What protein levels will maximise margin?

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Broiler compound feed prices have fluctuated over the last few months in part due to soya meal prices. Fig. 1 shows monthly soya bean prices for 2003 and 2004.

When raw material prices increase it is tempting to consider controlling the cost of the finished feed by reducing nutrient levels in the diet.

Protein is a major contributor to this cost. In this article we explore the effect of reducing protein levels to control feed cost on biological and financial performance.

Biological performance

The graph of results from a recent trial (see Fig. 2) demonstrates the effect of increasing protein levels (available amino acids) in the diet on Ross 308 male growth and FCR to 41 days of age.

The control treatment was formulated to meet the current Ross 308 recommendations, while the protein level in the other treatment was formulated to achieve 85% of the control diet.

The results from this latest trial are consistent with previous trials and field experience. In this article, protein refers to available amino acids and all trial diets were designed to provide different levels of balanced protein using the ideal amino acid profile as per the recommendations published in the Ross Broiler Manual

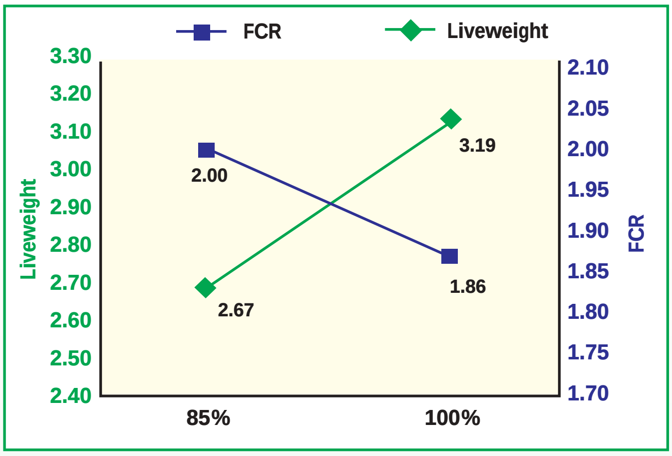

Fig. 2. Effect of increasing protein on liveweight and FCR (41 day males).

(2002). It can be clearly seen from this graph that bodyweight and FCR improve significantly as protein levels are increased.

However, a lower protein level in the diet will be cheaper, so the effect on the overall financial performance of the flock needs to be assessed. The following financial assessment has been based on the same trial data.

Financial performance

All calculations are based on Asian costs and revenues. The control diet will cost approximately $US248/ton; a 15% cut in the dietary protein level will save about $US14/ton (about 5%).

Fig. 3. summarises the impact of a lower protein concentration in the diet on margin (in $US per bird) after feed cost.

The calculations have been made based on both current and increased feed costs (+10%).

Within the protein ranges used in this trial the key points are:

- Reducing protein levels will reduce cost but also decrease margin due to lower biological performance.
- Reducing diet protein regardless of feed price will reduce margin.

The full calculations are given in Table 1.

Processing performance

A lower dietary protein will also affect white (breast) and dark (leg) meat yield. Using the same trial data Fig. 4 shows a significant reduction in white and dark meat yield when protein levels are reduced.

The effect of reduced protein on margin per bird for eviscerated carcase can be calculated and is shown in Fig 5. A lower dietary protein level will also reduce processing yield and margin.

It is clear that significant reductions in protein density have a negative impact on physical and financial performance.

However this does not answer the question 'What level of protein should be fed to maximise margin?'

Aviagen publish nutrient density recommendations for diets fed to broilers in the starter, grower and finisher period (Table 2), accompanied by the warning that the nutrient levels will need to be adjusted to maximise profitability under local conditions.

It is now widely accepted that the choice of dietary protein level is an economic decision to be made for each company or enterprise.

This idea replaces the concept that birds have characteristic 'requirements' which should be met under all conditions.

To identify the dietary amino acid levels that maximise margin for individual companies Aviagen have developed the Balanced Protein Calculator.

This calculator combines feed and revenue prices with broiler

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Fig. 1. Soya bean meal prices from July 2003 to July 2004. (Source: Feed Info.Com).

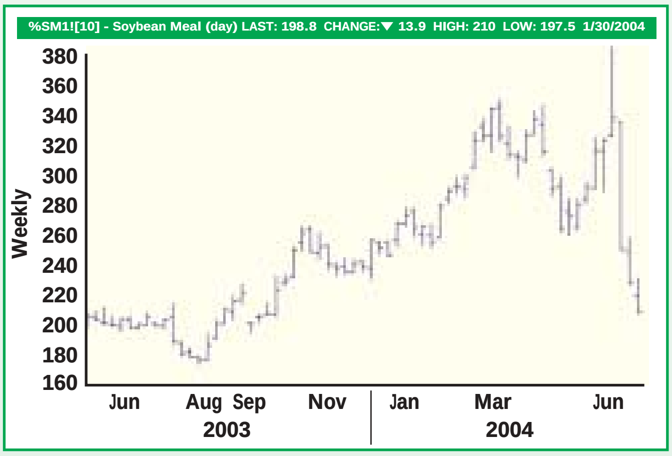
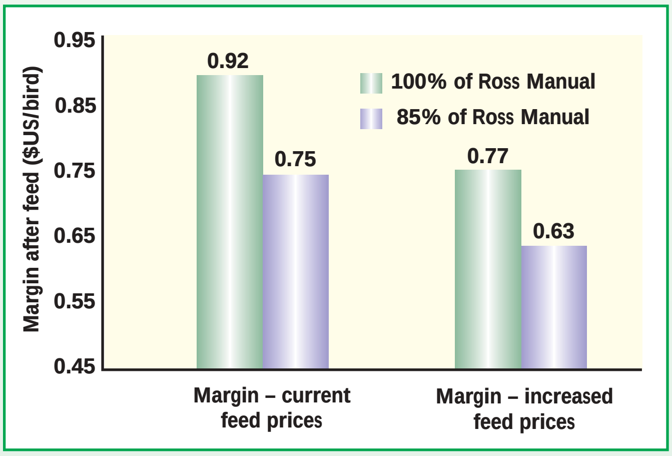


Fig. 3. Influence of increased feed prices (+10%) on farm margin at different protein levels for 41 day males.



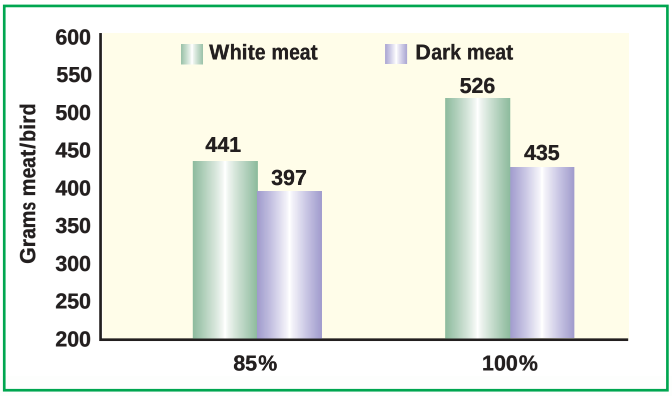


Fig. 4. The effect of reducing protein on white and dark meat (41 day males).

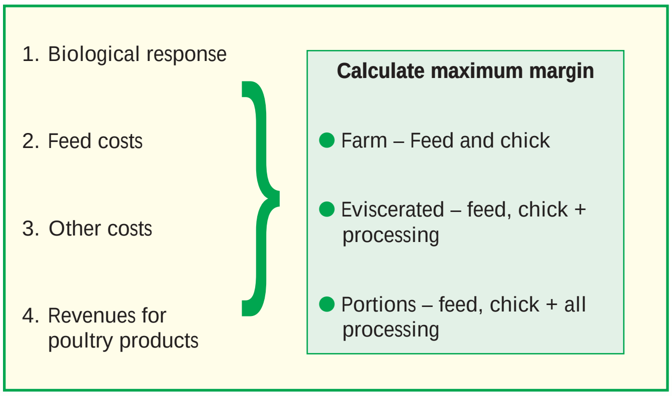


Fig. 6. A general scheme for calculating balanced protein levels to maximise profitability of broiler production.

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biological response data to establish what dietary amino acid level is maximising profit for different objectives, for example farm versus eviscerated carcase margin.

Balanced Protein Calculator

The calculation of an optimum balanced protein level involves several inputs (see Fig. 6). Feed cost at different protein levels is determined by conventional least cost feed formulation.

Other costs, of broiler rearing and processing are allocated appropriately. Broiler performance at each protein level is then determined from response curves established by experiment.

Finally, the revenue from production is calculated, taking account of different types of product and their value. These elements are then combined to calculate the profit for each level of balanced protein and the optimum is identified by examination.

Biological response data

The most important part of the Balanced Protein Calculator is the set of biological response data.

	85% of Ross Broiler Manual	100% of Ross Broiler Manual
Physical performance		
Liveweight (kg)	2.67	3.19
FCR (kg)	2.0	1.86
Feed consumed (kg)	5.34	5.93
Current financial performance		
Feed price ($/kg)	0.234	0.248
Feed cost ($/bird)	1.25	1.47
Revenue (0.75 US$/kg)	2.0	2.39
Margin current feed prices ($/bird)	**0.75**	**0.92**
Future		
Future feed price + 10% ($/kg)	0.257	0.273
Future feed cost ($/bird)	1.37	1.62
Margin future feed prices ($/bird)	**0.63**	**0.77**

Table 1. Calculation of farm financial performance.

	Starter	Grower	Finisher
Age fed (days)	0-10	11-28	29-end
Energy (Kcals)	3010	3175	3225
Digestible lysine (%)	1.27	1.08	0.88

Table 2. Ross 308 feed recommendations for as hatched broilers grown to 2.3-2.5kg liveweight at 42- 45 days.

The data is obtained by assessing the impact of protein levels in the diets on broiler performance.

Aviagen have evaluated the amino acid response of the Ross 308 broiler in an ongoing series of trials from 2002 to 2004.

In the experiments and in the calculator, sequences of feeds are used to feed the broilers.

The calculation of an optimum is made across all feeds and to facilitate this, balanced protein levels in each feed are expressed as a percentage of a standard.

The reference standard used is based on the current Ross Broiler Manual and is shown for digestible lysine in Table 2.

The approach taken is therefore restricted to constant relative protein levels across all feeds.

In the experiments and calculator energy levels were maintained at Ross recommended levels.

● **Trial procedures.**
Trial diets were designed to provide different levels of balanced protein using the ideal amino acid profile as published in the Ross Broiler Manual. Across all trials protein levels varied from 70 to 120% of the standard used and in all treatments the same relative level was used in the starter, grower and finisher phases.

Feeds were largely wheat based and formulated from ingredients available in a commercial feed mill using a high quality commercial database to describe ingredient compositions.

Birds were removed at 32 and 46 days for processing and determination of body composition.

Observations of liveweight, eviscerated carcase weight, breast, thigh, drum meat weight and wing portion weight and abdominal fat pad were made (see Table 3).

● **Calculating bird response.**
All trials included birds fed

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Fig. 5. The effect of reduced protein density on eviscerated margin (per bird after feed) for 41 day males.

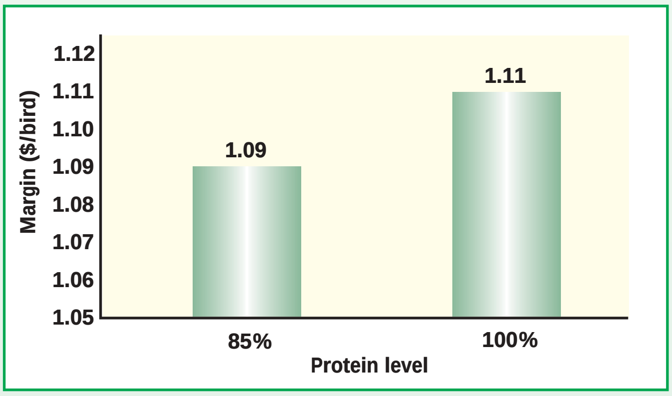
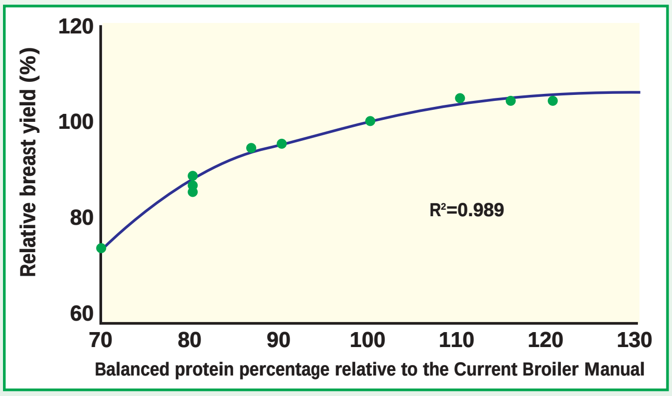


Fig. 7. Example of a breast meat response curve for 3kg males.



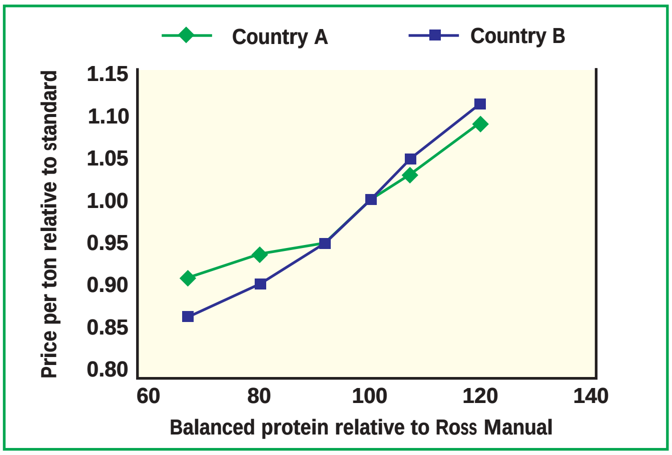


Fig. 8. Relative feed costs for 2kg broilers at different relative protein levels. Ingredient costs for two countries (2004). Costs for starter, grower and finisher feeds were weighted according to standard proportional feed intakes.

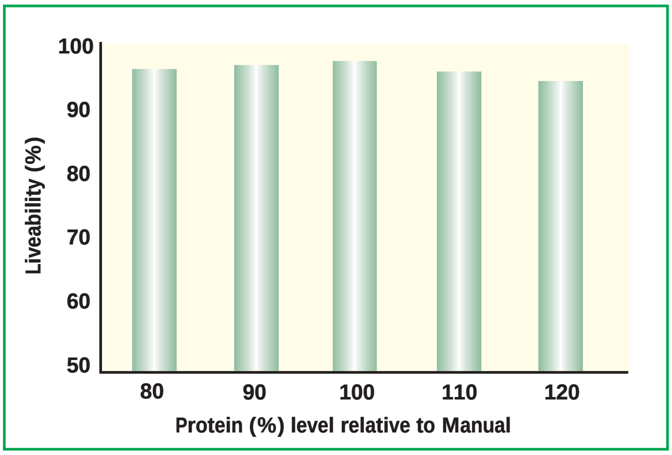


Fig. 10. The liveability of Ross as hatched birds over increased levels of protein.

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according to the Ross Broiler Manual (2002) – treatment 100%.

To combine the data from different trials all data were expressed relative to this treatment for the definition of bird response to protein.

Response trait
Age
FCR
Mortality
Thigh meat
Drum meat
Thigh portion (including bone)
Drum portion (including bone)
Breast meat fillet
Wing

Table 3. A list of response traits used in the Protein calculator.

Slaughter weights of 1.7, 2.0, 2.5 and 3.0kg for males and females separately were considered in the analysis. In total 72 responses have been identified.

Fig. 7 is an example of a response curve

Additional response curves for abdominal fat have been established, downgrades can be customised to represent actual levels.

Calculating feed cost

Feed costs were calculated at different balanced protein levels by linear programming. Diets will vary depending on the ingredients available, their qualities and price and also on the range of nutrient and ingredient constraints that the nutritionist chooses to use.

An example of relative feed ingredient costs for two countries in 2004 is shown in Fig. 8. The slope of this relationship has a very critical effect on this choice of optimum protein level.

Other costs

The following costs are also used in the calculator:

- Day old chick cost – takes into account all breeder, hatchery and transport costs.
- Fixed overheads per broiler – these are costs incurred on the farm excluding feed cost.
- Processing cost – costs incurred in the processing plant. Primary processing cost relates to the cost of processing an eviscerated carcase and further processing to the production of portions.

Revenue to the enterprise

The calculation of profit requires data for determining income of various kinds accruing to the enterprise. Income is calculated by the value of live birds (per kg), eviscerated carcase (per kg) and value of portions (per kg).

Optimum amino acid level

The various data discussed above are combined in a spreadsheet.

The output from the calculation is a plot of profit against relative protein level, an example of which is shown in Fig. 9 as an illustration of the method.

Feed cost data were based on ingredient prices in Asia for 70, 80, 90, 100, 110, 120 and 130% protein levels. Revenue was valued at $US0.75per kg live weight, $1.25 per kg eviscerated carcase and $1.90 per kg breast meat and $3.00 per kg leg portion.

Estimated chick cost, broiler grower overheads and processing costs for the Asian industry were constant for all protein levels. In this analysis the effect of protein level on production cycle and economic consequences were ignored.

The optimum amino acid level to maximise profit was also identified for eviscerated carcase and processed portions. Table 4 summarises this data for males, females and as hatched grown to 3kg.

As expected, the results show that the most profitable level of protein increases as additional sources of revenue are brought into consideration, for example the optimal amino acid density for males is 101% for farm margin increasing to 111% for portions margin. Males are more responsive than females in this respect.

The magnitude of change depends on the detailed responses of individual components to

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Fig. 9. Farm margin (after feed) for 3kg males and females. An example of the output from the calculation of optimum protein levels using the calculator. Revenue is determined on a live weight basis only.

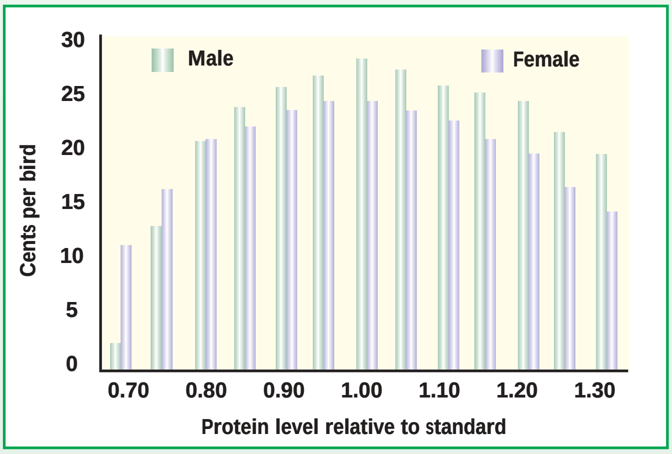
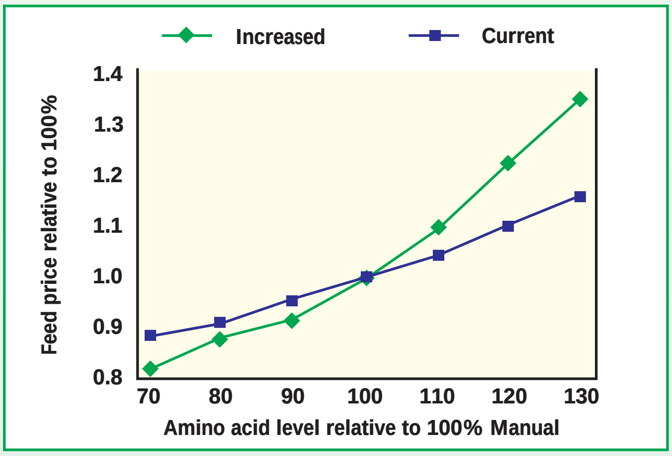


Fig. 11. Relative feed price changes – current compared to increased.



Margin (3kg)	F	M	A/H
Farm	90	101	96
Eviscerated carcase	93	110	102
Portions	95	111	103

Table 4. Optimal amino acid density (%) for males, females and A/H 3kg broilers – based on Asian costs and revenues prices.

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changes in protein level at different slaughter weights.

However, a widespread conclusion may be that feeding decisions based on revenues at the farm gate will lead to lower levels of protein being used than when processing is taken into account.

An additional factor influencing this economic response is the high liveability experienced with Ross broilers. Increasing diet nutrient density will increase growth rate and live weight for age.

The Aviagen pedigree selection process has minimised the incidence of metabolic related diseases even at high growth rates, hence feeding higher levels of nutrients to the Ross bird will not compromise liveability.

Fig. 10 shows the liveability of Ross as hatched birds to increased levels of protein.

It is clear that feeding the Ross bird for optimal performance does not compromise the welfare of the bird as defined by liveability.

The calculator can also be used to explore what other factors will affect optimal amino acid density.

● **Protein raw material price increase.**

Table 5. Optimal amino acid density (%) for 3kg males.

Margin	Current protein raw material price	Increased protein raw material price
Farm	101	91
Eviscerated carcase	110	97
Portion	111	100

Margin	1.7kg	2.5kg	3.0kg
Farm	96	96	96
Eviscerated carcase	97	99	102
Portion	98	102	103

Table 6. The optimal amino acid density (%) for as hatched.

Optimal amino acid density will change if the cost of balanced proteins increases. This situation is likely to arise if the price of any of the protein raw materials increases, for example soybean meal and fishmeal.

If alternative protein sources are limited then the situation is likely to be exaggerated.

Fig. 11 shows relative feed price changes based on current versus increased protein prices.

When protein prices increase it will cost more to achieve a higher level of amino acids in the diet and Table 5 shows the sensitivity of increased protein prices on optimal amino acid density.

● **Change in factory liveweight.** Feed and protein prices are not the only influence on optimal amino acid density. A change in kill weight will impact on the optimal amino acid density.

In the example shown in Table 6 the optimal amino acid density for farm margin remains unchanged.

As kill weight increases the potential for breast and portion growth increases hence optimal amino acid density for eviscerated carcase and portion margin increases as kill weight increases.

● **Revenue price changes.** As revenue price changes the optimal amino acid density remains the same for farm margin but changes for eviscerated carcase and portions margin.

Table 7 shows the optimal amino acid density when Asian revenue prices are increased or decreased by 20%.

Optimal amino acid density increases and decreases when revenue prices increase and decrease.

● **Relative revenue price change.** The price of white meat relative to dark meat is different in different regions and is subject to change.

Table 8 shows the optimal amino acid density when white meat price is increased by 100% relative to dark meat. The optimal amino acid density is sensitive to relative changes in white and dark meat revenue prices.

Margin	-20%	100%	+20%
Farm	96	96	96
Eviscerated carcase	98	102	106
Portion	100	103	106

Table 7. Optimal amino acid density (%) for 3kg as hatched.

Summary

● Aviagen have collated a unique set of biological response data showing how the Ross broiler responds to inputs of balanced amino acids.

● This biological response data is the backbone of the Aviagen Protein Calculator.

● The Aviagen Protein Calculator combines biological response data with feed and revenue prices to identify the optimal dietary amino acid level maximising farm, eviscerated and portions margin.

● The optimal amino acid density is dependant on the objectives of the organisation.

● Maximum margins in deboning companies will be achieved when higher levels of dietary amino acids are fed; while maximum farm margins are achieved on lower levels of dietary amino acids.

● The excellent liveability of the Ross broiler allows profitability to be maximised without compromising welfare. ■

Table 8. Optimal amino acid density (%) for 3kg males as breast meat price increases.

	Breast meat revenue	
Margin	Current	Increased
Farm margin	101	101
Eviscerated carcase	110	110
Portion margin	111	115