding;
- Posture (e.g., head-up or head-down, alertness, avoidance, stance with back arched and grunting respiration suggestive of peritoneal pain, tucked-up vs. upright, head turned back along the side, stretched back legs, changes in individual and social behaviors, position of ears, "staring" into space, reluctance to move, guarding of affected areas, limping or carrying a limb);
- Vocalizations;

- Reduced water/food intake, indices of catabolic state (e.g., low plasma glucose and increased plasma ketone body concentrations), increased heart rate, increased stress hormones concentrations (i.e., ACTH, cortisol, prolactin); loss of appetite;
- Indices of sickness behaviors, such as increased time spent lying down or sleeping.

– Monitoring should be carried out for an appropriate period after a particular challenge, using purpose-designed checklists.
– When choosing an analgesic regimen for use in pregnant ewes, its safety for the fetus should be considered.
– The sheep fetus responds differently from the adult to pain stimuli and analgesics. There is evidence that the fetus is unconscious throughout pregnancy and birth, however fetal surgery should be performed under general anesthesia of both the ewe and the fetus (Mellor et al., 2005; Mellor and Diesch, 2007).
– The benefits of reducing anxiety as an indirect outcome of pain relief, as suggested by limited anecdotal evidence in humans, should be considered.
– Further research is required to define safe and efficacious analgesic regimes for sheep, as there is insufficient evidence to guide the choice of analgesics (Fisher et al., 2008).
– All of these pain-minimization strategies represent classical Refinements.

Principle 6 – Facilities
All facilities should provide a safe environment, the precise features of which will depend on the nature of the procedure and the age, condition, and breed of the sheep.

Explanatory details

– All facilities used by sheep should be well designed, constructed, and maintained. They should be designed and managed to ensure that competition for resources (e.g., food and water) does not disadvantage individuals within a group and that low status animals can avoid bullying (e.g., by provision of dividers within a pen). Overall, they should be comfortable living quarters that are suitable for the amount of time they will be occupied.
– Apart from newly shorn sheep and young lambs requiring particular attention to their thermal requirements, sheep are relatively tolerant of a wide range of environmental temperatures, although this tolerance should not be taken for granted, especially at temperature extremes. The breed of sheep, purpose of the work, presence and nature of bedding, facility ventilation rate, experimental requirements and demands, and interactions between these factors all need to be considered when evaluating the thermoregulatory implications for sheep of the provision of particular facilities.
– Housing requirements:
  - From the choice of housing options available, those that best meet the requirements of the experiment and minimize risks to welfare should be chosen. This involves balancing experimental needs, duration, and degree of confinement against risks to animal welfare. Although there is increased concern for welfare as the level of confinement increases, and taking into account the balances involved, it is recognized that a range of housing environments can meet the welfare requirements of sheep.
  - While there are few studies on space allowance for sheep, it is commonly recommended that a space allowance for singly and group housed adult sheep of 1-1.5 m^2 per animal be provided (e.g., Anonymous, 2002). Factors that need to be considered are the size of sheep, group size, and how the space is utilized for various activities.
  - Social contact with other sheep must be provided, unless the experiment requires isolation and AEC approval is obtained. The important aspects of social contact are, in decreasing order of importance, visual, auditory, olfactory, and tactile.
  - Consideration should be given to the provision of environmental elements that meet the needs of sheep, e.g., subdivision of space to allow subordinate sheep to avoid dominant animals, and provision of choices such as salt licks, molasses blocks, and stalky hay. Anecdotally, sheep in confinement systems do not appear to take much interest in "play" objects (e.g., balls, bottles) that are provided with the intention of enriching their environment.
  - As sheep find both transport and adaptation to new environments stressful, experimental protocols should be well planned to minimize the number of such movements.
  - Appropriate shelter from weather extremes should be available for sheep kept outdoors.
  - Sheep housed indoors need to experience periods of both light and dark in a 24 hour cycle.

– Experimental crates/metabolism cages – see Principle 7: Confinement.
– Flooring and bedding:
  - The type of flooring and use of bedding should balance the needs of the sheep and the experiment.
  - Wooden slats, woven wire, and welded wire mesh flooring may all be suitable provided they support the animal, minimize pressure points on the sole of the foot, and are maintained in a good state of hygiene. Experience indicates that heavy sheep (> 100 kg) require impact-absorbing mats to maintain foot health.
  - Bedding (e.g., straw, rice hulls, rubber mats) can improve comfort, especially where wool cover is short. This factor needs to be balanced with the need for increased hygiene in the peri-operative stages when surgical procedures are involved. If bedding is provided, dirty bedding must be replaced regularly to avoid injuries (e.g., brisket burns). For sheep held for long periods on hard floors, bedding/mats should be provided to reduce the risk of arthritis.

– Air quality should be monitored in all indoor facilities and waste managed to prevent the build-up of noxious gases, especially ammonia. Note: the human occupational health and safety exposure standard for atmospheric ammonia is 25 ppm (Time Weighted Average over 8 hours) (National Occupational Health and Safety Commission, 1995).

Principle 7 – Confinement
Any confinement must be appropriate for the scientific purpose and be justified in terms of its degree and duration.

Explanatory details
– For each experiment, the level and duration of close confinement must be justified. Experimental cages/metabolism crates were originally used to collect urine and feces for energy metabolism studies but are now used for a range of procedures that require all around access to animals and to prevent damage to instruments attached to animals, e.g., catheters and probes.
– When deciding on individual housing for sheep, options that should be considered include double-size cages and pens that allow more mobility but may be reduced to single-size to enable closer confinement when required.
– A sufficient number of animals should be housed together so that the removal of one (e.g., for surgery) does not leave a single animal alone.
– When using experimental cages, consideration must be given to whether sheep need to be confined in the cages for the entire period of the experimental protocol or only for specific procedures.
– Duration of housing in experimental cages is a matter for determination by individual AECs. Experience suggests that sheep can be successfully held in experimental cages for several months with no demonstrable risks to their welfare, provided that there has been appropriate selection and acclimatization, and caring staff who have the time both to physically interact with the sheep and to provide ongoing monitoring to a high standard are in place.
– Recommendations on duration of use and dimensions of experimental cages should be the subject of research.
– The use of tethers in cages is undesirable and should be limited to contingencies described in an appropriate SOP for the animal facility. Such use should be reported to and reviewed annually by the AEC.

Principle 8 – Movement of animals
Animals must be handled and transported in a safe environment in facilities and vehicles appropriate for the class of sheep.

The standards for transport should – at the very least – conform to industry standards and relevant codes of practice and should recognize the high degree of expertise required.

Animals whose health, fitness, strength, or ability to cope in any other way has been lessened or affected by their preparation for experimental procedures or by the procedures themselves must be handled and transported according to the needs of their condition, and expert advice should be sought relative to this if necessary.

Explanatory details
– Animals should be transported in a safe environment that minimizes injuries and stress.
– Transport, particularly loading and unloading, is stressful for sheep and therefore multiple transports should be planned and minimized.
– Sheep of a different size and class should be separated. Extra care needs to be taken when transporting ewes with their lambs so that the lambs are not trampled.
– Sheep should be placed at an appropriate density in the transport vehicle to minimize slipping and falling and to allow animals that fall to recover a standing posture. If the transport vehicle is too large for the number and size of sheep, options such as the use of secured straw bales or panels should be considered to reduce the floor area.
– Sheep should not be transported individually. Non-experimental sheep may be used as companion animals if necessary.
– Sheep should not be transported with their legs tied.
– The transport vehicle should provide shelter from extremes of weather and buffeting from the wind, while providing adequate ventilation.
– Use of a mesh and/or tarpaulin cover can provide shelter and discourage animals from jumping out of the crate.
– The floor should provide grip for the sheep's feet and separation or absorption of waste.
– There should be no need to starve sheep before transport of short duration (e.g., less than two hours), and they may be provided with feed until being readied for transport. For sheep on pasture, depending on its quality, there may be a need to withhold feed prior to transport (e.g., if diarrhea is a problem).
– Water should be available to sheep until transport commences.
– Ewes should not be transported in the last month of pregnancy except for short distances or durations. Use of a glucogenic drench before transport may reduce the risk of inducing pregnancy toxemia.
– Animals should be loaded and unloaded in a safe environment that includes the ability to walk in and out of the transport vehicle, thereby avoiding the need for lifting devices.
– The use of dogs to load and unload sheep can speed these operations; however, exposure to dogs is stressful to sheep (Kilgour and de Langen, 1970) and should therefore be avoided unless specifically justified.
– Personnel transporting sheep should be trained and competent. In particular they should be capable of assessing the welfare of animals prior to and during transport and be able to deal with emergencies. Commercial transporters should be accredited.

Principle 9 – Monitoring
Monitoring is an essential task for both good animal welfare and good research. Standard operating procedures should be developed to include the frequency of inspection, hazard analysis, record keeping, and utilization of records to review procedures/management.

Explanatory details

- Monitoring should commence at selection and continue until the end of use.
- For animals used periodically over time, monitoring should also occur during any non-experimental period(s), and animal health and husbandry records should be maintained throughout the entire period of use.
- Monitoring parameters used should include food and water intake, body condition, body weight, and general appearance, demeanor, and behavior. These basic parameters may be supplemented for specific purposes to include body temperature, heart rate, blood pressure, and parasite status, depending on the nature and duration of the study.
- Frequency of monitoring will depend on the nature of the study and the interventions undertaken, but it should be at least daily.
- The results of monitoring should be recorded, and the form that the monitoring takes and the data collected should enable the detection of adverse trends.
- If facilities or procedures are changed, the animals' behavioral responses should be observed to provide an indication of any adverse effects of the change.

4 Concluding remarks

The policy developed during the workshop is beneficial in several ways. First, it provides a knowledge-based template for the development of more detailed SOPs that are specific for sheep. Second, in highlighting important features of sheep biology, behavior and husbandry, which are different from those of many other species, it provides clear guidance for individuals who are inexperienced with sheep and who, nevertheless, have responsibilities for their management and use in research, teaching, and testing (RTT) contexts. This increases the likelihood that any restrictions applied to such sheep use will be appropriately based and will better protect the welfare of the animals. Third, it provides a framework for sheep-specific up-skilling of novice researchers, animal care staff, and AEC members – and of experienced researchers who are unfamiliar with the use of sheep. Finally, it also points to the value of developing similar policies for other species used in RTT contexts.

With particular regard to the nine policy principles and their explanatory details elaborated above, Principles 1 and 2 address issues of regulatory ethics, defining areas of responsibility, teamwork, and training. The characterization of "good practice" and Principles 3 to 9, together with their explanatory details, relate directly to the selection, husbandry, experimentation, and care of RTT sheep and have both direct and indirect implications for Three Rs applications, especially for Refinement. Taken together, they are designed to facilitate rational, harmonious, and cooperative communication and decision-making, and the confident and competent exercise of professional responsibility by animal welfare officers or designated veterinarians, researchers, and members of AECs as they seek conscientiously to apply the Three Rs.

For general relevant references refer to Adams and McKinley (1995) and Anonymous (1993, 2000a,b, 2003, 2004a,b, 2009b, 2010).

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Dedication

This paper is dedicated to Associate Professor John Barnett who died tragically in the bush fires that devastated large areas of the State of Victoria, Australia on February 7 and 8, 2009. John is particularly remembered for his research on pigs and poultry and the impacts of confinement housing on animal welfare. He also made major contributions to the Animal Welfare Science Centre's research and teaching programs. His thoughtful and reasoned discourse and his gentle humor are widely missed by his colleagues in the animal welfare research community.

Correspondence to

David J. Mellor
Institute of Food, Nutrition and Human Health
Massey University
Private Bag 11-222
Palmerston North 4442
New Zealand
e-mail: d.j.mellor@massey.ac.nz