

Future Directions in Farm Animal Genetics and Genomics

The Royal Society of Edinburgh (RSE) is pleased to respond to the Biotechnology and Biological Sciences Research Council (BBSRC) consultation into the future priorities for BBSRC research in farm animal genetics and genomics. This response has been compiled by the General Secretary, Professor Andrew Miller and the Research Officer, Dr Marc Rands, with the assistance of a number of Fellows with considerable experience in this area

Research and its Implications

Underlying Principles

Should the UK be investing in farm animal genomics and similar types of research? If so, what overriding principles should govern its direction and priority setting?

The UK should invest in this research and the basic principles that should govern the priority setting should be: a) opportunities to advance basic science; b) opportunities to develop knowledge and techniques which may be of application in health care, biotechnology and agriculture; c) The need to maintain a strong and competitive UK presence in genetics and genomics internationally in order to participate in and benefit from international projects and funding.

Please explain any positive or negative effects farm animal genomics and similar types of research might have.

Livestock are an important component of food production in the UK and many questions concerning performance, welfare, health, and efficiency of production remain unanswered. Looking further afield, ruminants, in particular, are the only potential exploiters of vast areas of grazing and scrubland around the world which are unlikely ever to be cultivated and the UK has an international responsibility towards alleviating world problems in making animal production in these regions (and our own hill and remoter areas) more effective.

The use of research in this area would also lead to opportunities in many fields including:

- a) the understanding of the biology of traits such as lactation, growth and ovulation, in terms of their gene function, control and interaction
- b) the development of more productive, efficient or environmentally friendly livestock
- c) the development of exogenous systems (such as antibodies to hormones, genetic suppressors) for animal improvement using genetic knowledge
- d) the development of health care systems, both for animals and humans, using the animal model;
- e) the development of animal systems for drug production, and
- f) the development of stem cell systems.

Please comment on any societal or ethical issues you think might arise from this research.

This broad question has been well rehearsed elsewhere (for example the House of Lords Science and Technology Committee 2002 Report into Animals in Scientific Procedures). It is not the research *per se* which is the basic issue, but the specific problem or system tackled, and the public's perception of that, as well as more general issues relating to animal research.

Potential Research Areas

Should the UK be investing in these areas?

The UK should be investing in these areas, however the BBSRC has dispensed with much of the experimental farm facilities of its Research Institutes. Sustainable animal production depends on the improvement of efficiency, quality and welfare and these cannot be changed by investigating only, or even primarily, at the molecular level. Unless the research and development is taken beyond the fundamental level, its impact on society in general, and animal production in particular, is likely to be lessened.

If so, which genetic traits do you feel are the most important to invest in, and why?

The most important traits to invest in would be those which are not expressed at similar levels in, or not readily studied in, other species. For example, the milk yield of cattle and the ovulation rate and characteristics of poultry. Other key traits would be those for which livestock can act as models for human genetic disease.

If BBSRC invests in this type of research, which species do you think researchers should concentrate on, and why?

- a. Pigs. They are relatively easy to work with and cheaper and more fertile than cattle. They provide a model for human physiology and there can be a ready transfer of technology to the few important breeding companies.
- b. Poultry. Egg production species are limited and there could be benefits of high reproductive rate. There would be a ready transfer of technology to the few important breeding companies but genetic manipulation is very difficult.
- c. Cattle. Milk production species area limited and there are good public databases of production traits. There are also some opportunity for technology transfer.
- d. Sheep. With the development of commodity producers, it is going to be increasingly important to breed animals which are robust, in order to cope with ranching, otherwise we will start seeing major welfare problems.

What should be the future priorities and strategic aims for UK farm animal genomics and why?

A key priority is for the UK to maintain an activity so it can participate internationally. To facilitate this, development of database/data analysis/ data interpretation technology (in which the UK is strong) is an important part, as is work on cloning/gene replacement technology. A link also needs to be made between genes and gene expression in the animal, which in turn involves the mundane task of collecting data on animal characteristics and the evaluation of variation. Marker-assisted selection may account for no more than a small proportion of the variation for a particular trait (usually a complex of traits) while a major part of existing genetic variation may remain unaccounted for. To neglect the major source of variation would be a mistake.

International Issues

Where could UK research in farm animal genomics make the greatest international impact?

The UK is a major player internationally, and should be involved in all major international initiatives. It can do so by:

- a. being, as it already is, an active host for livestock databases
- b. having access to, and funds for, major genome sequencing resources (not restricted to animals, for example the Sanger Centre helps in this role)
- c. developing new tools for data collection, analysis and interpretation
- d. the presence of resource populations, for example the broiler layer cross, which is important in facilitating international input and collaboration.

Please describe any positive or negative effects genomic research might have on the developing world.

Much animal production in the developing world is still relatively primitive and in environments that are stressful and where investment potential is low. Research which would aim to make the animals (and most especially ruminants) more tolerant of climatic, nutritional and disease stress would be a major benefit from targeted research. The most immediately promising area might be in the area of disease and parasite resistance, but there is reason to believe that other aspects which would allow the animal to accommodate to climatic stress or nutritional deprivation may also be under a measure of genetic control.

The Future

What are the most important scientific challenges facing researchers in farm animal genomics over the next 10-20 years?

Understanding the function and interaction of genes (the post-genome challenge).

What will be the most important social, ethical, legal and regulatory challenges to arise in this area over the next 10-20 years?

The need to have legislation which facilitates development of technologies and appropriately regulates their use (for example GM animals), but which also facilitate animal research through protection of facilities and people.

The Utilisation of Research

Ecology and Biodiversity

Is research in farm animal genomics targeted at improving animal health and welfare and/or human health an appropriate use of BBSRC's resources?

Yes, both for animal and human health

Is research targeted at maintaining genetic diversity an appropriate use of BBSRC's resources?

Yes, research targeted at maintaining genetic diversity within livestock is appropriate as it impacts on long-term opportunities for improvement and, to some extent, diversity for cultural/tourism and conservation benefit.

Commercialisation

How appropriate are the mechanisms for successful utilisation of academic research outputs in farm animal genomics?

The Faraday Centre provides an excellent interface between research and industry in farm animal genomics, but a major problem is that the UK animal breeding industry is small and a company of a few hundred employees can (and does) breed the nucleus flock for almost half the world's broiler chickens. Biotech companies are also often small, and do not have ready access to capital.

In the international arena, what are the key research-based threats to UK commercial interests in the sector?

Key threats to UK commercial interests in this sector are the much larger input of resources in terms of finance and personnel in the US, and public opposition in the UK to animal experimentation.

Resources & Facilities

How important are our proposed resources to future progress in farm animal genetics/genomics, and how highly do you rate the access currently provided in the UK to such resources?

All of these are important:

- a. Large scale genomic resources (critical)
- b. Functional genomics centre (very important)
- c. Farm animal genome databases (very important),
- d. Research farms including genetically characterised herd (fairly important)
- e. Containment facilities (very important)

The reduction of research farm facilities with genetically identifiable and characterised herds and flocks over recent years has, however, been a mistake because it has inhibited the proper exploitation of the work resulting from the other research resources and most especially the molecular work.

How feasible is the use of commercial resources in place of experimental herds for livestock genetics and genomics studies in your area of interest? What are the advantages and disadvantages of the two systems?

Commercial resources, in place of experimental herds, often lack reliability and sustainability. However, a more widespread recording of data on a comprehensive set of traits in commercial livestock could assist both in the identification and solution of problems and narrow down the choice of research initiatives. Where such data are not available, for example on poultry, the experimental herds become the only practical option.

Funding

Where should farm animal genetic/genomic research take place? What, in your opinion, is the advantage of institute-led and university-led research in this area?

Most solutions related to changing farm animal performance (productivity, efficiency, health and fitness, quality, welfare, etc.) require multi-disciplinary approaches on an underlying foundation of genetic/genomic research. The need is to have large-scale adequately funded core facilities for genomic analysis, functional analysis and bioinformatics, and where relevant, animal facilities together, with some expectation of long-term funding. It does not seem critical whether institute or university led, indeed many large institutes are parts of universities.

How appropriate are the mechanisms for supporting postgraduate, postdoctoral and other research training for UK farm animal genomics research?

Many of the problems associated with training in this area are general. For example, inadequate PhD training beyond the project itself; the lack of a clear research career, with many stuck in the post-doc cycle; and low salaries for researchers in contrast to industry careers. It is also hard to attract quality students.

Additional Information

In responding to this inquiry the Society would like to draw attention to the following Royal Society of Edinburgh responses which are of relevance to this subject: *A Forward Strategy for Scottish Agriculture* (September 2000); *National Scrapie Plan - Scrapie Flocks Scheme* (February 2003); *Animal Health and Welfare Strategy for Great Britain* (May 2003); *Preparing a new GB strategy on bovine tuberculosis* (April 2004); *UK contingency plan for the possible emergence of naturally occurring BSE in sheep* (August 2004) and *the Scottish Executive Environment and Rural Affairs Department Research Strategy Review* (September 2004). Copies of the above

publications and further copies of this response are available from the Policy Officer, Dr Marc Rands (email: mrands@royalsoced.org.uk) and from the RSE website (www.royalsoced.org.uk).

November 2004