EXECUTIVE SUMMARY

THE USE OF SIMULATION MODELLING IN IMPROVING THE UTILIZATION OF DIETARY PROTEIN

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One of the requirements of the Protein Research Trust is that it should be possible to apply in practise the research that is done with their financial assistance, i.e. that the latest technology can be transferred to the Industry. The aim of this project is to increase our understanding of the interaction of the animal with its food and its environment, so that the accuracy of the simulation models that are being developed can be improved, and that further simulation models and expert systems of value to the Industry can be produced. These models package together all the relevant information on the subject and made this accessible to the Industry. The models have been developed in a friendly and usable form, making available information that is needed to make decisions about amino acid requirements at different stages of the growing period and about feeding strategies. Also, they enable different genotypes to be evaluated in relation to their potential outputs and requirements. All these attributes represent major steps forward in our ability to determine the amino acid requirements of pigs and poultry.

A research trial was initiated in 1995 in the controlled environment chambers, which measured the response of male and female broilers during three different stages of growth to three feeds varying in protein-to-energy ratio and to four environmental temperatures. Energy intake and retention were measured from which heat loss was calculated. This trial is to be replicated during the latter half of 1996, in order to collect sufficient data to allow a proper statistical analysis to be made of the temperature treatments. The objective of this research is to determine the amount of heat that is produced by birds at different degrees of maturity and at different environmental temperatures, as the amount of heat that a bird can lose to the environment is a function of these factors, as well as to the degree of feather cover. More accurate estimates will be made of the effects of these factors on the amount of heat that a bird can lose, thereby improving the accuracy of the existing broiler simulation model.

Two series of experiments have been conducted in the controlled environment rooms with pigs this year. In the first, the response of 48 entire male pigs, from 12 to 25kg in weight, was measured to six dietary threonine concentrations (from 3.6 to 8.9 g thr/kg) and four environmental temperatures (18, 22, 26 and 30°C). These pigs were placed in individual pens and food intake and body weight gain were monitored until they reached 25 kg live weight, at which stage they were killed and the entire animal was minced then analyzed for water, protein, lipid and ash. There were two replications of each feed x temperature treatment. The responses in food intake, average daily gain, body protein and lipid gain, measured in the threonine response trial indicate that the range of threonine concentrations chosen in this experiment was correct for pigs of that growth rate, and that the experiment was successful. The responses were not the same at the four temperatures, justifying the importance of conducting experiments of this nature under different environmental conditions. These results will be useful in determining the optimum economic amount of threonine to include in feeds for pigs during the period 12 to 25kg live weight, and will enable producers and nutritionists to make more efficient use of protein sources when formulating pig feeds. In the second trial, the same number and size of pigs as before were used to measure the response to dietary lysine, at the four environmental temperatures used in the threonine trial. These pigs have just reached their final weight of 25 kg and have subsequently been treated in the same way as those in the first experiment, but no results are as yet available.

A pig experiment has just begun that is designed to determine the optimum nutrient density of pig feeds as perceived by the pigs themselves. Apart from feeding a range of feeds differing in nutrient density, but having exactly the same balance between all nutrients and energy, some pigs on the experiment are

given the opportunity of choosing between two feeds containing a high or a low nutrient density. They will be grown from 20 to 90 kg live weight, and their food intake (of each feed on offer) and body weight will be determined weekly throughout that period. 48 pigs are on the experiment, and they are being housed individually.

A major genotype evaluation trial was conducted last year at the University of Queensland in Australia. Eight broiler strains (by two sexes) were reared under optimal conditions, with some birds of each genotype being sacrificed at frequent intervals for the measurement of feather growth, the weight of wings, thighs, drums and breast, and for chemical analysis. This was a major undertaking which required a great many chemical analyses to be completed before the results of the trial could be finalised and published. The laboratory analyses obtained from the University of Queensland appeared to be inaccurate, so I elected to re-analyze the samples here in Pietermaritzburg. The nitrogen analyzer that has been commissioned from funds supplied by the PRT has been used extensively to analyze the nitrogen content of these samples, but as yet the lipid analyzer purchased from the same firm has not worked, so we are still without the lipid contents of these carcasses. It is not possible to continue with the statistical analyses of the results until the nitrogen and lipid results are available.

The Reading Model is accepted as the most progressive way of determining and expressing the optimum economic intake of amino acids for laying hens. However, up to now the model has had to be run on a mainframe computer as there were no DOS versions available; the first part of this project was therefore to rewrite the program for the personal computer (PC), and simultaneously incorporate the latest optimisation routines into the program to improve its efficiency. The latest version of the program, which is Windows-based, can now accomplish this, as well as determine automatically the marginal costs of the different amino acids and the marginal revenue for eggs, thereby automating the entire process of determining the economic optimum intake of each of the essential amino acids for laying hens. In addition, the model is now capable of determining the amino acid that is first-limiting economically and biologically, which is accomplished by ascertaining the egg output that would be sustained by the optimum economic intake of each amino acid. Thereafter it determines the intake of each amino acid that will sustain the same output as that on the limiting amino acid, and formulates a range of feeds of increasing nutrient density, determines the cost of feeding each of these feeds from which the optimum economic nutrient density is determined. In other words, the program is capable of determining, for a given flock, cost of feed and egg revenue, the feed composition that will result in the maximum profit for the organisation. In so doing, the dietary protein is utilized in the most economical and biologically efficient way.

Funds are required in 1997 to continue this research programme. Three broiler trials are planned, two of which have not been conducted previously, and one will be a repeat of the experiment to be conducted in the latter part of 1996, thereby providing more replications of the temperature treatments. One pig trial is planned, in which the effect of different nutrient densities under different environmental temperatures will be measured, the results of which will enable nutritionists to determine the optimum economic nutrient density to use in commercial operations at different times of the year, thereby improving the utilization of dietary protein. One large switch-over experiment is planned to be conducted on individually-caged laying hens in 1997, in which six feeds differing in protein content will be fed, one at a time, in all possible combinations, for six weeks at a time before being switched to the next feed in the sequence. The results of this trial will be used to model the effect of a switch in protein content on the subsequent food intake of hens - of particular importance being the rate at which the hen changes food intake and egg output. These experiments are all designed to address different aspects of the theory related to the prediction of food intake by broilers, pigs and laying hens, thereby improving the efficiency of utilization of dietary protein.