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FINAL REPORT FOR THE PRF OF RESEARCH WITH BROILER BREEDERS
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EXECUTIVE SUMMARY

This report takes the form of a number of scientific papers that have been written on the research that has been conducted for the PRF over a period of about six years. The overall objective of these trials has been to provide information that could be used to develop a simulation model of the reproductive performance of a flock of broiler breeders, and this model is part of the final report 'package'. Essentially, the project addressed issues that have not been adequately researched with broiler breeders in the past, with a view to developing and then improving the accuracy of the broiler breeder simulation model.

The report includes papers on the following:

1. **Meeting the energy and amino acid requirements of broiler breeder hens during the laying period: A review.**
This review outlined the state of knowledge of this subject at the start of the project. As a result of the information reviewed it became evident that there were many gaps in our knowledge that needed to be researched before a model could be developed. Similarly, as the development of the simulation model progressed, further topics for research were identified. This procedure proved successful in identifying areas for research.

2. **Changes in the feather-free body of broiler breeder hens after sexual maturity**
In order to simulate the changes that occur in the composition of the body of broiler breeders over the laying period a study was initiated that measured these changes in a flock of broiler breeders. It is the only study to date in which changes in feather content have been measured. The results strongly suggest that breeder hens do not deposit body protein once laying begins, thus there is no obligatory requirement for growth during the laying period.

3. **Modelling changes in component proportions over time in eggs from broiler breeders**
Even more important than the changes that occur in the body of the breeder, it is necessary to understand the changes that occur in the composition of eggs over time, and a study was initiated in which these changes in the eggs from the two most popular broiler strains in South Africa were measured. The results provide data from which the potential weight and composition of eggs can be determined with the use of equations that are specific to a given genotype. From this information the nutrient requirements for potential egg output from a hen can be calculated.

4. **Threonine and lysine requirements for maintenance in chickens**
The daily amounts of energy and amino acids required to enable a broiler breeder to reproduce at its potential can be calculated by summing the requirements for maintenance and for yolk and albumen production. The potential performance of the hen and her body protein content must be known or simulated, and the amounts of each amino acid required for maintenance and production must also be known. Very little research has been conducted on the maintenance requirements of birds so the paper on this topic is relevant and relatively unique.

5. **Utilisation of synthetic amino acids by broiler breeder hens**
Because broiler breeders consume their daily allowance in a short space of time, and because synthetic amino acids are more readily digested than are intact proteins, the amino acids

supplied in a synthetic form are absorbed and deaminated before the intact proteins appear in the blood stream, leading to amino acid deficiencies. By demonstrating this principle, this research indicates that the inclusion of synthetic amino acids should be kept to a minimum in broiler breeder feed.

6. Broiler breeders utilise body lipid as an energy source

As a result of broiler breeders being allocated a given amount of food each day as opposed to being allowed to eat *ad libitum* certain factors related to the storage and utilisation of lipid are important. It may be self evident that lipid stores are labile and available when the bird requires more energy than is provided, but it is necessary to demonstrate this, and this study provided the necessary evidence.

7. Energy partitioning at low temperatures in broiler breeders

Determining the amount of energy required for thermogenesis (keeping warm in cold conditions) is difficult. The method used in this trial, in which broiler breeders were subjected to a range of energy intakes and environmental temperatures, used the decline in egg output at low temperatures to calculate the amount of energy required to maintain a constant body temperature. The resultant coefficient is used for this purpose in the simulation model.

8. The effect on performance of modifying the composition of feed allocated to broiler breeders during the laying period

The objective of this study was to address the issue of determining the optimum economic feeding programme for broiler breeder hens. Although egg weights were reduced in treatments in which the energy content of the feed was consistently low and amino acid supply decreased over time, rate of lay was unaffected by any of the treatments. It may thus be possible to reduce the cost of feeding broiler breeders by reducing their daily energy intake over time, and adjusting the amino acid intake according to the level of egg production during the laying period.

9. Feed allocation and form influence feeding time in broiler breeders

Considerable differences were evident in the time taken by broiler breeders to consume their daily allocation of feed when this was given in either a mash or pelleted form, and when different daily quantities were allocated. To reduce the behaviours indicative of frustration, boredom and hunger, like stereotypic object pecking, mash feed would be preferred over pelleted feed and a greater feed allowance would also lengthen the time spent by broiler breeders at the feed trough. This is both a welfare and an economic issue, with maintenance requirements being increased the longer a bird spends at the feed trough.

10. Response of broiler breeders to a range of feed intakes and a reduction in intake over time

It is apparent from the results of this trial that Cobb broiler breeders do not need to be fed more than 160 g of a commercial breeder feed each day in order to reach their potential reproductive performance. The effect of feeding higher daily allocations is that egg size increases as does the body weight of the hens, neither of which is advantageous to the production process. Profitability of the enterprise is also reduced when more feed is offered without any increase in returns.

11. Simulation modelling for predicting responses in broiler breeder and laying hens

This paper summarises the workings of the broiler breeder model and provides information about the way in which such a model can be used to optimise the feeding of breeders. Optimising the feed and feeding programme for a flock of broiler breeders can be achieved with three components, namely, a feed formulation program, an egg production model and an optimisation routine. The optimiser defines nutritional constraints for practical breeder feeds, which are passed to the feed formulation program where the least-cost feed that meets these constraints is determined. The characteristics of this formulated feed are then passed, as input, to the breeder model. The performance expected from this feed when given to a defined flock of hens in a given environment is predicted by the model, and this predicted performance is then passed to the optimiser to complete the cycle. The next cycle starts with the optimiser modifying the feed specifications, moving, according to some in-built rules, to an optimum point. Both the composition of the food and the amount to be supplied may be altered during the laying period. The objective function to be maximised or minimised can be defined in terms of any output from the simulation model, but realistically would be an economic index of some sort. Because of the high value of the hatched chick in the case of broiler breeders the objective function would mostly be to maximise the number of eggs per hen.

12. Modelling egg production and nutrient responses in broiler breeder hens

This paper describes the basis of the broiler breeder model. The model simulates the response of a population of broiler breeders to a daily allowance of a feed of specified composition for up to 280 days from sexual maturity. The population is generated using normally distributed values for initial bodyweight, initial body lipid and protein weight, age at first egg, yolk weight constant, and 'aggressiveness', the latter producing different feed intakes around the controlled mean. Age at sexual maturity for each bird is predicted from bodyweight and from information about rearing lighting programmes. Egg production, clutch patterns, yolk weights, egg component weights, double-yolked eggs, internal laying and soft-shelled eggs are predicted. Body protein growth, including feathers, is assumed to cease at sexual maturity, thus bodyweight changes after maturity are due entirely to accumulation or utilization of lipid.

Energy transactions are expressed in units of effective energy. Protein required for egg production is calculated from the composition of the next egg to be laid and an assumed fixed chemical composition. Assumptions for protein partition rules are that maintenance has highest priority, yolk protein deposition second and albumen protein third. Provided that sufficient energy and nutrients are available, yolk protein deposition is assumed to occur continuously to meet the predicted growth rate, unless inter-clutch intervals exceed 2 days (user defined), when yolk growth ceases. Energy and nutrients (amino acids) for albumen production accumulate in a pool which has some controlling influence over ovulation. If the energy and nutrients in the albumen pool will support the predicted development of the next egg then ovulation will occur, otherwise ovulation is delayed until sufficient energy and nutrients are available. All events are timed within a 24 h day assuming that feeding is at one time in the morning.

The desired feed intake is calculated each day according to the supply of the first limiting energy or nutrient (invariably an amino acid) in relation to potential need. Actual feed intake is either the desired intake or the feed allowance, whichever is the lower. Account is taken of the additional energy required for thermogenesis, but not of the constraining effects of high temperature or the bulkiness of the food as a constraint to voluntary food intake.

Some shortcomings of the current model are discussed, these being areas suitable for further research on broiler breeder nutrition.

Also included in the Final Report is an installation disc which enables the broiler breeder model developed as part of this project to be installed on a PC or laptop computer.

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