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Recent achievements in cereal feed grains nutrition

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The demand for grain by the livestock industries of Australia has increased greatly over recent years with the expansion of intensive animal production and a significant increase in the amount of grain being fed to dairy cattle. There has been concern from the livestock producers that insufficient grain of high quality will be available domestically for their expanding industries unless there is an increase in the dedicated production of grains for animals. For grain growers to be attracted to producing grains specifically for livestock, there must be an economic advantage at least equal to the production of grain for human consumption. Consequently, rapid and accurate procedures need to be developed for establishing the nutritional value of grain for the different livestock enterprises so that grain prices reflect their value in terms of animal performance.

In 1996, the Grains Research and Development Corporation in collaboration with the animal Research and Development Corporations established a new research project, “Premium Grains for Livestock”, with the major aims of improving the quality and marketing opportunities of grains for the livestock industries. The ultimate goal of the project is to establish a basis for the rational trading of grains for livestock with the benefits being shared between grain growers and animal producers. The Project involves collaborative research between scientists and producers from across Australia.

The research strategies and achievements to date for the overall project are outlined below.

1. Seventeen review papers describing grain characteristics likely to affect energy and amino acid availability for ruminants, pigs and poultry and appropriate methodology for evaluating the nutritional value of grains were written and published in a special edition of the Australian Journal of Agricultural Research (Vol. 50, No. 5, 1999).

2. Approximately 1750 grain samples covering the widest possible range in chemical and physical characteristics that may influence animal performance have been collected. The samples have been derived from plant breeders, special farmer-grown crops, a genotype by environment trial, a fertiliser trial, grains selected for seed multiplication on the basis of extreme values in near infra-red spectrometry (NIR) and commercial grains suspected of having extremes in nutritional values because of severe drought, frost damage, germination or because they were “waxy” cultivars.

3. Approximately 105 analyses of chemical and physical characteristics thought to influence nutritional value have been conducted on all grains fed to animals. These involved analyses for individual carbohydrate, fatty acid and amino acid components, α- and β-amylase and anti-nutritional factors such as lectins, tannins and phytic acid. Physical properties included measurement of grain weight, hydration capacity, seed colour, seed diameter, seed size distribution, seed hardness index and profile, and the viscosity of whole grain, starch extract and acid soluble extract. Light microscopy has been used to examine the physical structure of some grains.

4. All grains fed to animals have been examined using *in vitro* systems simulating both rumen fermentation and intestinal digestion. In addition, the rumen fermentation measurements on over 400 samples of hull components from barley, oat and sorghum grains have been conducted. These analyses have been of significant value for identifying grains that potentially have large differences in nutritional value for different classes of livestock.

5. A relatively small number of grains covering the range identified in chemical and physical characteristics have been fed to animals to determine the digestion of energy, individual grain components and amino acids. Hypotheses have been developed for the causes of differences in nutritional value of grains across animal species. Forty grains have been fed to sheep, 24 to pigs and 22 to both broiler chickens and laying hens. A second series of experiments with the feeding similar grains to sheep, cattle, pigs, broiler chickens and layer hens is in progress. The site of digestion in cattle of selected grains has been examined.

6. The effects of processing and storage on the nutritional value of grain for different animal species have been evaluated using the *in vitro* systems. Research has concentrated on identifying processing methods that may improve the digestibility of sorghum and whole grains by cattle. However, hypotheses are being developed for ways of increasing the availability of nutrients from cereal grains in other animal species. The effect of storage on a range of grain species is being examined using the *in vitro* systems.

7. Development of rapid and accurate analytical tests for measuring the most important chemical and physical characteristics that determine nutritional value of feed grains has commenced. Analyses using NIR have been developed for predicting the digestible energy content (DE) of cereal grains for pigs and whole animal energy digestibility for sheep. Future development of rapid assays depends on identifying, quantitatively, the most important determinants of nutritional value for each cereal grain and animal species.

8. A review has recommended the development of rapid analytical procedures for identifying, semi-quantitatively, contaminants of grains that may affect either animal productivity or marketing opportunities. Research has commenced outside the Program on development of ELISA assays for identifying the presence in grain of organochlorines, methoprene, cyano-pyrethroids, benzoylphenylureas, organophosphates and carbamates. Strategies are being developed also for identifying weed seeds that contain toxic alkaloids.

9. A computer simulation model is being developed for predicting the performance of feedlot cattle in relation to the feed ingredients eaten, genotype of the animal, climatic conditions and other factors determining animal growth and body composition. A comprehensive, mechanistic representation of rumen function has been achieved and representation of the animal component has commenced.