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CALCULATION OF ECONOMIC VALUES FOR TURKEY BREEDING USING A PRODUCTION MODEL

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SUMMARY
This paper describes the development of an economic model and the use of that model to calculate economic values for vertically integrated turkey production in North America. The nature of vertically integrated production required an objective that was balanced across parent stock (egg production, fertility and hatchability), commercial production (bodyweight, feed intake, and mortality) and processing (yield traits). Feed intake, bodyweight and breast meat yield had large economic weights relative to other traits reflecting the importance of feed costs and breast meat as the major revenue source. Less important traits in the breeding objective were mortality, processing plant condemnations and the reproductive traits. Level of production was important when considering the reproductive traits, and as egg production decreased, the economic value of the reproductive traits rose substantially.

INTRODUCTION
The poultry industries and the turkey industry in particular, have become increasingly consolidated with large, vertically integrated companies dominating production especially in the area of the further processed carcass. The genetic package supplied (i.e. male and female parent stock lines together) must meet the requirement of those large integrated companies. Determining the economic value of a trait is not a trivial matter and is dependant on production circumstance, particularly the mean production for some traits. Economic values have been calculated for turkeys (Pasternak *et al.* 1986) but considered growth to a fixed weight (similar to broiler chickens) using European/British cost structures. The aim was to use an economic model to calculate economic values for turkey production relevant to a North American integrated company and to access the sensitivity of those values to production level (egg production) and input costs.

MATERIALS AND METHODS
Economic model. The economic model used has been outlined previously (Wood and Buddiger 2006) and followed the basic chicken broiler model as described by Groen *et al.* (1998). The structure of an integrated turkey company is shown in Figure 1 with the major input parameters shown for each level of the production chain. While the structure of the industry is similar, the broiler model was improved to better describe aspects of turkey breeding and commercial production that weren't adequately contained in the chicken model. In particular, practices such as growing to heavier weights at the same age (as compared to same weight at earlier ages) and phenotypic weight selection within parent stock flocks. The selected percentage was calculated as the number of parent stock used for poult production from an initial placement of parent stock. Selection in toms was assumed to be at the industry average of 50% while no selection was used in the hens with losses of placed poults due only to normal rearing mortality. Maximum housing densities were included with

housing and labour costs described in terms of cost per unit area to better reflect the practice of growing to heavier weights for age and to account for a decreased capacity with heavier weights. This increases the housing and labour cost on a per bird basis. The sexual dimorphism required separate modelling of each sex, and consequently, separate economic value calculations for commercial toms and hens. Scaling between production segments was used to account for the differences in expression of traits with scaling from multiplier breeder to commercial production the production of one poult, commercial to processing the production of a unit of live weight, and the further processed product back to this same unit of live weight at the plant. Consequently, economic values where expressed in $/ kg live weight delivered.

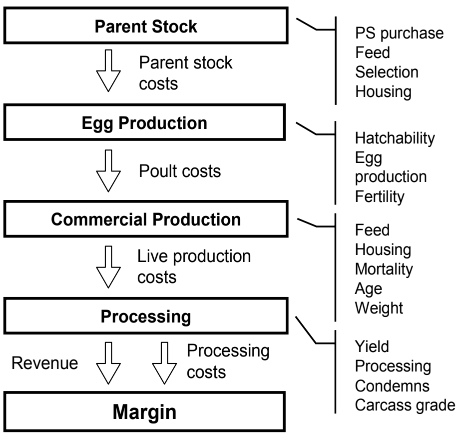

Figure 1 Integrated company structure and significant inputs

Model parameters. Base values for parent stock and commercial production are shown in Table 1. Parent stock egg production was assumed to occur over a 26 week period. Investment in breeding stock and egg production was considered an opportunity cost and was determined using an interest rate of 7%. A portion of the investment in breeding stock is recovered in sale of unselected breeder toms and spent breeder hens at the end of lay. The turn around time between commercial flocks for the calculation of housing expenses was assumed to be 14 days. Base carcass composition and the value of each component of the carcass are shown in $US in Table 2.

Economic values. Economic values were calculated as the difference in gross margin after a shift of 1 unit for each trait, with other traits constant. These were calculated for parent stock reproductive traits and the traits body weight at a fixed age (20 weeks), feed intake, breast meat yield, condemnation, and early and late mortality.

Table 1 Management, reproductive and commercial production parameters.

Parent Stock	Unit	ML[a]	FL[a]	Commercial	Unit	Tom	Hen
Selection percentage	%	50	93	Housing	$/m^2	14.00	14.00
Selection age	days	140	140	Labour	$/m^2	7.00	7.00
Male/female ratio	ratio	1:18		Feed price	$/kg	0.18	0.18
Number of inseminations	AI/bird	26		Feed intake	kg	51.4	30.0
Insemination cost	$	0.15		Density	kg/m^2	53.7	43.9
Egg production	eggs	110		Slaughter weight	kg	19.4	11.2
Egg fertility	%	90.0		Slaughter age	days	140	126
Egg hatchability	%	90.0		Early mortality	%	3.0	1.5
Hatch & sexing	$	0.09		Late mortality	%	14.0	8.0
Sex ratio progeny	ratio	50:50		Condemns	%	2.5	1.5

[a] ML = male line parent stock, FL = female line parent stock

Table 2 Carcass yield (as a % of live weight) and the value of each carcass component.

	Yield (%)		Value ($/kg)
	Toms	Hens	Toms and Hens
Breast	28.25	28.59	3.30
Thigh	12.00	11.60	1.70
Wing	9.49	9.70	0.90
Drum	7.69	8.73	1.00
Rack	18.1	18.5	0.20
Giblets	3.89	3.75	0.25

RESULTS AND DISCUSSION

Calculated economic values are shown in Table 3. Parent stock level economic values for traits such as mortality and feed intake were not of a significant size due to the high fecundity. Even at low mean egg production levels the economic values were still small. Similarly, traits such as giblet yield in the commercial product did not have a significant value. The relatively large impact that body weight, breast meat yield and commercial feed consumption has on margin in returns and costs, respectively, means that they all have a relatively large economic value compared to the other traits. The reproductive traits had a significant but relatively smaller value economic value compared with feed, weight and yield. To examine the sensitivity of the economic value of egg production to mean production, a range from 70 to 140 eggs produced per lay period was modelled with Figure 2 showing the sensitivity to mean number of eggs produced over a 26 week lay. The exponential increase in economic value represents the increasing egg cost, and subsequently live poult cost.

Table 3 Economic value ($US) per live kg delivered to the processing plant for an integrated turkey company.

	Units	Economic Value	
Multiplier breeder			
Egg production	$/egg	0.0005	
Egg fertility	$/%	0.0007	
Hatch of fertile	$/%	0.0007	
Commercial production		Tom	Hen
Finishing weight	$/kg	0.0139	0.0244
Feed Intake	$/kg	-0.0050	-0.0084
Early mortality	$/%	-0.0020	-0.0011
Late mortality	$/%	-0.0027	-0.0028
Processing plant			
Breast meat yield	$/%	0.0165	0.0165
Thigh meat yield	$/%	0.0085	0.0085
Wing meat yield	$/%	0.0045	0.0045
Drum meat yield	$/%	0.0050	0.0050
Condemnations	$/%	-0.0039	-0.0041

It is difficult to compare the economic values directly with those calculated previously by Pasternak *et al.* (1986) because both the level of production and final product differ significantly between the two studies. The previous study considered production of a whole bird to a set weight compared to this study with production of a turkey for further processing. The level of assumed production, for example growing toms to 14.6 kg in 23 weeks compared with 19.4 kg in 20 weeks, also has the ability to alter the relative economic values decreasing the value of growth relative to a similar egg production in the current study. Other values such as table egg value have no meaning or value in the North American turkey industry.

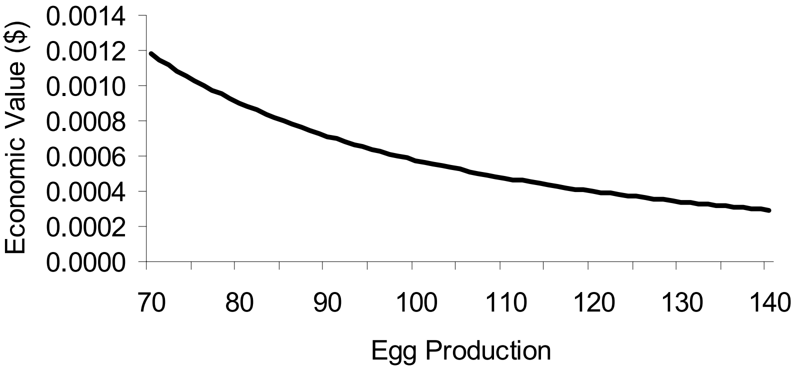

Figure 2 Sensitivity of the economic value of egg production to mean production level

CONCLUSION

Feed intake, body weight and breast meat yield have a major impact on the profitability of integrated turkey production and consequently have relatively large economic values on which to base index selection upon. Of lesser value but still significant are the reproductive traits expressed in the breeder flocks and mortality expressed in the commercial flock. The economic values show the clear trend in the industry towards growing turkeys to increasingly heavier weights for further processing. The significant value of reproductive traits, particularly egg number, shows that a turkey selection goal must include some level of selection pressure on reproduction and that this increases with falling mean performance. With four way cross-breeding, the challenge is to translate the economic value at the commercial and parent stock levels into separate breeding objectives for pure lines whose genetics constitute one half of the breeding stock or one quarter of the commercial bird.

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