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Breeding Technology: Genotype by Environment Interaction

Establishing the Breeding Goal

Probably the most important issue in animal breeding is the definition of the breeding goal, or more simply stated “what direction do we want our products to go?” As customers are our driving force, one of our main goals is to improve performance of products at the commercial (customer) level. At this level a lot of variance exists in terms of climatic conditions (geographic area), housing systems, feed formulation and disease challenges. Are the genetic selection programs at Hybrid designed to meet the varying needs of customers in different regions?

Environment and Its effect on Breeding

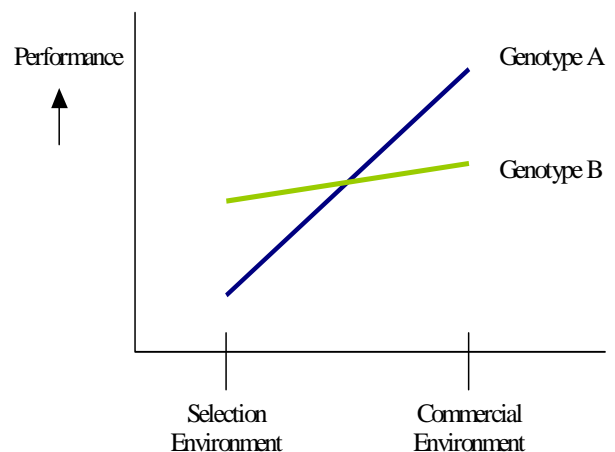
At the primary breeder level, birds are centralized on specialized farms under controlled conditions. Breeder Parents are therefore “designed” and selected in one environment, while their offspring are grown in many different types of environments. All growers and processors, regardless of location, have the same expectation: the best performance from the genetics received (in their own environment).

Is it possible to create an “all-around” product that performs well in a wide variety of environments, or is breeding a turkey more similar to designing a car? When designing a car it is very important to define the environment in which it is going to perform. A desert environment will require a very different car than one designed for a nicely paved, straight road. Does this concept carry through to turkey breeding?

Hybrid’s breeding program is carried out on pedigree farms in south-western Ontario, while Hybrid’s commercial products are performing all over the USA, South America, Asia and Europe. An extremely important question we asked is: “are the best genetics in Ontario also the best genetics in other regions where there are great differences in climate, housing, feeding – issues that can affect performance”. Or, in other words, is there a “genotype by environment interaction” for Hybrid’s commercial products?

What is Genotype by Environment Interaction?

The “genotype by environment interaction” concept can be illustrated by the following example:



This graph illustrates that genotype B performs better under the Selection Environment than genotype A. However, under the Commercial Environment performance favors genotype A. In this example, the breeding goal in the Selection Environment should reflect the best performance at the customer level (Commercial Environment) and therefore genotype A (despite its lesser performance in the Selection Environment) should be selected for producing the next generation of commercial birds. Genotype B, despite its greater performance in the Selection Environment, would produce offspring which would not perform as well in a Commercial Environment. This contradiction in performance is called genotype by environment interaction.

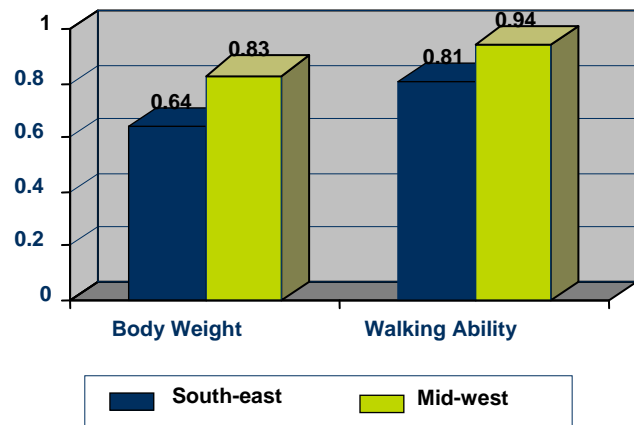
How Does Hybrid Ensure That Its Breeding Program Will Satisfy Growers In All Environments?

To evaluate whether genotype by environment interactions exist for Hybrid products, specific crosses of pedigreed (individually identified) toms were placed simultaneously on Hybrid's pedigree farms as well as on commercial farms in the south-east and mid-west USA. Full brothers were therefore placed in both selection and commercial environments. One of these groups was a "winter flock", one a "summer flock" facing extreme temperatures.

Body weight measurements and walking ability assessments were carried out at 20 weeks of age. Because the pedigree of every individual bird was known, genetic correlations were calculated between traits measured in Hybrid's selection environment, and the same traits measured in the commercial environments. The higher these correlations, the less important genotype by environment interaction is. In other words, a high correlation between the two locations means that genetic improvement of birds performing in a commercial environment will be achieved by selecting birds at Hybrid's pedigree farms.

The results of this study are as follows:

Genetic Correlation with Ontario



This graph illustrates that the genetic correlations between the selection environment in Ontario and various commercial environments in the USA are very high. This means that the best performing birds in Hybrid's pedigree selection program are also the best performing birds in other regions of the North America.

It can be concluded that, today, "genotype by environment interaction" is not an issue for Hybrid's genetics to be concerned with.

Going Forward

Beginning in 1993, Hybrid introduced more 'commercial-like' conditions on the Maple Glen and Woodside pedigree farms. Growing densities, feed, and litter management were adjusted to better reflect commercial conditions, creating a turkey better suited to perform well under these (commercial) conditions. The results of this study show that genetic improvements achieved on Hybrid's pedigree farms are carried directly over to improved results on Hybrid's customers' farms.