Agriculture Department
Food and Agriculture Organization
of the United Nations

Genetics and animal health

As veterinary drugs falter in the face of increasingly virulent pathogens, FAO proposes to improve animal health strategies - by breeding for disease resistance

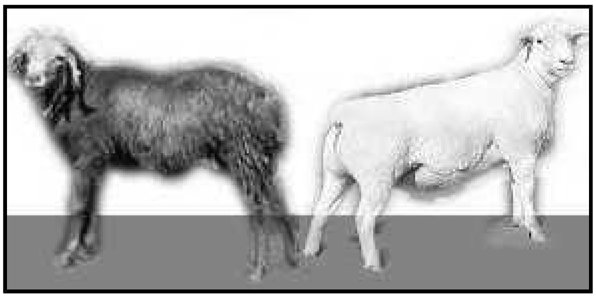
Gastrointestinal infections caused by nematode parasites - more simply, worms - are one of the most serious diseases of livestock world-wide. And, using conventional disease control strategies, the problem can only get worse: in all major sheep-producing countries, nematodes have developed resistance to chemical de-wormers (anthelmintics), and long-promised vaccines against the parasites are still not commercially available.

But, suggests a recent FAO study, there is another straightforward - and sustainable - strategy against nematodes. First, collect the faeces of young sheep and count the worm eggs. Then, identify those animals with the lowest number of eggs and the most desirable production characteristics - and you have found the rams or breeding females most suitable for producing flocks with nematode resistance. (Alternatively, check eyelid colour to assess infection-induced anaemia.)

The FAO study, *Opportunities for incorporating genetic elements into the management of farm animal diseases*, argues that governments and the livestock sector have generally overlooked the potential of simple - as well as very high-tech - genetic approaches. It says enhanced disease resistance or tolerance will lead to reduced need for inputs, especially drugs, and would be especially beneficial in low-input agricultural systems in developing countries. **AG21** asked Keith Hammond, of FAO's Animal Production and Health Division, for the details...

Does this mean farm animals are generally not bred to resist disease and infection?

"It's worse than that. In the developed world, breeding has focused almost exclusively on characteristics such as the milk, meat, egg and fibre produced, with drugs as virtually the only disease management strategy. The result is a serious reduction in the genetic potential of our livestock populations to resist or to tolerate



infection, while actually *increasing* the genetic infectivity of the parasites themselves - worms, bacteria and viruses. In much of the developing world, of course, there is often a shortage of drugs to treat disease and infection, which explains annual losses of 30-35% in the livestock sector. The farmer is left to suffer losses, or treat individual animals as best he or she can."

The FAO report says chemical intervention strategies are "not biologically sustainable". How serious is the problem?

"As well as increased nematode resistance to anthelmintics, we are seeing increasing bacterial resistance to antibiotics, which is especially worrying for intensive production systems where antibiotics are used to control unknown and sometimes sub-clinical disease problems. There is now widespread resistance to the drugs used to control protozoans responsible for animal trypanosomiasis. With each new generation of vaccine for Marek's disease in poultry, a new and more virulent strain of the virus has arisen. Even for foot-and-mouth disease, many governments consider the available vaccines inadequate to the challenge."

In practice, how would "genetic elements" be incorporated in disease management strategies?

"For almost every disease that has been intensively and carefully investigated, evidence has been found for host genetic variation - some animals are more resistant or more tolerant to the disease than others. Almost certainly, there will be genetic variation for a wide variety of other diseases. There are three levels of genetic differences to consider: species, breed and unique genetic variation among animals within each breed. These levels will have most impact when applied in combination. A simple example at species level: goats are far more resistant to the footrot fungus than sheep. At breed level, we need to choose those most appropriate for the production environment - in tropical countries with severe endemic diseases that exotic breeds are not adapted to, locally adapted and indigenous breeds are likely to be superior to imported exotic genotypes. Where exotic breeds are appropriate in every other respect, crossbreeding can introduce genes for tolerance or resistance. And finally, individual animals would be selected for breeding based on their resistance or tolerance, which could be established through simple observations or using genetic markers or gene tests to assist in the selection."

Which diseases are most responsive to genetic strategies?

"Most animal diseases present opportunities for incorporating genetic elements in disease management. Progress is already being made in using genetics to eliminate scrapie in sheep in Europe. Convincing research has shown that many breeds of goats and sheep have better performance in the presence of worm challenge than other breeds. For example, in humid areas of Kenya that are heavily infested with nematode parasites, the native Red Maasai sheep is far more resistant to roundworm - and produces three times more meat - than improved breeds such as the Dorper. In poultry, research indicates substantial opportunities for incorporating genetic elements into disease management for Newcastle disease, coccidiosis and nematodes, but new knowledge is needed to take genetic approaches to smallholder systems, where the benefits are potentially enormous."

But life evolves - won't parasites adapt to genetic changes in the host?

"Any control measure that aims at reducing numbers of parasites can lead to genetic change in the parasite population to evade the control strategy. This is best documented in the case of antibiotics. And it could also happen in the case of using genetics. This has been documented in plants, but there are currently no recorded examples of it occurring in domestic animal populations. For macro-parasitic diseases, such as gastrointestinal parasites, genetic improvement of resistance will lead to only weak pressure on the parasite to evolve. This is in contrast to chemical control measures that impose strong selection pressure. Therefore, in parasite evolution terms, genetic strategies are expected to be more sustainable than many other intervention strategies for those infections. However, this may not be true for bacteria and viruses, where evolutionary change in the parasite population may eventually occur."

How important for disease management are today's rapid advances in the field of molecular genetics?

"They will be crucial. There is already a broad range of potentially very powerful molecular techniques and procedures, and they're being added to practically by the day. Work on the biology of avian and mammalian livestock - which are more complex than plants - is being greatly facilitated by the massive amount of molecular genetic work on human diseases. The revolution in animal molecular genetics offers vast potential for major breakthroughs in understanding disease, at the genetic, protein, physiological, animal and population levels. Over the next 10 to 15 years we are going to substantially change many, if not most, animal disease management strategies."

Is there a risk that the genetic approach will require technologies - such as molecular markers - unavailable in many developing countries?

"In the short-term, genetic management will generally use technology somewhat simpler than genetic markers - more frequently, selection of individual animals or breeds with enhanced resistance will rely on phenotypic assessments. There are a number of diseases, especially those affecting extensively managed ruminants, where sufficient knowledge exists to start selection of individual animals or breeds for resistance immediately."