Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Scientific methods test farmers' indigenous knowledge to identify sheep and goat breeds resistant to parasites

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Each year, sheep and goat farmers around the world lose an estimated US $10 billion due to gastrointestinal parasites that infect their animals, leading to loss of weight and wools and even death – a problem that is now escalating as parasites become resistant to the drugs used to eliminate them. In developing countries, sheep and goat owners are mostly resource-poor or marginalized farmers who cannot always afford the antiparasitic drugs. They are also more likely to keep a small number of animals of indigenous breeds that have adapted to the local conditions and, in some cases, are said to have developed a natural resistance to the parasites. The Joint FAO/IAEA Division has been exploring farmers' reports of natural resistance, seeking scientific evidence that can be used to improve breeding programmes and enhance and quicken benefits to farmers. Working in ten countries in Africa, Asia and Latin America to identify parasite-resistant features of local animals, the exploration included everything from checking their eyes for anaemia to checking the 60 000 DNA markers of their genomes for variations that indicated resistance.

The effort to identify sheep and goats with natural resistance to parasites began with a challenge. Each of the ten countries involved in the Joint Division's study identified one breed that farmers considered tolerant or resistant and one breed farmers considered susceptible. Twenty young animals of both the tolerant and susceptible breeds were selected and "challenged", meaning they were purposely infected with parasites. Researchers monitored them at field stations, noting their weight and wellness – if tolerant to parasites, they should have a normal level of red blood cells and gain weight; if susceptible, they should lose weight and become anaemic. They also counted the number of parasite eggs in their faeces to determine if the worms had taken residence in the animals' stomachs. Interestingly, with only a few exceptions, most of the indigenous knowledge as to animal susceptibility or resistance was correct.

Countries involved in this research included Argentina, Bangladesh, Brazil, Burkina Faso, China, Ethiopia, Indonesia, Iran, Nigeria, Sri Lanka.

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Armed with this knowledge, the second test was a field trial. The goal was to identify any individual animals within the breed that were "very tolerant or resistant" or "very susceptible", and to identify a visible clue – something obvious to help farmers determine which animals to breed for what is called "genetic gain". At this level, weighing the animals to measure their growth for meat production and recording wool yield would give some information to farmers but not enough for making good breeding

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decisions. It was also prudent for farmers to collect faecal samples so the lab could identify how many parasite eggs they contained.

Identifying animals with natural parasite resistance has value beyond a local farmer's herd. It can be the beginning of large-scale breeding programmes. Until now, developing countries have not exploited the potential of animals with natural resistance due in part to lack of infrastructure and skilled scientists. Thus, this programme, which screened more than 5 000 animals in the ten participating countries, helped establish sound animal selection programmes and fill in the blanks in performance data.

DNA markers identified for parasite resistance

Once the screening had identified the best animals using faecal eggs and blood testing, the project moved to the genetic level. Samples were sent to the Joint Division laboratory in Seibersdorf, Austria, for analysis, seeking to identify variation in DNA markers that would indicate resistance. Using specialized software to perform meta-analyses of genomic and phenotypic data, researchers could identify components in the genome associated with parasite resistance or tolerance. Adding the genetic information to the mix enables researchers to identify the most resistant males, select them for breeding, and use modern reproductive technologies such as artificial insemination or embryo transfer for faster dissemination of the desired traits well beyond local farmers' fields.

In Argentina, the institutional farms recorded a clear reduction in the parasite loads of sheep by selecting rams with fewer parasite eggs in their faeces. The process has now gone through four generations of sheep selection and the technology is being transferred to private breeders. Herders may still need to use deworming drugs if animals do not have absolute resistance, but just cutting the deworming from three times a year to just one time drastically reduces the costs for farmers and the threat of parasites building resistance to drugs. Having the genetic information means farmers also know the breeding value of a male sheep or goat and can use that in breeding for sustainable improvement of animal productivity.

The scientific journal *Nature/Biotechnology* published the important technical findings of this research in an article "Sequencing and automated whole-genome optical mapping of the genome of a domestic goat (*Capra hircus*)".

For further information
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