Cost-Benefit Approach to Animal Use Ethics Review

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In the review of protocols by an Animal Care Committee, the Canadian Council on Animal Care has provided guidance that the committee members should weigh the benefits and the costs of the proposed research.

… the use of animals in research, teaching and testing is acceptable only if it promises to contribute to the understanding of environmental principles or issues; fundamental biological principles; or development of knowledge that can reasonably be expected to benefit humans, animals or the environment.
(CCAC guidelines on: animal use protocol review (1997))

This implies that the committee's deliberations will encompass a consideration of the adverse effects to the animal and the benefits that are likely to be achieved from the proposed research or teaching project. The work is considered justified if the benefits are likely to exceed the costs to the animals in suffering.

However, committee deliberations rarely focus specifically on this aspect of the review to a great extent. This is in part because the scientist proposing the research has usually had to go through an extensive grant review process that weighs the value of the proposed work, so the committee may feel that this evaluation has already been done. But grant review typically focuses on factors such as the excellence of the researcher, the merit of the proposal, and the contributions to training of highly qualified personnel. The scientific peer review is not intended or expected to consider the effects on animals, but focuses on originality and innovation, significance or impact, appropriateness of methodology, feasibility, relevance and budget (6). Therefore the onus lies with the Animal Care Committee (ACC) to consider the effect on animals.

Whether the proposed research or teaching involves basic biology, biomedical science, livestock production, veterinary medicine, wildlife/fish ecology and conservation, or any other field, the principles of cost-benefit analysis can be applied. Here I will focus mainly on livestock research, veterinary research and wildlife research, since these are areas that often seem overlooked in debates about

the use of animals, and many others have debated the use of animals in basic biology and biomedical research quite effectively.

For an ACC to effectively consider the cost-benefit of a particular research protocol, some background understanding of this approach is useful. The cost-benefit relationship is one that we often use to consider other decisions, whether it be the purchase of a house, the choice of a vacation spot, or the hiring of an employee. Economists have long used these principles and they may be applied to provide useful insight into the cost-benefit considerations of animal use.

The relationship may be expressed as a very simple equation (1).

$$\textit{Justification} = \frac{\textit{Benefits}}{\textit{Costs}}$$

But some elaboration of what is meant by "benefits" and "costs" provides a bit more clarity.

$$\textit{Justification} = \frac{\textit{Importance of objectives x Probability of Achievement}}{\textit{Cost to animals in Suffering}}$$

Or different elements may be considered, providing some additional insight.

$$\textit{Justification} = \frac{\textit{Background/objectives potential benefits x Scientific Quality}}{\textit{Adverse effects and coping strategies}}$$

There are a number of principles of introductory economics that are also useful to keep in mind (4).

The first principle has to do with trade-offs that must be faced. In economics these are referred to as *opportunity costs*.

Opportunity costs: the cost of one choice (of production or consumption) is the forgone opportunity to produce or consume something else with the same inputs.

With respect to animal use, there might be opportunity costs of many types. In essence, our cost-benefit analysis may come down to a choice between invasive use of animals and potential scientific discovery.

The second principle has to do with *externalities*, sometimes known as *spillover effects*, which may be either positive or negative. Sometimes, the production or consumption of a product inflicts incidental costs, or spillover effects such as pollution on others, and these costs are not borne by those who inflict them. Some might view the effects on animals as an externality of research since it is not a desired outcome, yet it is a very important factor to be included in the equation.

The third principle of economics worth considering is the *Law of Diminishing Returns.* For example the productivity of a factory may increase as labor is added, but at a certain point, the incremental increase in productivity begins to decline with each added laborer. Eventually productivity may actually be lost as further laborers are added, due to inefficiency, lack of resources, and so on. We know this principle to hold true in animal research too. Good research productivity may result from use of animals. But where the use of animals includes "costs" to animals through decreased welfare such as discomfort, distress, or pain, increasing these costs to animals beyond a certain point may eventually reduce the output (accuracy, effectiveness, applicability) of the research due to the effects of the animal's reduced welfare.

But the trade-off may not be simple. Not all the benefits are accrued to humans. Not all the costs are necessarily borne by animals. There is also a cost of *not* doing research, in terms of foregone benefits to both humans and animals – that is, there is an *opportunity cost* if we choose instead to apply our resources to other types of research.

Economics textbooks often illustrate this trade-off relationship as a *production-possibilities curve*, such as is illustrated here for environmental protection. Assuming we have a defined amount of resources to devote to the equation, we have to make a choice or trade-off between economic output and protection of the environment (Fig. 1). Without increasing the resources we apply, we might have to choose between high economic output and minimal protection of the environment (P) or a highly protected environment and low economic output (T), or some balance between the two along or within the curve (Q, R, S or M).

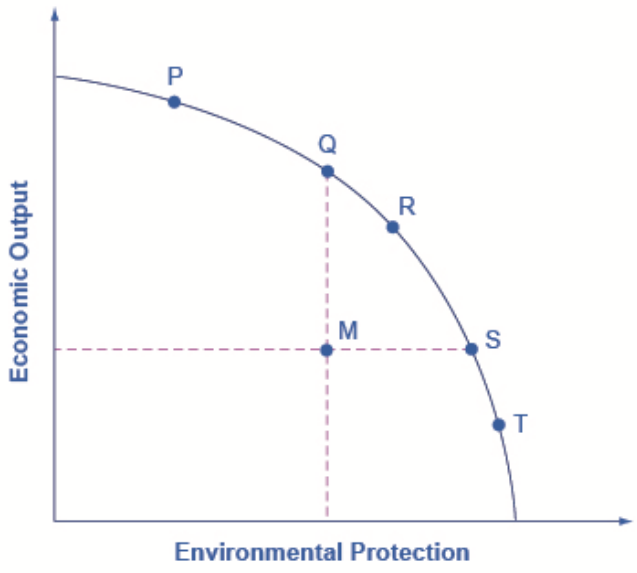

Fig. 1: Production-possibilities curve for environmental protection and economic output

We can use the same curve to represent the choice between scientific progress and animal welfare. If we want to improve animal welfare without losing scientific progress we have to find a way to move the curve. We can invest resources, and/or use the principle of *refinement* to do this – and thus we can sometimes improve *both* the care of animals and the research output (N).

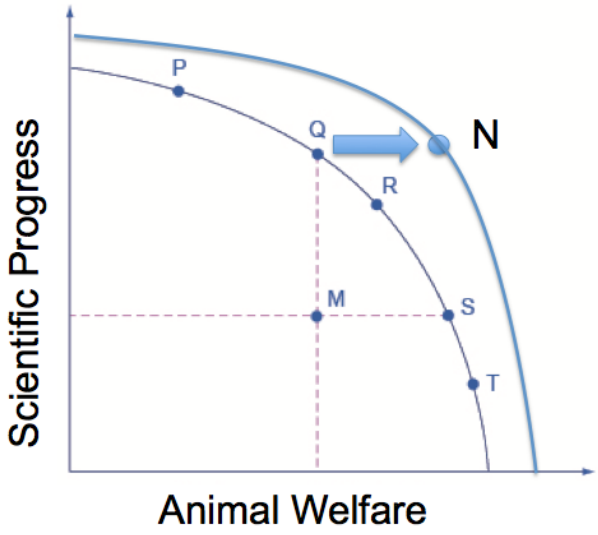

Fig. 2: Production-possibilities curve for animal welfare in research.

Biomedical Research

In biomedical research the benefit of the research mostly accrues to humans. We can achieve understanding of disease, and new, improved or safer treatments and medications and longer life. Animals may also be the beneficiaries of biomedical research, as medical findings are applied to veterinary treatment of companion animals. Future animals used in research also may also benefit from medical advancement, since many of the refinements used in animal research are the result of previous biomedical research.

Agricultural Research

The cost-benefit analysis of animal use in agriculture or animal science research has some different considerations. Animal use protocol forms may not even accurately reflect these differences. Researchers may be stymied by questions on these forms that ask them to justify the animal model used, and sometimes struggle to answer a question about why they chose the particular animal model: "I'm using dairy cows as a model because we want to study the nutritional needs of dairy cows to improve their health." In this field, research uses animals to study how to use animals more effectively/efficiently for production, so it could even be argued that the research itself facilitates further use of animals in another way. This has up until now not been the focus of significant activism, but the potential is certainly there.

As part of the cost-benefit analysis of agricultural animal research, the wider global benefits are important to consider, in addition to the more proximal justifications offered in typical grant proposals. The world's population is growing (Fig. 3).

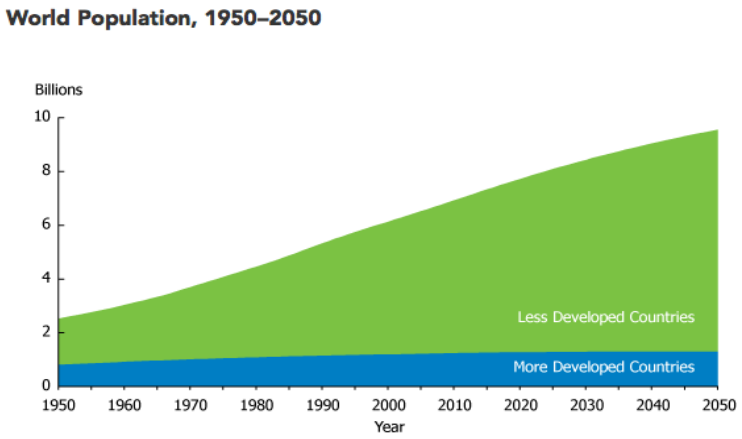

Fig. 3: Forecast world population change 1950-2050

Food production is necessary and ongoing, and a significant increase is necessary to reduce malnutrition as well as to supply the growing population (Fig. 4). Despite trends toward reduction of meat consumption in developing countries, demand for livestock products is likely to increase significantly in the developing world (Fig. 5). Even if per capita meat consumption declines, the rising global population will continue to increase overall demand for animal products.

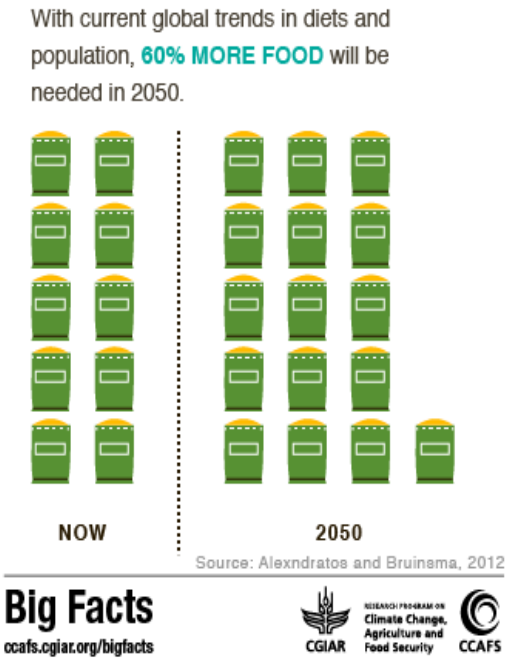

Fig. 4: Trends in food demand

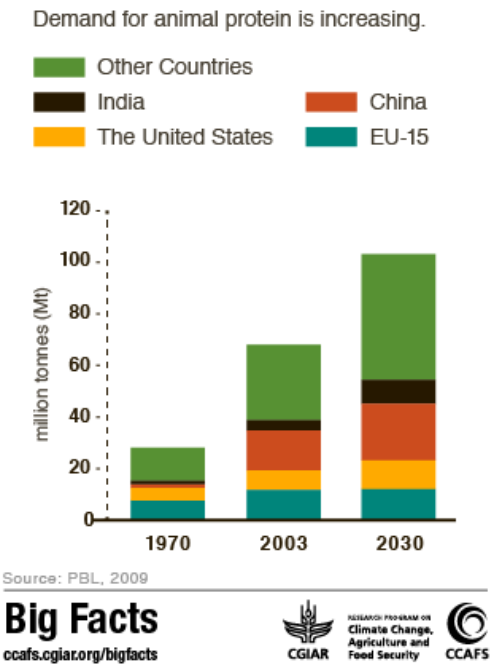

Fig. 5: Trends in protein consumption

On the other hand, there are a number of factors that affect the costs to the livestock involved in such research. These are typically, large, sentient and often intelligent animals such as pigs, cattle and sheep, with complex behavioral and environmental needs, requiring significant environmental enrichment. In some types of studies, such as poultry research, large numbers of animals may be used to provide results relevant to livestock production systems. Though such large studies may be minimally invasive (a low "cost") to individuals, some types of research are quite invasive (a high "cost") to the animals involved. In this type of research, animals like dairy cows may be used on multiple projects in sequence over many years, though these studies are usually fairly low in invasiveness. Due to the longer lifespan and gestation periods, experiments and projects may be quite long compared to studies in rodents or other small species.

In developing an equation for calculating the cost to animals, these factors may be summarized as follows:

Cost = # animals x animal complexity x level of invasiveness x duration of project

The benefits of such agricultural research are also broad. The benefits may be to individual humans, for example to the income of the farmer. Livestock other than those in the study may also benefit, through improvements to health or welfare practices. Consumers may benefit through reduced food cost and thus more disposable income for other uses, through improved food availability, or improvements in quality, nutritiousness or food safety. The world's population more broadly may benefit from improved nutrition, or through availability of a secure, plentiful food supply. Wild animals and the rest of the ecosystem may

benefit from animal science research that results in efficiencies that reduce the impact or the ecological footprint for feed production or manure management.

Thus an attempt to summarize the benefits of this type of research in an equation may appear as follows:

Benefits = Farm income x animal welfare x value to consumers x population benefits x environmental factors

Veterinary Research

Veterinary research sometimes includes work in the field of livestock production, but also includes other aspects. The beneficiaries of research in veterinary medicine and surgery include not only livestock, but also companion animals/pets and also wildlife. But since much veterinary work has comparative medicine implications, research innovations here may also improve human healthcare. A recent example is the discovery by veterinary researchers at the Oregon State University of a unique group of proteins in dogs that indicate the presence of transitional cell carcinoma – the most common cause of bladder cancer – and may lead to a new assay which could better diagnose this disease in both dogs and humans (2, 7). Much research into the human-animal bond has demonstrated the benefits humans receive from our relationship with pets. Thus humans benefit from research that keeps our pets healthy. Humans benefit from research into livestock health that improves our food security and safety. And research that deals with wildlife health not only benefits the animals but also the humans who enjoy these species.

In this type of research the costs to the animal might be very similar to those incurred by animals in livestock research. But the equation summarizing benefits must include benefits both to animals and to humans, and would include benefits accrued to individual animals and the species or strain of animals, as well as benefits the human companion or owner receives from healthy pets or livestock, and the translation of animal health advancements to human medicine.

Wildlife Research

In wildlife ecology and conservation research there are some differences from other fields. Much of this work is done in the field rather than in a laboratory on a university campus, using techniques that may be borrowed from common hunting or fishing practices. The lay person may assume that all such research is done for the "good of the species" though it may not be quite that simple. Much research of this type is done to manage fish and wildlife species that are commercially important to the fishing or hunting industries. Other goals may be to understand the effects of human activities, or to understand the basic biology of the animal and its relationship to the ecosystem.

A number of interesting factors may affect the costs to the animal or the value placed on such costs by the ACC or the public. These may include the situation where the species studied is threatened or endangered (5). Some of society's perceptions of the value of individual animals may be skewed by its status. For example a relatively plentiful animal such as an elk may have the status of "charismatic megafauna" in that it is viewed as a noble symbol of wildlife. Elk are also valued and managed as an important game species and the goals of a proposed project may be a mixture of population management and pure research. To study them, great lengths may be taken to ensure humane, live capture to attach a GPS collar, collect blood, tooth and hair samples. Such studies are often highly scrutinized by ACCs and many precautions taken to avoid animal injury or death. Conversely, small, less attractive, or less prominent species may receive less attention from the ACC. A study of small and lesser known but endangered or threatened fish species might require lethal capture, but the focus of the same ACC may be on the effects on the individual rather than on its species, or the research might even be reviewed less rigorously in general.

Fig. 6: Selected elements of ecological ethics (From: Minteer, B.A, and J.P. Collins, 2008)

Research and conservation Practices	Ethical issues (examples)
Research on threatened or endangered species	Animal welfare vs. conservation ethics; increased extinction risks posed by invasive research, etc.
Specimen marking and monitoring techniques	Harm to sentient creatures (disruption of breeding and migration patterns, increased physiological stress, etc.); harm to nonsentient organisms (e.g, trampling); unintentional introduction of exotic invasive species by researchers
Culling animal specimens	Justification of killing living beings; evaluating harms to individual specimens vs. expected scientific and conservation benefits to populations or species
Treating wildlife disease**	Interference in the dynamics of wild populations; risks of unforeseen consequences of treatment; positive duties to promote wildlife health through treatment interventions

In evaluating the costs to animals, the ACC must consider not only the cost to the individual, of stress or distress, pain or death, but also the costs to the species if that individual is lost, and costs to the community, or to the broader ecosystem. There may also be many benefits to consider. Some studies offer direct benefits to the species in question, or to the broader community or ecosystem. There may be no direct benefit to humans in some studies, while in others humans may benefit from improved management of important species, or more generally from the aesthetic enjoyment of a diverse ecosystem.

Aldo Leopold (1887- 1948) is known as the "father of wildlife ecology and conservation". He wrote that human ethics typically direct individuals to cooperate with each other for the mutual benefit of the community (1). Leopold asserted that this 'community' should be enlarged to include non-human elements such as soils, waters, plants, and animals, *"or collectively: the land."*

Leopold wrote that *"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.'*

Animal Care Committees should try to consider this broader imperative in our deliberations of wildlife ecology research, and not become too narrow in our consideration of these projects.

Summary

In reviewing Animal Use Protocols, the ACC has to consider a broad variety of factors, whether the research is investigating basic biological mechanisms, biomedical advancements, livestock production, veterinary medicine, or wildlife ecology and conservation. Regardless of the field, these reviews may be difficult for ACCs, as many tough questions and dilemmas arise. In my experience the ACC often has to deal with many technical and procedural questions and rarely has enough time to spend on broader deliberations involving weighing costs and benefits. If committee members can spend some time thinking about and becoming comfortable with the cost-benefit approach in general, outside their deliberations on a specific Animal Use Protocol review, they may find they are more confident with this approach within the framework of the review.

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