NON-TECHNICAL SUMMARY (NTS)

Project Title	Improving control of poultry diseases
Key Words	Eimeria, Poultry red mite, Chicken, Vector, Vaccines, Microbiota
Expected duration of the project	5 year(s) 0 months

Purpose of the project (as in ASPA section 5C(3))

Purpose	
Yes	(a) basic research;
	(b) translational or applied research with one of the following aims:
Yes	(i) avoidance, prevention, diagnosis or treatment of disease, ill-health or other abnormality, or their effects, in man, animals or plants;
No	(ii) assessment, detection, regulation or modification of physiological conditions in man, animals or plants;
Yes	(iii) improvement of the welfare of animals or of the production conditions for animals reared for agricultural purposes.
No	(c) development, manufacture or testing of the quality, effectiveness and safety of drugs, foodstuffs and feedstuffs or any other substances or products, with one of the aims mentioned in paragraph (b);
No	(d) protection of the natural environment in the interests of the health or welfare of man or animals;
No	(e) research aimed at preserving the species of animal subjected to regulated procedures as part of the programme of work;
No	(f) higher education or training for the acquisition, maintenance or improvement of vocational skills;
No	(g) forensic inquiries.

Describe the aims and objectives of the project (e.g. the scientific unknowns or scientific/clinical needs being addressed):

The ultimate objectives of the work proposed here are to improve control of parasites, enhancing economic and welfare-friendly production of poultry, and increase knowledge of host/parasite biology. A series of

scientific challenges will be addressed through six work packages, building on previous studies to develop new approaches.

In the first and second work packages we will focus on developing new vaccines to control parasites which cause the disease coccidiosis in chickens. At present coccidiosis is primarily controlled by drugs, but attempts to reduce or remove routine drug use in livestock production will leave chickens unprotected, with consequences for productivity and welfare. The work will involve identification of new candidate proteins to be used in vaccines, and development of effective and scalable approaches for delivery of candidates that we have already validated. We have recently established proof of principle for a new live parasite vaccine approach and will continue to develop the work here.

The third work package has been developed in response to reports of cryptic coccidiosis parasites which do not conform to any of the recognised species descriptions. The drive to replace routine drug control with vaccination requires understanding of these parasites since it is likely that new vaccines will need to protect against them. We have isolated examples of these parasites and intend to characterise them, working towards appropriate new vaccines which will be combined with those produced in work packages 1 and 2.

The deployment of novel vaccines is likely to impact on the recipients (chickens) and their gut-dwelling microbes, influenced by genetics of the chicken and the microbes. In work package 4 we will extend pilot genetic studies to identify regions within chicken genomes which support (i) natural resistance to parasite infection or (ii) improved response to vaccination. Such knowledge can be used in future breeding programmes for chickens to improve their health and welfare. In work package 5 we will complement these studies by exploring the effects of parasite infection/host interaction on populations of bacteria such as *Campylobacter jejuni*, a pathogen of chickens and a leading cause of food-borne human disease.

Other significant parasites of poultry include the poultry red mite (PRM), widely considered to be the most important external parasite of chickens throughout the world. The parasite can cause blood loss, itching, weight loss and decreased egg production. The mite can also feed on the blood of many species including humans and rodents. We recently began development of a mouse model that could be used for testing PRM vaccines and we now intend to improve and validate the system. Should this prove successful the model will be used in future applications to evaluate vaccine development.

What are the potential benefits likely to derive from this project (how science could be advanced or humans or animals could benefit from the project)?

A new vaccine(s) that can immunise against multiple pathogens and can be administered safely (orally) at day of hatch or through the diet, offers benefits to poultry (fewer vaccinations/injections; better disease protection; less handling; wider uptake of vaccines), to farmers (cost of control, ease of administration) and to the environment (reduction in use of antimicrobials and anticoccidials). Identifying panels of parasite antigens that induce immune protection is critical for development of new vaccines against diseases such as coccidiosis. Commercial development of such a vaccine would have many benefits (fewer birds used for vaccine production, cheaper vaccines and wider uptake). A prototype next-generation vaccine will ensure that the UK animal health industry has a solid foundation from which to retain a leading position in coccidiosis control, contributing to overall wealth creation. Breeding for disease resistance requires understanding of host genetics. Identifying sections of the chicken genome linked to resistance and improved responses to vaccination will facilitate development of tools to inform future breeding strategies towards the production of

naturally parasite resistant birds. Developing a mouse model for the study of poultry mites will provide an efficient methodology for testing new vaccines against this important parasite which is an emerging pest of laying hens throughout the world.

What types and approximate numbers of animals do you expect to use and over what period of time?

Chicken: Up to 6,600 in total over five years. Mice: Up to 100 in total over five years.

In the context of what you propose to do to the animals, what are the expected adverse effects and the likely/expected levels of severity? What will happen to the animals at the end?

Methods for infection of chickens with parasites have been refined over many years and are carried out with a minimum of stress to the animals. We minimise animal suffering by having well defined end points and carefully controlling doses of parasites administered. For the vast majority (~95% of animals used) it is expected that suffering will be within a mild severity band. Nonetheless, we require a moderate severity limit because we cannot rule out rare occasions where animals may show clinical signs of disease (e.g. intestinal discomfort, diarrhoea). Work on poultry mites is not well established in mice and the work described is limited to pilot experiments. We expect that all work will be within a mild severity band, but because these are pilots we require a moderate severity limit. At the end of each protocol the animals will be humanely terminated using appropriate methods.

Application of the 3Rs

Replacement

State why you need to use animals and why you cannot use non-protected animal alternatives

Replacement

The use of living animals is essential because the parasites we will be working on only grow productively in/on live animals in a host-specific manner. For this reason replacement has been focused on identifying approaches for complimentary studies, increasing the use of cell and parasite culture in predictive screens for the most effective tests before working with live animals.

Reduction

Explain how you will ensure the use of minimum numbers of animals

Reduction

To minimise overall numbers the research group operates a pooled resource so that each parasite batch is utilised efficiently, with minimal wastage. Key factors include the use of statistical power calculations to identify the minimum number of animals required for a valid outcome and detailed parasite knowledge to optimise parasite production per animal without compromising welfare.

Refinement

Explain the choice of animals and why the animal model(s) you will use are the most refined, having regard to the objectives. Explain the general measures you will take to minimise welfare costs (harms) to the animals.

Refinement

Chickens and rodents are the natural hosts and the data generated is of direct relevance for development of improved control strategies. Methods for infection have been refined over many years and are carried out with a minimum of stress to the animals. We minimise animal suffering by having well defined end points and carefully controlling doses of parasites administered.