FINAL REPORT

THE STRATEGIC UTILIZATION OF AMINO ACIDS IN THE NUTRITION OF POULTRY AND PIGS

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EXECUTIVE SUMMARY

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This project was initiated following the successful development by this researcher of a broiler growth simulation model, and was designed to improve the accuracy of the model, by providing corroborative evidence that the theories incorporated into the model were acceptable, and by improving the accuracy of the numbers that are part of this model. The research programme involved a number of experiments on broilers, one dealing with the utilization of dietary protein following a period of fattening, the others involving the effect of dietary energy to protein ratio on the efficiency of utilization of protein. Three experiments were conducted in which the theories incorporated into the growth model were tested in pigs, all of which were conducted in controlled temperature chambers, in which the efficiency of utilization of different limiting amino acids was measured at increasing temperatures. This work is particularly relevant in the hot climate that is prevalent in South Africa. In addition, and in preparation for a new simulation model designed to predict the performance of laying hens following different lighting and feed restriction programmes used during the rearing period, a series of experiments was conducted in which pullets were subjected to a range of rearing treatments, and their subsequent performance was monitored. The rationale behind this research programme was that with access to accurate simulation models, nutritionists and producers in the balanced feed industry in South Africa would be in a better position to make more efficient use of the protein sources available to them.

No simulation model, nor any rational theory, exists at present which can predict the effects of different rearing treatments on the subsequent performance of laying hens. Consequently, laying pullets are reared on a varied range of programmes, even though it is not certain to what extent, or in which direction, the subsequent performance of the hens is being influenced by these programmes. In the three experiments reported here, on the effects of different feed and lighting programmes on the performance of laying pullets, it was concluded that both light and feed restriction have an effect on the age at maturity of laying hens, that the length of time between the release from light or from feed restriction differs depending on the age of the pullets when the releases occur, and that egg weight is significantly affected by the age at release from feed restriction, but not from light restriction. Empirical equations were developed that may be used in future simulation models to predict the effect on age at sexual maturity and egg weight at an age following the release from light restriction, feed restriction or both at different times during the rearing period, thereby enabling producers to decide upon optimal economic strategies to be used during rearing.

Different methods were employed to reduce the growth rate of pullets, rather than make use of the time-consuming and labour-intensive method of quantitative feed restriction. These included qualitative feed restriction (the use of low protein feeds) and high stocking densities, the latter being shown to be effective in reducing growth rate, delaying maturity and in reducing the amount of protein consumed during the rearing period. The pullet rearing experiments were consistent in indicating the superiority of short daylengths during rearing over longer (>14h) daylengths. In all cases laying performance was improved, and body weight, and hence

dietary protein intake throughout the laying period, was reduced, by the use of daylengths of less than 8h/d.

In the research on broilers two trials addressed the problem of factors influencing the efficiency of utilization of dietary protein, the hypothesis being that the efficiency of utilization of protein is dependent on the energy: protein (E:P) ratio of the food. The results provided useful information on the effect of dietary energy, protein and protein quality on the rate of protein and lipid retention in broiler chickens. In essence, as the protein content of the feed is increased, either as a means of overcoming the effect of low quality proteins, or as a means of matching the protein content of the feed with the protein requirement of a small, fast-growing animal such as a broiler chicken to two weeks of age, or a turkey poult, the energy content of the feed must be increased concomitantly, otherwise too little energy is available to process the excess protein, and the efficiency of utilization of protein is reduced resulting in considerable protein wastage and a slower growth rate.

In the other two broiler trials, the hypothesis tested was that an animal will at all times attempt to retain its inherent lipid:protein ratio. All birds made fat at the start of the experimental period, by giving them a low protein feed, had a much reduced fat content in their subsequent gain, providing that the protein content of the feed used was sufficiently high, indicating that they were making use of the excessive lipid reserves as an energy source. This information is of significance in the broiler and pig industries, in which the tendency is to offer a feed of a fixed protein content for a period of time before switching to a lower protein content in the feed. Invariably, the protein content chosen is initially inadequate in meeting the requirements of the animal, leading to overconsumption of energy, inefficient utilization of the food, and overfatness, but later provides more than sufficient dietary protein, thereby enabling the animal to draw on the excess fat reserves as an energy source, resulting in the efficient utilization of food in this period. The above theory has been an intrinsic part of the broiler growth simulation model from its inception, so by providing evidence to corroborate this hypothesis the value of the model and the predictions therefrom have been increased.

Three pig projects are reported in which the effect of different environmental temperatures on the performance and food intake of the animals was measured, when feeds differing in protein content or in threonine or lysine content were offered *ad libitum*. These experiments were conducted in controlled environment rooms, with pigs between 12 and 25 to 30 kg in weight. The efficiency of protein utilization increased with temperature but the response was dependent on the protein supply. It is concluded that on low protein diets pigs increase their food intake to maintain potential protein growth until a point is reached where the animal can no longer compensate and food intake will decline. The extent of the compensation will depend on the amount of heat the animal can lose which in turn is dependent on the environmental temperature. An understanding of the interactions between the animal, the food and the environment are crucial in ensuring that protein is efficiently utilized. It is imperative that nutritionists and producers are made aware of these interactions.

Simulation modelling of a system accomplishes the objectives of identifying areas of research that require attention, as well as integrating knowledge into a usable form. In the balanced feed industry, and in poultry production specifically, simulation modelling of food intake, egg output and growth is seen as a major link between research, development and production practice, being an ideal way of packaging dispersed pieces of knowledge into practical, usable, systems advice. One of the primary objectives of this project was to produce working simulation models of populations of laying hens, broilers and pigs such that it would be possible to integrate information about the animal, the food and the environment, thereby determining the effects on

food intake, egg production, growth rate, carcass composition and overall profitability of changes to the quality of food supplied to the animals. These models should assist resource planners in making decisions regarding the strategic use of protein sources in this sector of the economy. This is how I believe a contribution could be made towards the more effective and efficient use of protein sources in the poultry and pig industries in South Africa.