Achieving good quality table eggs through genetics and management

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It is well recognised that the acceptability of an egg by both the egg producer and the consumer in all parts of the world depends on its optimal size, shell quality (external quality) and interior (internal quality). The quality of table eggs is determined both by genetics and by management. So the improvement of the quality of table eggs can be done in two ways:

- Through genetic selection, which brings a long lasting solution to the egg quality.
- Through environmental influences, of which the main part is linked to the technical choices made by the egg producers. This is a solution which needs to be done again and again for each commercial flock.

Within Institut de Sélection Animale (ISA), the goal for the R&D team is clear: meet the expectation of all its customers and also the customers of its customers: consumers of table eggs, through an improvement of the genetic component.

The technical team gives recommendations to provide the correct environment to make sure ISA customers get the maximum performance out of their layers.

Genetic component

Data collection and accuracy

More than 90 traits are measured in the ISA breeding program, of which more than 50 are linked to the quality of table eggs.

Historically, the first quality trait under selection was egg weight, followed by traits like shell thickness, egg specific gravity and other external egg quality traits (the most well known nowadays are breaking strength and egg shell colour) and also internal egg quality traits have been added (like Haugh unit, meat- and blood-spots).

To select the best birds, every year we collect data on around 150,000 pure line birds housed in R&D facilities until 100 weeks, and 350,000 in all kinds of commercial circumstances in order to account for the challenging conditions of the field. Each year, nine million measurements are done on the eggs laid in the R&D facilities and more than six million measurements on the eggs produced in commercial circumstances.

With all this data we are able to select with a high accuracy the best birds to produce the next generation and to improve the performance of the commercial flocks.

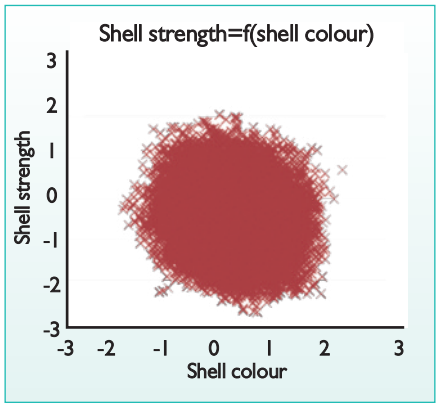


Fig. 1. Shell strength breeding values plotted against shell colour breeding values in standardised units.

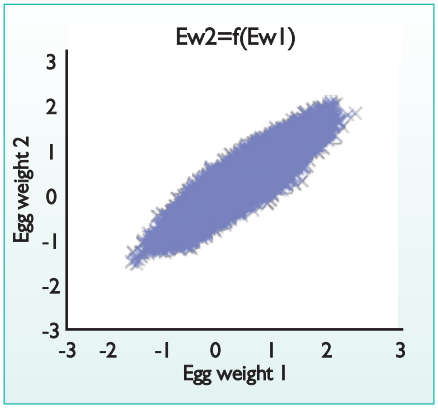


Fig. 2. Egg weight breeding values period 2 plotted against egg weight breeding values period 1 in standardised units.

Heritability, correlation and selection

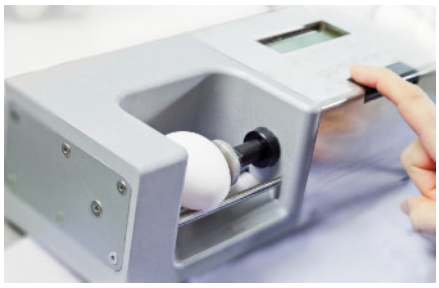
The heritabilities of table egg quality traits are moderate: from 0.2-0.5, except for egg weight, which is around 0.6.

Heritability is not all; we need also to take into account the correlations between traits. If some traits are not correlated with each other, for example egg shell colour and breaking strength (Fig. 1), this makes life of a geneticist easy. Both traits can be improved, without affecting one of them. But this is not always the case. Really high correlation can be found for the same trait measured at different ages, for example $corr_{(EW1,EW2)}$ (Fig. 2). Having high and positive correlations between traits does not mean that we can not increase one and decrease the other. By looking at what has been done on the egg weight curve we have the proof that it is possible (the early egg size has improved substantially while the late egg weight has decreased, resulting in a nice flat egg weight curve).

Of course many other traits exist and are under selection like dark brown spot, shell less egg and roughness.

For each renewal of pure lines, a balanced selection is done. Heritabilities and breeding values are estimated for all measured traits (not only the table egg traits but also the others) and all values are checked before the selection of the breeding candidates takes place. Indeed, focusing only on table egg quality could bring undesirable results in other traits if they are not checked.

Shell strength measurement in the ISA breeding program.



Longer production cycle and genomics

To maximise economic results of the egg producers who sell table eggs, eggs need to have an excellent quality until the flock depletion.

This is why ISA keeps its pure line birds until 100 weeks of age without moulting – with the goal of 500 first quality eggs by 2020.

We are ahead of what is being done in the field (generally flocks are depleted between

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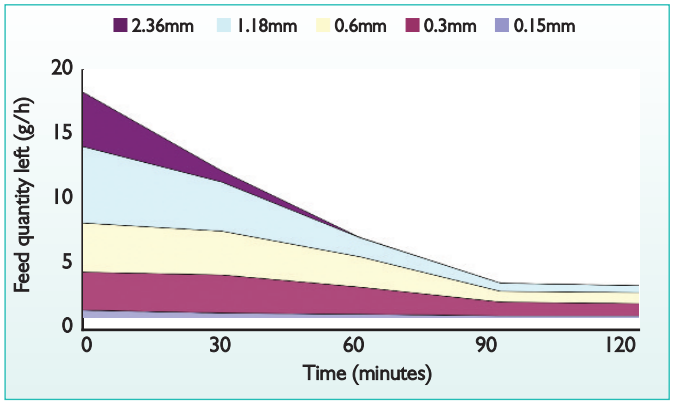

Fig. 3. Feed structure at feeding time and after 120 minutes (V. Roussel and F. Rudeaux).

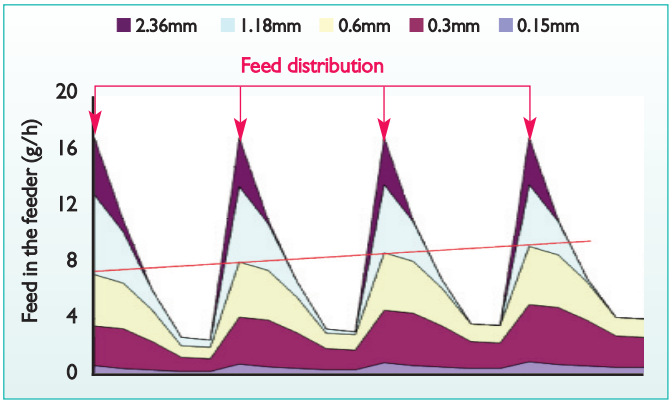

Fig. 4. Accumulation of fine particles after several feed distributions (V. Roussel and F. Rudeaux).

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80 and 90 weeks) which is the key to be ready for the future. Indeed, the best bird at 100 weeks will also be the best one at 90 or 70 weeks but the opposite is not necessarily always the case. To accurately use the information retrieved at a high age, without losing progress through increased generation interval, we need genomic selection. Indeed, genomic selection gives the opportunity to have a good accuracy of breeding values at a young age for traits that are only measurable at older ages.

ISA has been using genomic information since 2008. In our routine breeding program we genotype our birds on a 60K SNP-chip.

The SNPs used have been chosen specifically for our lines to be sure that all SNPs will be informative. But do not think that genomics will substitute the phenotypic data collection. The link between phenotype and genetic markers can easily change by DNA reorganisation. That is why ISA measured, is measuring and will measure all its pure line birds until 100 weeks for all the different traits.

Management factors

Besides the genetic background, the management of a layer flock is also very important to achieve and maintain good egg shell quality during the life of the flock and to use the maximum genetic potential of the birds.

It is obvious that health issues (IBV, EDS, MS, etc), stress in general, and nutrient intake (Ca/P/vitamin D) are very important factors to optimise shell quality. In many cases, the nutrients are present in the right quantities and sources, but mistakes are made in feeding. Feeding management is therefore important as well.

Empty feeder technique

ISA is promoting the so called 'empty feeder technique' or 'stack feeding technique'. When the lights are turned on at the beginning of the day, feed must be available for the birds.

During the second part of the morning, when most of the eggs are being laid, we do not want to stimulate feed intake, especially not in alternative systems.

This is important to get an (almost) empty feeder around noon. For floor housing systems this is necessary to get less floor eggs, but the principle of this management technique is that the birds are consuming all parts of the feed, including the smaller particles which are very important for the mineral and vitamin intake.

As we all know, birds prefer the bigger feed particles and if we constantly add new feed on top on the old feed, accumulation of fine particles in the feeding system will be the result. Because of this, the general feed intake will go down. We can often observe the same problem when feeding the last part of the feed from a traditional feed silo in which the feed was separated and only the very fine fraction is left.

In Figs. 3 and 4 we can see particle size intake after feeding and the accumulation of fine feed particles if the feeder is not emptied once a day. After the feeder is empty (around the middle of the day) the majority (minimum 50-60%) of the total feed intake should be consumed in the last 3-4 hours of the day. This also gives a positive effect towards shell quality because the calcium is provided closer to the time it is needed for shell formation.

Split-feeding technique

Already several tests have been done in split feeding with very good results. With this technique the feed provided in the morning provides a higher energy and protein level and the feed in the afternoon, which is another type of feed, a higher calcium intake. This is closer to what birds would consume when they can make their own selection in raw materials during the day.

Besides the positive effects on shell quality, this split-feeding did not show negative effects on production. Although split-feeding is not yet applicable everywhere, the principles behind it are very important to understand.

In conclusion, to get the best table egg quality, good genetics, good technical support and of course the experience and know-how of the stockperson managing the flocks, is required. ■

Fig. 5. Results of shell quality using single feed or split-feeding (Nutreco Research). ES = egg shell; SWUSA = egg shell weight per unit of surface area.