Breeding laying hens for improved field performance

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Laying hen breeding companies have been breeding and selecting closed pure line populations for decades. At the beginning of agricultural industrialisation, the different pure breeds were kept as commercial laying stock.

Later, after the hybridisation of corn and other plant species had successfully been introduced, breeding companies started to hybridise commercial poultry in the 1940s.

This hybridisation meant that four different pure lines were crossed to obtain a four-way commercial hybrid cross. Some other developments took place in parallel:

- Globalisation of the market.
- Consolidation of breeding companies.
- More and more veterinary demands on international chick trade.
- Increased biosecurity standards in breeding and production companies.

This has resulted in pure line breeding stock being kept in biosecure, high health breeding and production sites, whereas the commercial stock is still being kept in all kinds of harsh and challenging conditions all over the world.

In the past, breeding companies who based their selection decisions only on pure line performance records could stay in business because the breeding environment was relatively close to the commercial environment. Those breeding companies are now out of business because their products were not free from disease and they could not meet the international veterinary demands.

Currently, all worldwide active breeding companies make use of some 'field performance based selection decisions'. For many years within Institut de Sélection Animale (ISA) the selection decisions were based on data obtained from pedigreed crossbred daughter groups held under field test conditions. When males of a male line are tested it is called Recurrent Test (RT) and when males of a female line are tested this is called Reciprocal Recurrent Test (RRT).

Principles of RT and RRT

For every new generation of a pure line, individual semen samples from the males are collected to be inseminated on a group of hens of another line to create the pedigreed crossbred daughter groups.

All daughter groups of the males of one line are all hatched in the same hatchery on the same date, going to the same rearing facility and the same laying house. This way, a fair comparison between the daughter groups can be made. These daughter groups consist of at least 60 hens and are housed in a normal commercial poultry house with cages that allow the performance data to be tracked.

At housing time the ISA RT crew makes sure that in each cage all birds originate from the same father. Depending on the housing equipment of the RT farm, birds are housed in cages with either 4, 5, 6, 9 or even 12 birds per cage, in the case of enriched cages. All the test farms worldwide use a management practice which is representative of the region they are in.

Table 1. Consistent yearly genetic progress in ISA products.

Trait	Brown	White
Early maturity	0	0
Peak production (%)	+ 0.2	+ 0.2
Laying persistency (%)	+ 0.75	+ 1.0
Total production (eggs)	+ 2.3	+ 2.5
Liveability in rearing (%)	+ 0.05	+ 0.1
Early egg weight (g)	+ 0 - 0.25	+ 0 - 0.15
Average egg weight (g)	+ 0.1	+ 0.1
Mature body weight	0	0
Shell colour	+ 0.5 darker	white
Shell strength	+ 25-75	+25-75
Haugh units	+ 0.4	+ 0.4
Feed intake	0	0

A Recurrent Test farm in Canada.

This means that the ISA test birds are exposed to variable and stressful circumstances like different climates (temperate vs. tropical), different kinds of feeds (North American vs. European), different types and levels of disease pressures (low density vs. high density poultry regions) and different farming systems (single age vs. multi age farms).

This reflects the many commercial circumstances which can be found around the globe. Eventually, ISA needs to know which pure line families give offspring that perform under these circumstances.

Daily production and mortality data is recorded per cage on every test farm. Handheld computer technology and automatic downloading and uploading of data-files make this all possible in a time efficient way, every day. Every test farm has its own dedicated handheld computer and data connection line provided by the breeding company.

ISA has over 20 different test farms geographically spread around the world with more than 300,000 birds tested annually.

Measurements are taken for egg weight, internal and external egg quality, colour pigmentation, feather coverage, egg production and mortality. This adds up to about 15 million data records per year.

The highly sophisticated breeding database of ISA stores all these crossbred field performance data, next to all the pure line data which is collected from the individually

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housed pedigree birds at the ISA R&D farms. This allows the ISA geneticists to calculate overnight, accurate breeding values for crossbred field performance traits for every pure line bird individually housed on the R&D farms.

With this overnight breeding value estimation, the ISA geneticist can make use of the most up to date breeding values for any given selection moment. In fact, any cage in a Recurrent Test can be traced back to the daughter group it belongs to and to all the pure line relatives in the ISA R&D farm.

Eventually, the pure line males with proven daughter group performance in the field are used to breed the next generation of the pure line. This ensures that the performance of the commercial cross in the field will also continuously be improved.

Improved field performance

ISA test flocks in the past (1990-2000) showed peak egg productions of 95% with 20-30 weeks of production over 90%.

Commercial flocks were typically depleted at about 72 weeks of age for brown and 76 weeks for white layers. Nowadays, test flocks peak at 97-98% with 40-50 weeks of production over 90% and more and more commercial flocks are depleted at an age beyond 80 weeks for brown and even 90 weeks for white layers. This will make it possible for hens to produce 500 eggs without being force moulted in the near future.

Pedigree identification of RT birds.

Another essential feature of the ISA Recurrent Test system is that every time a new test is started, commercially available products (including competitor products) are added to the test.

These birds are treated the same as the crossbred daughter groups and are housed randomly throughout the laying farm. This creates our own Random Sample Test almost 20 times per year in all of our test farms around the world.

ISA geneticists use these data to benchmark their products with the products of the competition. Furthermore, it also serves as a valuable tool to evaluate the newest in-house generations with the currently available commercial products already on the market. This ensures the genetic process in ISA products stays consistent and at the highest possible level.

Latest developments

In order to safeguard future progress in field performance, geneticists at ISA and Hendrix Genetics work closely together with scientists of renowned universities in animal genetics to search for and develop new ways of selecting and improving the ISA products in the field.

One example of this is the introgression of Genome Wide Marker Assisted Selection (GWMAS) in the ISA breeding program. As an example, GWMAS has helped to eliminate the FMO3 gene causing fishy odour in eggs from the ISA gene pool.

Consequently, all brown egg layers of ISA can be fed high levels of canola meal in their rations for the economic benefit of the producers.

In the past the ISA geneticists had to wait until the daughters had completed their laying cycle, making the fathers more then two years old, before they could be used in renewing the pure lines. With GWMAS, ISA geneticists will have the same accurate breeding value estimation as in the past, but at a much younger age of the males (six months vs. 24 months), which represents a drastic decrease in the generation interval.

This will make much bigger steps in genetic improvement possible and this will be clearly visible in the commercial products. ■