The modern poultry yield (r)evolution

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On the surface, the global chicken industry is a conservative, slow moving, commodity business with little innovation or imagination. After all, how creative can you be growing and processing chickens for meat?

A closer look reveals a complex and challenging industry whose successful application of science (health, management, nutrition and genetics) to business has led to astounding changes in the final product.

In the 1950s it took 90 days to grow a 4lb (1.8kg) broiler that converted feed at 3.60 and exhibited about a 12% breast meat yield. Today a 4lb (1.8kg) broiler is less than 39 days old, eats less than half the feed of its ancestor, and exhibits 19% breast meat yield (Agri Stats data).

These changes are a direct result of the evolution of the final product from a live bird, to a carcase, to bone-in parts, to de-boned meat, and now to sized, cooked, marinated, battered, and seasoned product. As the final product has changed, the relative importance and even the definition of yield have changed as well.

The definition of yield varies regionally and is dependent on the market structure and product mix of the different world markets. For instance, yield in the US typically refers to white meat content, especially to a 100% de-boning operation. However, to a fast food plant doing an eight or nine piece cut-up, yield refers to carcase yield. Alternatively, in a fast food plant which does 'portion-control' de-boning, yield can be defined as the percentage of the fillets which fall into a certain size and shape category. In Asian markets, dark meat yield is more important than white meat yield to those producing for the domestic market, yet for integrations that are exporting to Europe, white meat yield is the driver.

In the non-integrated markets, where typically the final product is sold as a live chicken, yield is measured as the number of baby chicks per hen.

Feed price ($)	Bird weight 1.8kg (%)	2.3kg (%)	2.7kg (%)
125	44	48	51
150	49	53	56
175	52	57	60
200	56	60	63
225	59	63	66
250	61	65	68

Table 2. The relative impact of feed price on live cost as a function of bird weight.

Extremes of the poultry market

Table 1 lists the available wholesale prices for the various carcase components for a few selected countries.

At the two extremes is the US market where boneless, skinless breast meat is more than twice as expensive as boneless, skinless leg meat (and 3-6 times that of leg quarters) as opposed to Japan where the leg meat is 2.5 times more expensive. The gaps in Table 1 are a measure of the difficulty of getting accurate prices worldwide.

As the final product has evolved, so have the traits of economic importance. The importance of yield in particular has changed from a non-factor to a primary driver.

The term 'further processing' used to refer to cutting up the chicken into parts (in some countries it still does). Further processing subsequently evolved to define operations that were taking meat off the bone and now, more often than not, refers to prepared food plants. Today's further processing plants are de-boning, portioning, battering, marinating, seasoning, cooking, freezing, custom labelling and packaging.

Primary breeders have used a variety of methods to improve the white meat yield in their pedigree lines. These range from the simple (hand scores) to the sophisticated (ultrasound). We have even run Computed Axial Tomography (CAT) scans on chickens through a local hospital (the doctors loved it, but it was a bit messy, not to mention expensive).

One of the pioneers in yield designed and utilised a breast gauge which measured the breast meat angle at the tip of the front of the keel. Measured in degrees, it was an effective tool for increasing the width of the breast on the front end. A high yield line in the early 1990s would have an average breast angle of around 130°.

The breast gauge was an effective tool for improving yield (with a correlation of approximately 0.25) but is now essentially useless in yield lines as you can no longer feel the tip of the keel and the meat in the front is essentially flat (180°).

One of the consequences of using a breast gauge as a selection tool was to shorten the long bones, resulting in a compact frame with relatively small wings. It also accentuated the natural 'heart' shape of the breast as it only enhanced yield at the front of the keel and did nothing to the back end.

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Table 1. Available wholesale prices for chosen countries (US$/kg).

Country	Live bird	Carcase	De-boned breast	Breast	De-boned legs	Leg quarters	Legs
Australia		1.93	5.60	3.24			
Canada	1.04	2.18		3.39		1.17	
China	1.15	1.64					
India		1.96	3.45	1.73	2.30	2.53	1.73
Japan			1.97		4.97		3.23
Mexico	1.75	1.88	2.65			1.56	
Philippines	1.07	1.23		1.39			
Russia		1.81	3.24			1.84	
Saudi Arabia		1.23					
Thailand	0.77		1.31	1.04			
UK		2.21	4.29				
USA	0.76	1.24	3.35	1.92	1.61	0.56	0.89

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To address the long bone issue, some breeders utilised a tool that measured the keel length. This was a modified caliper that could be easily manipulated during the selection process to give an empirical measure of the length of the keel. The correlation between keel length and white meat yield is approximately 0.20.

That correlation has now dropped significantly due to changes in the width of the breast.

More sophisticated methods for improving yield include the use of ultrasound and the actual measurement of siblings for carcase and white meat yield (the CAT scan was great but unrealistic from a cost and process point of view).

Feed Price (US$/MT)	Breast meat price (US$/kg) 1.50	2.00	2.50	3.00	3.50	4.00
100% DE-BONED						
$100	10	15	19	24	30	35
$150	6	10	13	16	20	23
$200	5	7	10	12	15	17
$250	4	6	8	10	12	14
$300	3	5	7	8	10	12
25% DE-BONED						
$100	2.4	3.6	4.9	6.1	7.4	8.6
$150	1.6	2.4	3.2	4.1	4.9	5.8
$200	1.2	1.8	2.4	3.1	3.7	4.3
$250	1.0	1.5	1.9	2.5	3.0	3.5
$300	0.8	1.2	1.6	2.0	2.5	2.9

Table 3. The number of points of feed conversion it takes to offset a 1% advantage in breast meat yield as a function of feed price, breast meat price and the percent de-boned.

The siblings' data are attached to pedigree candidates and through sophisticated statistical packages such as BLUP (Best Linear Unbiased Predictor), genetic breeding value estimates are utilised to identify the elites.

The advantage of ultrasound is that you can take an actual reading on the individual, whereas this is obviously impossible when taking a direct measure of yield. As it turns out, the most rational (in terms of process) and effective way for increasing white meat yield, in my view, is also the simplest – a trained hand. The breeding companies that have developed high yield products have recognised that breast conformation is a highly heritable trait, much higher than previously thought. Some also recognised that the most efficient way to increase yield was to bring the meat back on the keel (looking more like a brick than a heart), and to increase the thickness of the meat.

The result of this simple selection methodology, coupled with decades of chicken handling experience, have produced lines in which some individuals exhibit 33% de-boned breast meat to live weight and this is on a dry yield basis! The US industry average is around 20% after going through a chiller.

In a survey of US chicken integrators, 92% of the respondents felt that the prepared foods (fully cooked and boneless) segments would be the driving forces for growth in the next year.

The main drivers behind this growth are food service, new products, convenience and health aspects.

While this is a US based view, the overall direction of the global industry will most likely follow this path, especially for those countries that export to Europe and avian influenza has restricted

	Weight	WOG	DB	BL	BW1	BW2	BT1	BT2	Surface	Vol.
Weight	1									
WOG	0.01	1								
%DB	0.13	0.58	1							
Blength	0.44	-0.01	0.03	1						
BWidth1	0.48	0.13	0.32	0.27	1					
BWidth2	0.57	0.17	0.36	0.27	0.74	1				
BThick1	0.34	0.35	0.66	-0.2	0.13	0.22	1			
BThick2	0.14	0.31	0.56	-0.2	-0	0.04	0.71	1		
Surface	0.62	0.11	0.11	0.75	0.79	0.79	0.02	-0.1	1	
Volume	0.63	0.23	0.35	0.35	0.6	0.65	0.71	0.62	0.65	1

Weight = body weight, WOG = carcase weight, % DB = % de-boned breast to live weight, Blength = breast length, BWidth1 = breast width at widest point, BWidth2 = breast width at narrowest point, BThick1 = breast thickness at thickest point, BThick2 = breast thickness at thinnest point, Surface = estimated surface area, Volume = estimated volume.

Table 4. Correlations between performance traits and breast fillet dimensions.

the export of their uncooked product. This increase in prepared foods is also intensifying the impact of the final consumer's concerns about animal welfare, the use of antibiotics and the sanitary status of the product on the US integrations (for example salmonella, campylobacter).

As the consumer questions the fast food and supermarket industry about these issues, they, in turn, are auditing their suppliers. While these concerns are firmly in place in Europe, they are becoming increasingly important worldwide. The change in breast meat shape and thickness is becoming more important as the industry moves toward prepared foods.

Before and after – the changing side view of a breast fillet.

Fast food restaurants have templates that specify a desired breast meat shape and size that command a premium price. The specifications also include tolerances for thickness and weight.

At the National Chicken Council's annual marketing seminar in the USA, all three speakers from the restaurant sector cited the increasing bird size as a major challenge. As most of these customers prefer a natural fillet, their specifications lend themselves toward a small chicken (3.3-4.5lb/1.5-2.0kg).

Similarly, they prefer tenders between 29 and 43g which, at an average of 3.6% of body weight, again works out to be a 4.5lb/2.0kg broiler. As growing a small bird is about 40% more costly per pound/kg than growing a big bird (>6.0lb/2.7kg), and the price premium for the smaller fillets is only about 10%, most integrators with this product mix want to grow big birds and utilise processing technology to maximise the number of premium cuts per fillet.

In many cases, the limiting factor is the thickness at the back end of the fillet. A side view of a typical fillet reveals a thick front that tapers off towards the back (see photo).

The width of the breast also tends to lessen toward the back, although this has been greatly reduced in some breeds through selection. This variation in thickness poses problems for a cooking plant because the meat will either be overcooked and unpalatable or undercooked and unsafe (see photos overleaf).

It is relatively easy to build a compara-

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tive economic model that evaluates the live performance and yield characteristics of different breeds. The major factors driving these models are the price of feed, the product mix (live bird, tray pack, fast food, percentage de-boned, etc) and the relative price of the various components of the bird.

Table 2 depicts the percentage of the cost represented by feed as a function of bird weight.

Table 3 depicts the numbers of points of feed conversion it takes to offset a 1% white meat yield advantage as a function of feed price, breast meat price and the percent of the product that is de-boned.

The changing breast shape and conformation.

Clearly the impact of the market prices drives the economics of the importance of yield (white or dark meat) as compared to the importance of live performance.

It is not so easy to build an economic model reflecting the increasing importance of prepared foods in the industry. New factors to add to the model on the cost side include the effect of the second processing (equipment and ingredients) the level of cooking loss, marinating and batter uptake, and the uniformity of breast shape, breast size and breast thickness, that is the number of premium cuts per fillet and/or the percent trim.

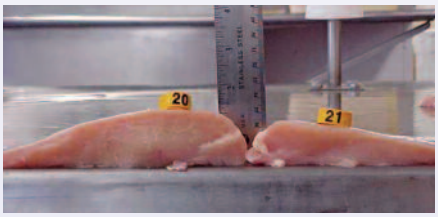
The value of the breast can no longer be looked at as a set price, as the value of the prime cut, the top of the fillet with the appropriate weight and dimension, can be worth more than 2-3 times that of the trim.

Also, none of the customers is looking for exactly the same cut or pay the same prices, so the flexibility of the model has to be custom tailored to the customer base of the integrator. The addition of new products (about 250 last year in the US) further complicates the model.

Table 4 depicts the relationships between various breast meat measurements and body weight, carcase weight and de-boned white meat yield.

An understanding of these relationships, how they translate into value for the integrator and the impact of breed is mandatory when processed food is the final product. One striking number is the negligible impact length has on de-boned yield ($R2 = 0.03$).

This means that less than 1% of the variation in white meat yield is attributable to fillet length. This is a direct result of the changing dimensions of the breast in terms of width and thickness.



Variation in thickness.

In the late 1980s, one breeder recognised that the traditional 'one size fits all' approach to breeding was outdated and that the growing importance of breast meat justified a separate product with optimum yield. Although the industry was sceptical at first (especially the competition), all of today's breeders now offer multiple products for the various segments of the market.

The further development of the prepared foods segment, with all its complicating factors, in my view, will require even further specialisation of genetic products, resulting in maybe even proprietary products.

Clearly, there will be an increasing need for a much closer relationship between the integrator and the breeder to optimise the profit in the evolving and complex further processed segment. ■