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Understanding the Interaction between Level of Nutrition and Gastrointestinal parasites*

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Collaborators

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*Evaluation of Anti-Parasite IgA Responses to Assess Nutritional Adequacy during Infection of Small Ruminants with Gastrointestinal Nematodes

Executive Message

- Gastrointestinal parasites such as *Haemonchus contortus* are an enormous constraint on the efficient production of sheep in developing countries where such stock are mainly owned by poorer farmers.
- *Haemonchus contortus* induces protein deficiency, which has the effect of weakening the host response and promoting parasite survival.
- This DFID project successfully evaluated the use of the antibody Immunoglobulin A (IgA) as a way of quantifying the influence of nutrition on the immune response of small ruminants to gastrointestinal parasites.
- IgA appears to suppress worm growth and fecundity and thus acts as a major mechanism of resistance to these worm infections
- Animals on low protein diets are more susceptible to infection because they produce less IgA. Farmers can counter this by feeding extra protein.
- Measuring the amount of parasite-specific IgA can indicate which animals are nutritionally stressed or identify those animals that are relatively resistant to infection. A cheap test is now required so that this information can be incorporated into livestock management strategies.



The majority of sheep in developing countries are infested with gastrointestinal parasites such as *Haemonchus contortus*.

Background

The gastrointestinal 'worm' *Haemonchus contortus* is one of the most pathogenic parasites in tropical and sub-tropical areas of the world. Infections by this parasite are a major constraint to the efficient production of livestock. Nearly all grazing sheep are infected; parasitised sheep are anaemic, they eat

less, the food they do eat is digested less effectively and the protein that they do digest is metabolised less efficiently.

The standard methods of treatment use anthelmintics to kill the parasites carried by the

sheep. This reduces pasture contamination that comes from parasitic eggs passed in the droppings, which grow into larvae that then infect further sheep. Unfortunately many farmers in the third world cannot afford these drugs. Even those farmers who can bear the costs of treatment find that many drug preparations are ineffective, partly because the worms are becoming resistance to the most common drugs.

Substituting a more resistant breed like the Red Maasai for susceptible animals can provide one option for farmers to overcome the effects of worm infections. For cultural reasons some farmers prefer

not to use indigenous breeds like the Red Maasai but opt instead for larger exotic breeds even though they are often less productive where there is a moderate to severe parasite challenge.

Gastrointestinal 'worms' such as *Haemonchus contortus* induce protein deficiency and symptoms of anaemia as they syphon off nutrients from the host. Animals on poor diets cannot then obtain enough nutrients to meet their basic metabolic needs and in severe cases will die if untreated. If the farmer can supplement the diet with additional protein animals will be able to withstand the effects of infection. The production of parasite eggs will also fall so reducing the parasitic challenge facing all animals in a herd. The optimal source of supplementary protein will vary in different locations, but in many cases cheap, indigenous protein sources can be used.

The results from this research project should help the matching of breeds and diets for particular disease and husbandry conditions. Most importantly this will provide appropriate and cost-effective animal health strategies for use by hard-pressed African small-holders.

Objectives

The project goal was to better understand the interaction between diseases and nutrition so that new knowledge could be incorporated into future livestock management strategies. Specifically the researchers wanted to understand the interaction between the level of nutrition and parasites such as *Haemonchus* in much more detail.

They tested four hypotheses:

- That growing lambs attempt to control parasites by suppressing worm growth and fecundity.
- The major mechanism of resistance is mediated through local IgA antibody responses.

- The level of nutrition (especially protein) influences the IgA response.
- Measuring IgA responses could indicate whether the diet was inadequate to produce optimal parasite resistance.

Highlights

The project met two targets:

- the relationship between circulating anti-parasite IgA levels, plane of nutrition and parasite resistance was established.
- the influence of diet on anti-parasite IgA responses was analysed.

The project examined over 1000 sheep and found that the results supported all four hypotheses. Growing lambs do attempt to control haemonchosis by suppressing worm growth and fecundity. Increased IgA responses are significantly associated with decreased worm length and fecundity. Animals on protein supplemented diets do produce more IgA. Measuring IgA responses can indicate which animals are on nutritionally inadequate diets. The manifestations and mechanisms of resistance appear very similar in animals infected with haemonchosis and ostertagiasis (the major disease constraint on sheep production in temperate climates). Parasitologists have often assumed that resistant animals control parasites by reducing worm burdens and possibly by reducing the parasite's fecundity as well. These results strongly indicate that in grazing lambs, reducing worm burdens is less important than reducing worm size and fecundity. This knowledge is now being incorporated into livestock management strategies. Future work will concentrate on the development of more efficient diagnostic tests to identify animals at risk of disease. Kenyan scientists plan to carry out follow up experiments with local breeds of sheep and diets with indigenous supplements.

Impact

Genetic resistance and nutritional supplementation work by improving the response of immunoglobulin A (IgA) to infection. In turn IgA regulates worm size and fecundity. This IgA response is the major means that sheep have of resisting parasites like *Haemonchus* prior to puberty. As animals get older they become hypersensitive to worm burdens, resisting incoming larvae and expelling adult worms, which enables them to manage worm burdens.

Being able to measure the IgA responses of an animal makes it possible to identify animals that are:

- at risk and before they develop clinical signs of disease
- on an inadequate diet to protect themselves,
- genetically susceptible to these parasites.

This information will enable steps to be taken to prevent animals deteriorating and dying. Early intervention will improve productivity and thus the livelihoods of animal keepers in areas such as East Africa where this disease is a major constraint to production. Scientists now need to develop cheap and reliable tests that enable vets or farmers to establish knowledge on how well their stock are able to resist infection. This will then let farmers select the most appropriate action to reduce production losses. They could for example keep only those animals that show a high resistance to *Haemonchus* or they could treat only those with low resistance.

Dissemination

The results from this project have also been presented at national and international meetings of parasitologists, geneticists and experts on animal production as well as being reported on television, national radio, national and local newspapers and the farming press.

Selected Publications

Mugambi, J.M., Bain, R.K., Wanyangu, S.W., Ihiga, M.A., Duncan, J.L., Murray, M. and Stear, M.J. Resistance of four sheep breeds to natural and subsequent artificial *Haemonchus contortus* infection. *Veterinary Parasitology* 69:265-273 1997

Stear, M.J., Park, M. and Bishop, S.C. (1996) The key components of resistance to *Ostertagia circumcincta* in lambs. *Parasitology Today* 12, 438-441.