

Laying hen genetics and breeding program: critical success factors

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In the last few decades, commercial layer flocks are showing significant progress in the production of eggs in all parts of the world. With increased production, the genetic improvement of egg quality – especially at relative older ages – becomes a vital part of breeding programs for laying hens. The crucial part of profitability in the egg values chain is the number of first quality eggs per hen housed.

ISA (Institut de Sélection Animale BV) has emerged in recent years as one of the leading layer breeding companies in the world, whose layers seem to top the list in independent random sample tests when it comes to production of first quality eggs. In this article, we explore some of the critical success factors that underlie the genetic progress of ISA-bred layers. As it turns out, the rapid progress is driven by having a clear and concise mission of 500 first quality eggs by 2020, and a balanced breeding program combined with an extensive test program to account for harsh conditions found in many parts of the world.

Historic starting point

Long before the French-owned breeding company ISA and Dutch-owned Hendrix Poultry Breeders (HPB) joined forces in 2005, their respective breeding programs were already aligned around laying persistence and long production cycles. This effort was combined with extensive field performance testing of pedigreed relatives in commercial layer farms in different temperate and tropical parts of the world (the so-called recurrent tests).

At the time of the merger in 2005, the pure lines were evaluated until 80 weeks of age in France for several years, whereas in The Netherlands this was already the case for more than a decade. Moreover, both companies used field based performance testing of



Measurement of colour intensity.

(crossbred) daughter groups of their male breeding candidates since the end of the 1970s.

Soon after the merger, the respective breeding programs were combined into a large operation, where the best of both worlds in terms of genetics, bird volumes, data records and recurrent testing program legacies, were combined.

Field performance data

With the large global market share obtained after the merger in 2005, the growing responsibility of ISA to supply layers for global egg production, has led to ever increasing biosecurity standards at our pure line and grandparent stock facilities. At the same time, the standards have diverged from those that are typically found at the level of egg production. For this reason, ISA is

nowadays testing well over 350,000 pedigreed birds annually in all kinds of commercial circumstances in order to account for challenging conditions. The testing of crossbred daughters of male breeding candidates encompasses:

- Daily recording of egg numbers and mortality.
- Monitoring of egg weight development.
- Determining all kinds of egg quality related traits, such as shell strength integrity, shell colour intensity, albumen height, Haugh units and occurrence of inclusions, combined with an overall grading of the appearance.

All these data are collected with the use of (handheld) computers and state-of-the-art measurement devices. Collected data is stored centrally with the (in-house developed) breeding database of ISA, where the data is combined with

Measurement of shell strength integrity.



equivalent data collected at ISA's pure line facilities. On the basis of the data, accurate breeding values are calculated and assigned to individual birds in order to predict their genetic potential for laying a maximum number of eggs without compromising on egg quality, daily feed intake and bird health. With these breeding values, the best candidates are then selected for further breeding which enables continuous improvement of ISA's gene pool with each generation.

Extended production life

For more than five years, ISA has adopted production cycles of 100 weeks in its breeding program to improve traits at relative older age. Upgrades and amendments to the R&D-facilities enables ISA to test the genetic potential of all their birds to 100 weeks of age. Initially, not all hens were producing top quality eggs at their later stages in life, but it gave the ISA geneticists the opportunity to really observe and select the birds that could keep up their top-performance not only until 80 weeks of age, but even until 100 weeks. Five years later, the ISA geneticists are witnessing progress in the lay persistence and quality of eggs of their pure lines (see Figs. 1 and 2).

The initial production performances until 100 weeks varied considerably between individuals and between pure lines. Some degree of variation between pure lines still exists at the moment, for instance we can clearly distinguish the female lines from the male lines, but the variation within most lines has decreased and in particular the percentage of 'low producers' has decreased. Just as important, the maximum number of quality eggs continues to increase and a growing number of birds is already capable of producing over 525 eggs, with a current record of 577 eggs in 84 weeks of production.

It is still very early to attribute any of the genetic progress witnessed in commercially produced egg num-

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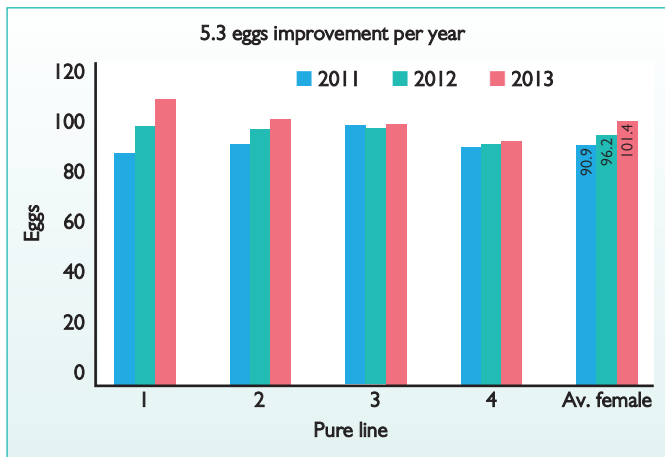


Fig. 1. Development of total number of eggs between 80 and 100 weeks of age for four female lines finished in 2011, 2012 and 2013.

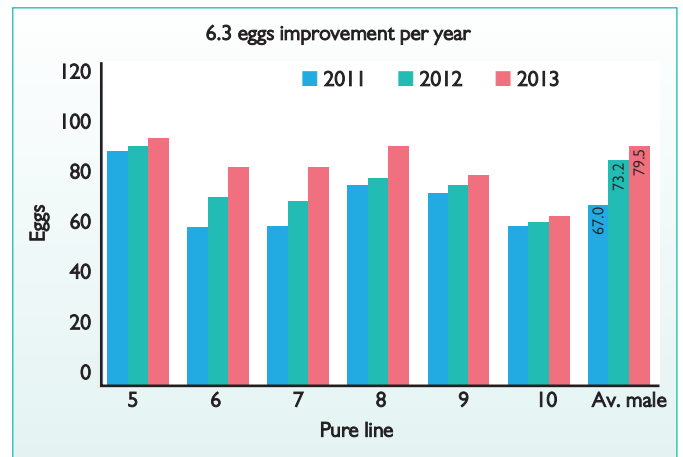


Fig. 2. Development of total number of eggs between 80 and 100 weeks of age for six male lines finished in 2011, 2012 and 2013.

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bers at the moment directly to extended production cycles adopted in our breeding program. However, the trend of increased persistency and longer life expectancy can already be seen by our customers who are able to keep their ISA products longer with each successive generation, without letting the birds moult (see Fig. 3).

Egg quality assessments

Egg shell quality data obtained from the latest generations of pure lines within ISA's breeding program shows that birds that produce good quality eggs at 60 weeks are definitely not always the hens with the best eggs at 100 weeks of age. ISA anticipated this observation with the extended production cycles of their pure lines and added many measurements on egg quality, especially between 80 and 100 weeks of age. An impression of the gradual changes in egg quality research is provided in Table I, where the approximate number of eggs assessed for egg quality over the years is listed.

The numbers in the table clearly indicate the increased importance of research on egg quality in the breeding program of ISA. After merging the two breeding programs into one program, the number of eggs that are used for quality assessment had increased with 40%.

By the time all the birds were kept until 100 weeks of age, another 1.6 million measurements were added, and a significant part of those eggs covers the period between 90-100 weeks of age.

Currently, with all egg research laboratories in Canada, France and The Netherlands renovated to the highest standards with state-of-the-art technologic equipment, ISA is able to add another 450,000 measurements to its breeding program on an annual basis to ensure absolutely no compromises are made in the pursuit of producing

Year	Description	Number of eggs quality assessed
2004	Before the merger of HPB and ISA	2.1 million
2007	After aligning the breeding program	3.0 million
2010	With 500 egg program in full swing	4.6 million
2013 *	Completion of latest new egg research lab	5.9 million

* Estimated from the first seven months of the year.

Table I. Number of eggs assessed for egg quality over the years in the ISA breeding program.

birds that are able to produce 500 top quality eggs.

Gallus Futurus project

Because laying hens are increasingly kept in all kinds of non-conventional housing systems, such as colony cages, enriched cages, aviary systems, barn-housing with and without access to the range area and organic systems.

With the Gallus Futurus project ISA aims at developing a breeding system that can make use of data collected in alternative housing systems. All in collaboration with researchers of the renowned institutes INRA in France and Wageningen University in The Netherlands.

Within this project, ISA is focusing a lot on egg production, egg quality, and behaviour (through video recording and behaviour tests) under normal and stable conditions but also under fluctuated conditions (feed and temperature). This gives ISA the opportunity to work on the forgivingness/robustness of their hens.

Genomic selection

Besides phenotypic data, ISA is using genotypic data in their breeding program and is making major steps in the utilisation of such data. With the Hendrix Genetics Research and Technology Centre, ISA has the knowledge, the techniques, the facil-

ities and know-how available to apply the newest improvements in breeding value estimation. Already since 2008, pedigreed ISA birds have been routinely genotyped for 60K SNPs to increase the accuracies of the estimated breeding values.

Making use of genomic breeding values helps ISA geneticists to select the birds with the highest potential at an early age. Besides, it is very helpful to distinguish between full sib brothers; which male has the best genes for persistent egg numbers with high quality.

Also in the field of genomics, ISA and Hendrix Genetics continue to invest in improvements. This year, all genomic analysis will move to the newly developed one-of-a-kind 60K SNP-chip. This new chip will

improve the accuracy of the genomic breeding values, as the new SNPs are more informative and better positioned across the genome.

Summary

ISA invests around 20% of its turnover in its breeding program to accomplish its objective to deliver hens that lay 500 first quality eggs in varying circumstances. In the last decade in particular, ISA has invested in the following ways:

- Expanding progeny field-testing to account for harsh conditions.
- Keeping all pure line hens until 100 weeks of age.
- Renovating all egg research.
- Collaborating with INRA and WUR in several research projects, including the Gallus Futurus project.
- Applying genomic selection to increase speed and accuracy of selective breeding.

With ISA being the first breeding company to expand the age of their pure lines to 100 weeks, it is good to realise that the persistency advantage that ISA products already have over other laying hens, will only become larger in the years to come. This brings profitability to the egg value chain. ■

Fig. 3. Commercial ISA product flock performance.

