

## Views from the Poultry Breeding Industry.

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### Introduction

Over the past 50 years the broiler industry has grown significantly in the US as the demand for broilers and broiler meat grew at around 5% annually to the current 90+ lbs/ capita. The pattern of consumption has changed as consumer preference is for ready to heat or ready to eat products. Whole bird sales are now less than 8%. Traditional hamburger fast-food outlets now sell more chicken products than beef. Healthy, low fat, value for money, flexible, choice of products, and no religious bias, are all part of the success of the broiler business. But none of this would have taken place without the biological ability to provide the numbers of broiler chicks necessary, the feed needed to fuel growth, and the continuously improving growing and processing facilities. Consolidation of processors( Tyson, Pilgrim and Perdue control 60%) has led to consolidation of Primary Breeder companies. Currently there are 4 broiler primary breeders supplying 98% of the US and 80% of the world. Egg layer primary breeders and turkeys are in a similar situation.

Table 1. Poultry companies and Products

Company	Owner	Products					US %
Aviagen	Wesjohann	Ross,AA, IR broilers	Hyline Egg layers	Nicholas Turkeys	BUT Turkeys	Hyvac	30:70
CVI	Tyson	Cobb, Vantress broilers					50:20
Hubbard	Grimaud	Hubbard broilers					10:1
Heritage	Perdue	Heritage broilers					9:8
Pureline	?	Pureline broilers					?
Case	Case						?
Hybro				Hybrid			?

## ***Gallus Gallus domesticus* advantages**

There are some species advantages shown by broilers that are not demonstrated at all or at a lesser level in quadrupeds that have impacted genetic improvement both directly and indirectly.

- Large effective population sizes,  $N_s = 180 - 360$  depending on line and multiplication supply needs
- One sire pedigree pen is 6'x8'
- Fecundity- one female can produce 40 to 50 progeny to 45 weeks age
- Generation intervals are between 35 and 50 weeks of age depending on role
- The need to include egg production extends the female line intervals
- Eggs- stratification and disease control
- G/E evaluations
- Phenotype manipulation- broilerization, restriction of mature size
- Magnitude of heterosis- up to 30% in some 2 way crosses
- Magnitude of specialization – think of egg-layers vs broilers
  - Egg-layers laying 266 eggs in 280 days but will only weigh 2 lbs at 50 days
  - Broilers weighing 5.75 lbs at 50 days but only laying 110 eggs in 280 days (150 eggs with modified phenotypes).
  - And within broiler lines Table 2 demonstrates the range in the 4 main lines in the Heritage program.

**Table 2: Heritage Pureline and Crossbred Performance**

Line	Grow-out to 60 days					Reproductive Performance 25 to 60 weeks				Female Parent Equivalents
	Livability %	Livewt	afcr	% yield	%db m/ livewt	HEP	Hatch %	chix	Usable chix	
<sup>a</sup> Bro male	87.9	9.11 lb 68.9g/d	2.024	72	23.41	85	65	55	23	9.13 mil
<sup>a</sup> Roa male	90.2	8.36 lb 63.3g/d	1.950	74	26.27	80	60	49	21	11.16 mil
Roa fem	91.3	7.38 lb 55.8g/d	2.134	71.7	24.25	120	78	94	38	6.56 mil
Roa fem	91.7	7.85 lb 59.4g/d	2.092	72	24.04	110	75	82	35	7.12 mil
<sup>b</sup> PS cross	92.9	8.14 lb 61.6g/d	2.020	71.9	24.06	145	82	118	116	4.75 mil
Roa cross	96.5	8.00 lb 60.5g/d	1.940	72	23.5					

<sup>a</sup>Bro and Roa are parental lines

<sup>b</sup>PS-Parental line cross

## **Specialization**

It is possible to group lines by function, male or sire lines and female or dam lines. In the Heritage program our 2 male lines are significantly faster growing (52/53 days to 8.00 lbs for the broiler line and 57/58 days for the roaster line.) Egg production is neither recorded nor included in the selection process so all intensity goes to growth, yield and fcr (residual feed consumption). If egg production is decreasing over time then we will simply place more GP flocks. The only commercially important reproductive trait is fertility at the PS level and manipulation of the phenotypes containing any correlated genetic trends. Chick production in these male lines (28-60 weeks of age) averages 49 to 55 cph. Provided the growth traits are improving, egg production will not become critical until selection intensities are reduced.

In the female lines reproductive traits are 30-40 eggs per hen higher or about 40-50% more. Livability is better but growth rate is slower and feed conversion rate is poorer. Historically about 50% of the selection intensity went to egg production and 50% to growth and yield. Selection for fcr(residual feed consumption) was not included until 4 years ago after we reached our egg production target of 160.

Going forward we expect the differences between the male lines and female lines to broaden since generally speaking heritabilities are maintained at much the same rate as before. We are moving to a continuous or overlapping generation procedure with 9 mating units regenerating annually (54 weeks). This suits our *Salmonella* eradication initiative and spreads the program to minimize risk.

The picture in the other broiler primary breeders is similar. This magnitude of performance difference does not appear to exist in the swine breeding world between sire and dam lines.

## **Heterosis**

Heterosis is the performance difference observed between the cross and the parental lines. This can be either positive or negative. It is the property of a specific cross and is predictable. Heterosis can provide a large payback to a breeding program.

Our Heritage parent stock female was originally identified in a series of di-allele cross tests. In the 1980s our roaster product was a 2 way cross but as demand grew the female line began to be limiting in terms of chick production. The two strategies applied were to increase selection pressure in egg production and look for a 2 way cross female. A candidate cross was identified out of a 6x6 design. This cross demonstrated higher than expected performance. The cross was further evaluated and when the performance was repeated, plans were made to supply 1.5 million breeder females as quickly as possible. Table 2 shows the heterotic advantage to both growth and reproductive traits. The advantage in chick production is due to the heterotic effects on livability, fertility and hatchability as well as rate of lay. We have tested the reciprocal mating and observed a reduction of five chicks but a marginal gain on growth and carcass quality. If the company accepts this bird we could produce 2 hybrids and gain efficiencies in the use of off-sex chicks.

It is doubtful if di-allele testing is normal or routine in swine operations. I remember listening to Maurice Bichard in the early days of PIC (ca. 1975) and it seemed to me that they were largely focused on pureline improvement. Maybe genomics will allow measurements of genetic distance to be a way to increase hybrid vigor.

Normally it is considered that heterotic effects are observed in traits with low heritabilities. We have measured heritabilities of 0.30 in egg production in broiler female lines while the literature describes many estimates of .05-.10 in egg-layers. Growth rate is considered moderate to highly heritable (0.20-0.30) but still there is heterosis to be obtained. Interestingly, broiler flock livabilities are consistently 95-96%, largely due to heterosis. Heterotic effects are present in swine but they are expensive to quantify.

Generally the annual gains observed with broilers are around 0.5 to 0.75 days reduction to kill weight. The industry seems to be moving in 2 directions with approximately equal volumes. There is the traditional small bird (4.00 lb) for fast food outlets and newer big bird deboners (7.0-8.0 lbs). The Cobb 500 and the Ross308 are more suited for the small bird program while the Ross708, Ross UY2, and the Heritage breeds are for deboning.

## **The Future**

Currently the industry is cutting back because the market is significantly oversupplied and feed prices are predicted to increase. In 1984 the economic weightings for breast meat were \$2.50/lb; in 2006 it is \$1.00/lb. The US is still a white meat market. Consolidation will continue and perhaps more importation will occur if security of supply can be guaranteed. Heritabilities and heterosis of the main traits remain at the level of 30 years ago and genomics through market assisted selection will be a way to improve secondary traits (eg egg production in male lines). Although live weights have increased significantly, inherent biological limits will prevent broilers from becoming turkeys. Our heaviest male line males can grow to 18 lbs at maturity so that is probably the limit. Growth rate has increased dramatically and it is possible to predict that the Perdue roaster which currently reaches 8.00 lbs live weight at 59 days will in 75 (a geneticist's lifetime) years from now reach 8.00 lbs in 1 day!