

## Conclusion and Recommendations

Nutritional management strategies which aim to maximise the acquisition of effective immune expression and to concurrently minimise the impact of these effector mechanisms on productivity both in young growing sheep and in reproductive ewes must be considered within the context of the particular production system, its economics, and the climatic environment in which such strategies are to be applied. A major benefit of effective strategies would be to reduce the requirement for anthelmintic treatment, and hence minimise the development of resistance by worms to drenches. Some general principles for testing and application in the field have been agreed together with priorities for further research to better understand mechanisms underlying the response of animals to parasites and the interactions with nutrient supply.

- The level of nutrition required for more effective management of the effects of worms in susceptible sheep may not differ from that usually considered optimal for production anyway. The essential criteria may be the same generally accepted benchmarks for growth rate of weaners or weight gain over the last trimester of pregnancy of ewes in a 'good' production system. To some extent, such benchmarking has been done in existing extension and management consulting programs, where there is considerable emphasis on managing feed supply and worms concurrently. In some production systems it may simply be a matter of better promotion of existing information.
- Definition of the nutritional composition and availability of the feedbase through the year is available for most Australian sheep production systems. There is a need to map this information with the epidemiology and population dynamics of the principal parasite species in the particular system and with animal requirements. This will facilitate identification of optimal times for strategic nutritional manipulation that match the need for extra metabolisable protein, or in some instances metabolisable energy or minerals or trace elements, to enable full expression of naturally acquired immunity without compromising productivity.
- Practical application of this information may require more intensive monitoring of faecal egg count in susceptible stock on a flock basis so that cost-effective grazing management or supplementation strategies are implemented at the most appropriate time relative to host need for protein in particular. For example, extension of the period of current supplementation practices in the Mediterranean and winter rainfall zones may be all that is required to enable weaners to achieve their full immune potential. Similarly, a change in supplement type towards delivering greater amounts of metabolisable protein may be all that is required in summer rainfall regions. Integration of models of worm epidemiology with decision support tools for managing forage supply to meet animal feed requirements is considered a high priority.
- Extension of this information to farmers may require an assessment of the currently available facilities, service providers, demonstration farms and on-farm collaborators. The ideal approach will be to integrate communication on feeding for better worm management with other nutritional messages for optimising utilisation of the feedbase to meet the animal's requirements for particular performance targets. It is also important to clearly define the potential client base. It is unlikely that messages targeted only on worm control will have high impact without a clear indication of economic and sustainability benefits, since for most producers this is not their highest management priority. Informed judgements of suitable options could be made for some production environments now for incorporation into extension messages without waiting for further validation. However, clear definition of the goals and context (currently and for the future) of a given production system will always be an essential prerequisite to determining what is realistic. Producers will be particularly interested in unequivocal advice on the quantity and timing of supplement use in terms of both production and worm control benefits.
- There is a need to better identify the benefits of animals selected for parasite resistance within the context of their apparent requirements for extra metabolisable protein during expression of what presumably is a more effective immune response. Do such animals have a higher requirement than more susceptible genotypes or do they mount the response more efficiently in a temporal or metabolic sense? Is it possible to shift random-bred animals towards the immuno-responsiveness of resistant genotypes using nutritional manipulation as some experimental evidence suggests? These are questions deserving of further investigation at the fundamental level particularly as genotypic selection will be an important element of the dual meat and wool production systems envisaged by the Sheep CRC.
- There is a need to draw on research being conducted in other areas and to apply this to the management of resistance and resilience to worms. This could include work on nutritional management to enhance microbial protein flow to the intestines as well as the influence of specific nutritional components on immune gene

expression or conditioning of the gut environment to inhibit establishment of infection or enhance expulsion of worms. There is presently little evidence that nutritional strategies can shorten the time taken for acquisition of immunity to worms. Basic research to define physiological and metabolic factors involved in immune acquisition may be required to determine appropriate strategies for manipulation or optimisation of the response. This may include quantifying the 'immunological cost' and whether there are adverse effects on competing requirements for limiting nutrients, as well as the possibility of specific supplementation.

- Within any particular production system it will be important to determine whether nutritional management to improve immunity is best targeted at the periparturient ewe or the growing weaner (or both). Similarly,

opportunities to augment resilience to worm burdens so that drenching can be reduced or avoided will vary between production seasons and environments and remain to be better elucidated.

- Any research on nutritional manipulation for enhanced parasite resistance and/or resilience should, wherever possible, include measurements to define the impact on lifetime productivity (wool, meat and reproductive performance). Longer-term economic benefits of short-term supplementation strategies may be a critical determinant of the acceptance of extension program recommendations by producers and need to be quantified.

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