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1 | 2019



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Genetic improvement meets review and flexibility

The continuous genetic improvement and development of our breed is the basis of our success. Only in this way can we adapt to the ever-changing requirements of the poultry industry. A high degree of flexibility is required in order to be able to meet increasing animal welfare standards. That also means adapting to new management forms like alternative systems which are still the focus here. To make these improvements usable and accessible to you, our customers, we are also developing and adapting other areas.

In this context, reviewing our management guides was an absolute necessity. Updated data, a new layout, easy handling - these are the key factors we have implemented. Transforming these new guides into an e-guide is the next step in the direction of better adaption and modernisation. An example of this innovative form of information is our Hatchery Guide, which is already available in the new format (<https://www.hn-int.com/eng/eguides/HATCHERY-Incubation-under-control/HTML/index.html>). The advantage for us and for you: the e-guide format allows us to actualise data quickly and easily and to make it accessible to you immediately. Always up to date!

Modernisation and adaptability not always digital and electronic. We will also improve and renew our training concepts, but here we still rely on personal contact. In addition to our well-established training

programs H & N Academy and H & N Hatchery Academy, this year we will organise the first H & N Cage Free Academy. The lectures given by our experts are tailored to the requirements of alternative housing systems and we are really looking forward to an active and mutual exchange of experiences.

So, as you can see, a lot is happening at H & N International. The excellent quality of our breed is the secure basis to realise the necessary changes and to face new challenges so that we always remain

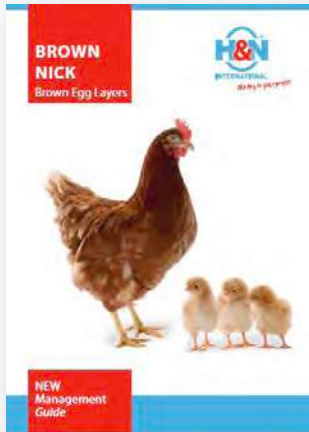
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I hope you enjoy reading this latest issue of our Facts that Figure.

Sincerely yours,

Javier Ramírez Villaescusa
Managing Director





OUR NEW H&N MANAGEMENT GUIDE IS HERE!!

A comprehensive review of the layer management practices has been conducted by our new Technical Service Team. New recommendations have been incorporated and new performance standards have been updated. The following articles give you a brief overview of what you can expect from the new Management Guide.

Original, visual and comprehensive

The aim of this new guide is to provide our customers with a clear and basic tool on how to manage H&N birds to get the best performance of our extraordinary birds in cage systems. The management guide contains useful recommendations that are adapted to our birds, as well as an overview of the different steps and points to be aware of to support good egg production. However, as the guide can't cover all the specifics in full detail, please contact the Technical Service Team for any questions not covered by the guide.

Overview of the new presentation of contents in the guide

From the beginning, the main goal was to produce a useful guide that was easy to understand and read, so that everybody can use it. The content is not only important for us, but also the way it is presented. To fulfil this aim, many new graphics and pictures have been included to support and clarify the text, to explain concepts and increase the guide's visual appeal. In addition, troubleshooting tables, check lists, diagrams, and calculation formulas

have been incorporated...our designers have certainly done a beautiful job!!

Egg producers are always asking for more knowledge and we wanted to meet this demand in our new guide. New and extensive chapters covering topics not previously included in other cage management guides, for example egg quality or bird assessment, have been added but also a review of standard subjects such as nutrition, health or lighting programmes.

Managing flocks for excellence

More than half the guide is dedicated to flock management practices. The guide is structured to describe all the production process as a flow from day-old-chick to depopulation. It starts by describing the cleaning and disinfection protocol for housing the day-old chicks and ends with egg collection advice. Our birds have the potential to be in production until the age of 100 weeks or more, but it is necessary to manage them correctly during their entire life to allow them to express this potential. If you want to keep the birds for long production cycles, you have to do a good job right

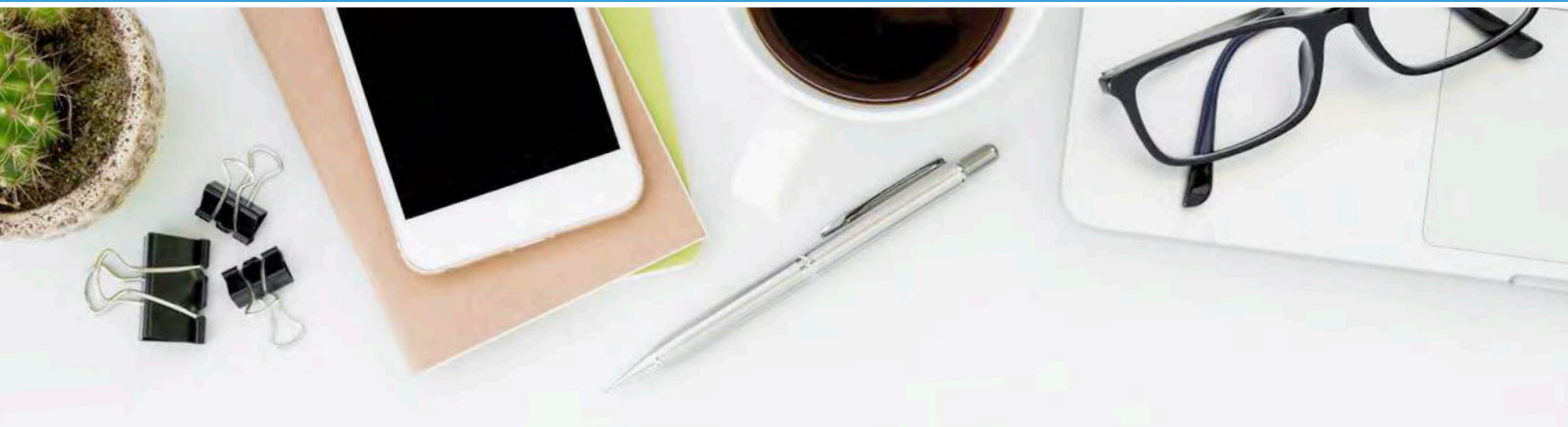
from rearing. Therefore, a special chapter has been included dedicated to managing birds for extended production cycles.

New performance goals

The genetic department is working hard to continuously improve the performance of the birds. The selection goals are continually fine-tuned to adapt H&N birds to the requirements of the different markets. The excellent results achieved by H&N birds in the field support this work. The outstanding persistency of our birds in producing saleable eggs enables the production cycles to be extended. The performance goals tables have been updated and extended up to 100 weeks of age.

Feeding for outstanding production

New, clear and extensive nutrition recommendations for rearing, production, onset and the laying period have been updated with illustrative tables and graphics based on the latest insights. The traditional tables of nutrient requirements have been complemented with additional nutritional information and formulation tips for egg producers.



A new nutrition philosophy has been developed for the production period: the recommendations are based on egg mass production. The daily egg mass output of the hens and their body weight determines their nutrient requirements. Since body weight does not change too much after 35 weeks of age, egg mass will be the parameter that indicates when to change from one feed to the next. The traditional phase feeding should be readapted, feed should not be changed based on age or laying rate but rather based on egg mass production. In addition, this new approach will help to adapt the nutrition to the production goals of each egg producer around the world. To conclude the chapter, further advice is given for a good feed structure and optimal feed quality.

Protecting your hens from diseases

Only healthy birds can express their complete genetic potential. From our point of view, the best tool to enhance and guarantee the health of our hens is biosecurity. A dedicated chapter focuses on this topic, not only as strict advice, but more as a work philosophy. New diagrams have been included that show how to improve biosecurity at farms in an easy and clear way. Furthermore, vaccine programmes, vaccine administration and monitoring programmes are explained using graphics and clear and practical advice.

And much more...

A new chapter about the house environment has been added. It covers all the basics on how to deal with temperature, lighting, water quality and air quality.

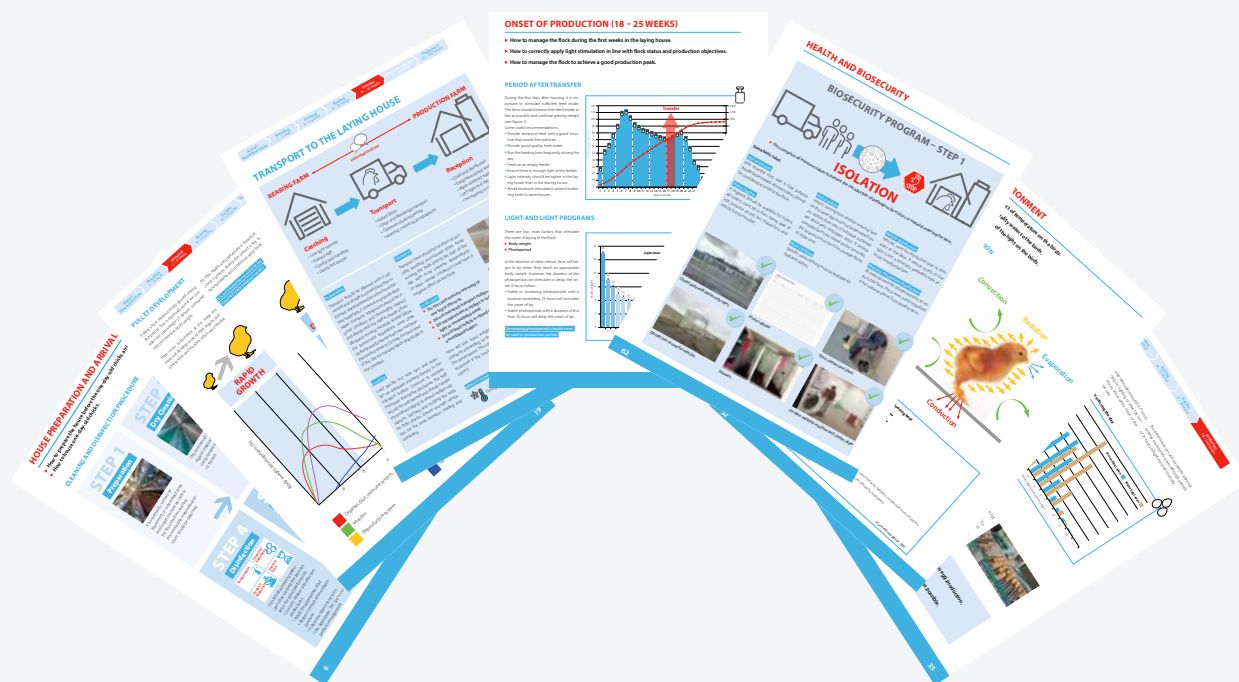
There is also brief information about how to produce in hot weather.

There are two new chapters that will provide lots of practical information on two topics that are key stones in production: bird assessment (including tips and formulas for calculating the most important data in production) and egg quality (including most of the main defects in eggs and their causes).

The new management guide is finally here. We hope and we believe that it will help egg producers to take the right decisions and to capitalise on the full profit of our outstanding birds. If you have additional questions regarding management practices, please do not hesitate to contact our Technical Service Team.

Enjoy reading the guide!!!

Your H&N Technical Service Team





VIV EUROPE 2018



VIV EUROPE 2018
 JAARBEURS, THE NETHERLANDS - JUNE 20-22
 WORLD EXPO FROM FEED TO FOOD

VIV Europe is the leading global trade event based on the, 'Feed to Food' principle and is organised every four years in Utrecht, the Netherlands. Last year it took place from 10–22 June.

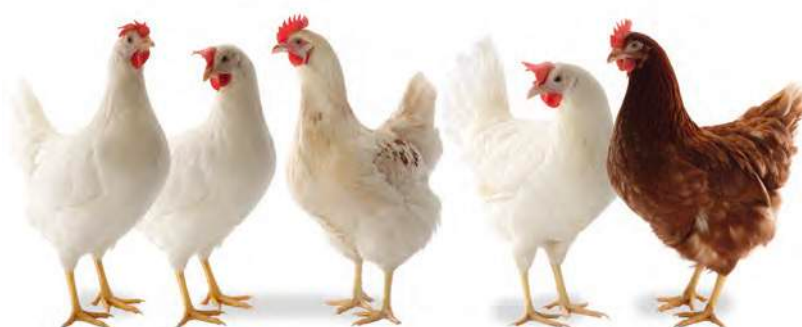
The exhibition was a great success for H&N INTERNATIONAL. We were very pleased to meet a large number of valued customers and potential business partners. VIV Europe offers a global multi-species event with a strong focus on the production and processing of poultry meat and eggs as well as the pig sector, veal and dairy production and fish.

This makes participation at this event an ideal platform to share our knowledge and ideas with many international customers and industry professionals.

We were happy to welcome so many customers and interested visitors to our booth. Thank you for visiting us! Close collaboration with our customers and potential customers helps us to make our brand even more successful and emphasises again that H&N INTERNATIONAL is

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Nicole Rehse





FIRST H&N DISTRIBUTOR CONFERENCE

Marrakesh, Morocco 9–13 April 2018

H&N on the road to success! This was the motto of our first H&N Distributor Conference held in Marrakesh, Morocco. It was the first time that an H&N symposium took place in this format: a technical conference for our customers and distributors worldwide. The event was organised as a blend of lectures, workshops and, of course in such a beautiful country as Morocco, offered a colourful leisure and cultural programme. Our invitation was accepted by 100 participants from 25 nations and they helped making this event such a great success.

On Monday evening our CEO Javier Ramírez and the H&N team welcomed our guests to a reception dinner, which opened with a traditional tea ceremony. The guests could enjoy a wide variety of Moroccan

food and had the opportunity to get to know each other before the meeting.

The next day, the conference started with lectures held by our colleagues Dr. Cavero, Dr. Carrasquer, Dr. Arbe, Mr Chairi and Mr Mozafar. Subjects were the five pillars of H&N genetics, nutrition and health concepts as well as steps into digitalisation. In the afternoon, we explored the red city of Marrakesh and ended the day with a typical Moroccan dinner followed by live entertainment.

On Wednesday, we travelled to the beautiful city of Essaouira on the Atlantic coast, for a taste of this aspect of this fascinating country. Then on Thursday, we were fully motivated to kick off the second part of the technical conference: our

workshops. The workshops were led by our technical service team and included the fundamental questions: "How to increase H&N breed sales" and "How to optimise production costs". The results of each group were summarised for all participants at the conclusion of the conference. The gala dinner on Thursday evening was a truly festive end to this successful event.

Once again we would like to thank all participants who took up our invitation to come to Morocco and hope that they enjoyed the event as much as the entire H&N team did. This symposium showed that we, H&N together with its customers, are "on the road to success!" together now, and in the future.

Nicole Rehse





H&N TECHNICAL SERVICE

Growth and Specialisation

Since 1 August 2018, Maurice Raccoursier Frost has supported the H&N INTERNATIONAL team. He is responsible for Incubation in the Technical Service and as such brings us his more than 10 years of experience as a veterinary surgeon in the poultry sector.

Maurice Raccoursier Frost began his professional career in Chile in 2008, where he worked as a veterinary surgeon for a Hy-Line distributor and was involved in

all production sectors. In 2014 he moved to the USA to study for his MSc in Poultry Science at the University of Arkansas. During this period he worked as a broiler manager for the Applied Broiler Research Farm at the University of Arkansas. Having obtained his MSc, Maurice worked until 2017 with Hy-Line International in Iowa.

With the specialisation of the technical service team in individual areas, we want

to further expand our customer service and, above all, provide an accurate, fitting answer for every concern of our customers, regardless of the area in question.

To further pursue this objective, we also welcome Mr Leon Schouren back to our Technical Service Team. He will now fully focus on flock management in order to provide advice and support to our clients.

Nicole Rehse



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Dirk Polke
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H&N ACADEMY AND H&N HATCHERY ACADEMY

We are expanding our basics

Our training concept has been crowned with success for a long time and still enjoys immense popularity. In 2018 our two training events H & N ACADEMY (5–9 March 2018) and H&N HATCHERY ACADEMY (6-10 August 2018) took place again. These annually recurring training events held in Cuxhaven are a concept that pays off for both parties: for us and for our customers.

Expert know-how

If our customers have sufficient knowledge of our birds and what good management practice is, they can achieve the desired performance goals. But where does the know-how passed on by our experts come from? Their expertise is based on sound knowledge, but also and especially, on the many years of continuously exchanging experiences with our customers. This is an aspect devoted particular attention in our training courses. Certain processes are discussed in detail and optimisation measures and solutions

can be found together. A win-win situation for both sides. We are experts because our customers are, we succeed because they do.

H&N Cage Free Academy

This concept implies that you also adapt to new circumstances. The subject of animal welfare is becoming increasingly important and does not stop at the poultry industry. Therefore, this year for the first time our H & N CAGE FREE ACADEMY will take place. Proven topics such as feeding and nutrition, vaccination and rearing management will be specifically tailored to alternative management systems. Our experts are already looking forward to exchanging experiences with customers, giving them the opportunity to consider and incorporate more and more aspects and experiences in alternative forms of housing.

We are really looking forward to welcoming you to one of our training events 2019!

Marketing





Sales Erik Hult (left) and Martin Ceder (right)

H&N SWEDEN

H&N Sweden sold their first DOC of Super Nick in May 2018. That flock was 32 weeks of age when we visited the farm with the feed supplier. So far it looks very good with 97% of lay and 60 grams in egg weight. The farm is home to 22,000 birds in a barn with an aviary system combo from Landmeco built in 2016. Sales have not yet reached the figures we forecasted, because many farmers want to wait and see further result before ordering new pullets.

H&N and Super Nick are new on the market in Scandinavia and not so well-known. This means that much of the work of sales is explaining the history, background and origin of H&N.

Swedish egg market

The Swedish egg market has made a quite rapid transition from egg mass to

egg number. The best paid weight class currently is medium. This means we must set up our management approach to achieve a rather low egg weight. Together with the H&N Global Technical Service Team we have created an adapted management programme for lighting and feeding and are trying to persuade feed suppliers in Sweden, too.

Vaccinations and infection pressure

One of the challenges is preventing the pullets from becoming too heavy during rearing, as Sweden has the advantage of having fewer vaccinations and a lower infection pressure due to the climate and low density of poultry in general. There are usually no more than eight vaccinations until 14 weeks and transfer is already done at 15 or 16 weeks of age.

H&N Super Nick

The Super Nick seems to be an adaptable bird with a good temperament, as one of the customers says "not nervous, but I would say active..."; so we are confident that time is on our side and we are here to stay.

H&N Sweden has sub-contracted activities such as rearing, egg production, hatching and accountancy – the only thing we do ourselves is sales – Martin and Erik (picture above).

The plan is to have our own facilities when volumes increase, and that process seems to have started now!

Erik Hult

NICK CHICK, THE LEADER IN EGG VALUE IN THE NORTH AMERICAN WHITE EGG MARKET

Flocks of all available layer breeds these days can peak well, and there is no more gain to be made in that period thru genetic selection. Further, pushing the onset of lay earlier than 18 wks is not very popular, due to the negative correlation with persistency. Therefore, any additional eggs/bird will have to be added after peak, that trend that has been going on with genetic research for a while now. High egg producing lines are persisting well now, with flocks getting beyond 75 wks of age while still producing 90% or higher. This has convinced many producers to switch to single-cycle flocks and take them to 95 wks or older without molt.

Egg mass output is the indicator for the bird's ability to convert feed into eggs efficiently, and modern layers are selected for high egg mass output without over-consuming feed. The earlier the birds start paying back for the pullet costs, the more desirable.

Several flock management software packages in use allow for analysis of feed efficiency in terms of feed per dozen (lbs/doz or g/dz). Some look at lbs feed/pound egg, especially those used by breakers. However, these parameters both do not capture the value of the eggs evaluated. Eggs in the US market are priced per weight category, and large and extra-large categories command a premium. While Jumbos have a higher value, they are deemed too wasteful, and medium and small categories have a lower value. The difference between medium and large ranges between 20–35 cents in favor of large (Urner Barry).

Nick Chick is the white-egg, N. American market leader in early egg-size development. Top producing flocks in reach the 48 lbs case wt (the sweat spot) as early as 27 wks, the average for white-egg layers is between 36–38 wks of age, while some of the lines selected for high egg number do not

hit the 48 lb case wt until 40 wks or later.

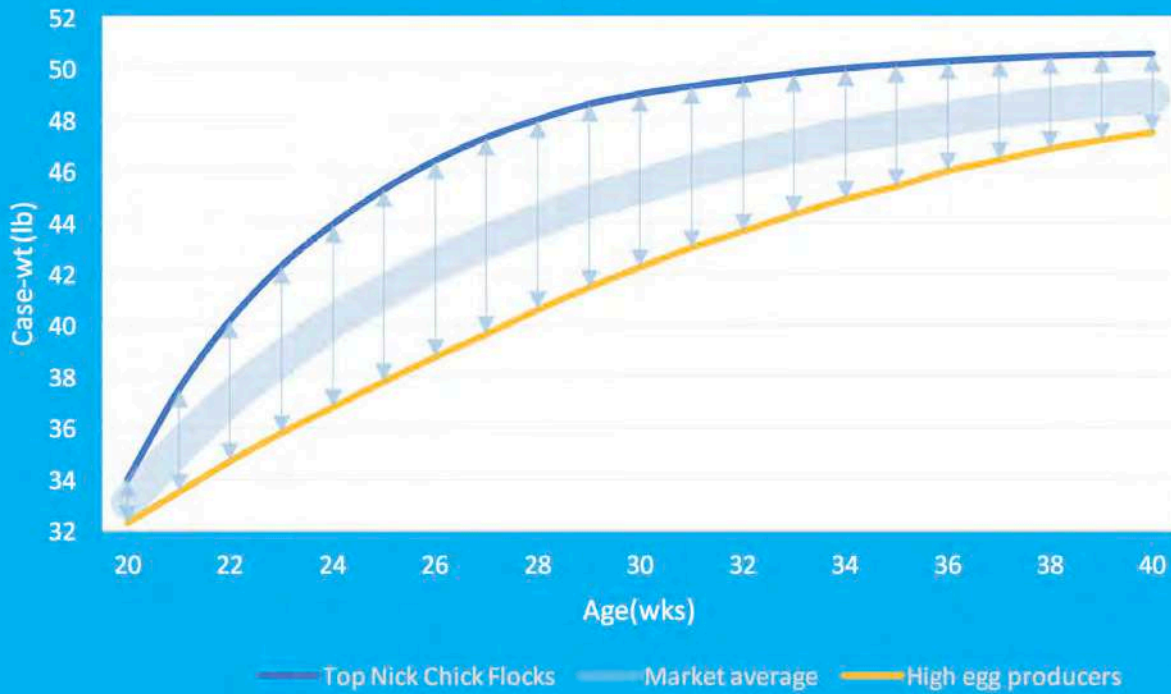
The table below shows the advantage in return for eggs based on the case wt development. With 40 wks taken as base-line, flocks where the case-wt reaches 48 lb can \$1.65 more than the base-line. (* using Urner Barry month average price for the Midwest). As prices vary in the market, this advantage can reach \$ 2.0 per bird especially when the spread between medium and large category prices increase.

The early egg size with NC chick is a result of the birds innate ability to increase its feeds consumption when most needed. When pullets are housed in the layer barn, their feed consumption can be 14–16 lbs/100, and many are under 17 lbs/100 at the onset of lay. In the 3 wks these birds can reach 85–90% HD production, and would need to increase the feed consumption quickly, to meet their nutritional requirements dictated by the egg-mass output. If not, birds would either deplete

Age at 48 lb case-wt (wks)	40	38	36	34	32	30	28
UB price (\$/dz)*	\$ 1.05	\$ 1.08	\$ 1.10	\$ 1.12	\$ 1.14	\$ 1.17	\$ 1.20
Egg-value from 20-40 wks	\$ 11.55	\$ 11.88	\$ 12.10	\$ 12.32	\$ 12.54	\$ 12.87	\$ 13.20
Spread per bird	\$ 1.65	\$ 1.32	\$ 1.10	\$ 0.88	\$ 0.66	\$ 0.33	\$ -

*Based on Urnar Berry month Average price for the Midwest

Case-wt development



their body reserves and then slow down egg-size increase and egg out-put (notorious post peak dip), or slow down % HD increase and delay the peak until they reach the target egg-consumption. The higher the egg mass, the greater the demand for nutrients. Birds that can satisfy the nutrient needs are the one that will peak well and increase egg-size quickly. NC has demon-

strated that ability repeatedly in the field. Case-wt can be managed to remain within the desired range through controlling amino acid intake, without affecting total egg numbers. Daily feed consumption depends on several factors like ME in the feed, barn temp, water temp and quality...etc. and is usually considered a management decision.

With an eggs size optimized for the market, coupled with the ability to get to the ideal case-wt early, and the superior shell quality especially in late-cycle (beyond 72wks of age), Nick Chick is the leading white-egg bird ins egg value (\$ EOFC) in the North American market.

Khalil Arar



Carrie McFarland

"It is my pleasure to announce that Carrie McFarland has joined H&N North America as a regional sales and Service manager as of Jan 15, 2019. Carrie will cover the region of the Upper Midwest and will be an integral part of the technical service team. She will be replacing Jim Cook who will be "slowing down" and focusing of the upper East coast.

New face at H&N North America

Before joining H&N NA, Carrie was in the live production division at Michael Foods Inc. in Neraska. She has extensive experience (over 20 years) in flock management and animal husbandry, with her recent hands-on experience in cage-free production management as she saw through part of the transition at MFI.

Carrie holds a Bachelor of Science degree in Animal Science from the University of Nebraska and through her carrier attended several professional training programs and participated in development and delivery of training courses in humane bird handling, biosecurity and occupational safety.

We are excited to have Carrie joining our team and are looking forward to her contribution to the growth and success of H&N North America."



AVICOLA ROLON, BOLIVIA

The brand that stands for innovation in egg production

Avícola Rolon is a family-run company founded more than 50 years ago by the engineer Erik Rolon and his wife Marta Rios de Rolón in Cochabamba, Bolivia. Today, the company is managed by their two sons, Erik and Ariel, who are Engineers, and their daughter Katya Rolon. For the past six years, Avícola Rolon has put its trust in H&N International and its commercial layers, Brown Nick and Nick Chick.

Bolivian Business Award

In 2017, the company won the prestigious Bolivian Business award in the brand category. This award denotes the marketing strategy Avícola Rolon implemented to achieve key product differentiation, an initiative launched ten years ago.

NutriRolon

One of the strategy's pillars is to refresh our ideas about one of the most basic foods in a healthy diet: the egg. To achieve this, Avícola Rolon decided to develop the NutriRolon line of products. This line includes four distinguishing features that set it apart from

what the Bolivian market currently offers. First and foremost, the egg shell is white instead of brown, the colour of 98% of the market's eggs. Additionally, the NutriRolon line is enriched with vitamins and Omega 3 fatty acids. Furthermore, Avícola Rolon has invested in the development of a traceability system that guarantees its clients freshness and transparent product origin.

Altogether, these features set the company's products apart on the Bolivian market and respond to major trends on the international market.

The strategy is two-fold:

1. Differentiate egg products
2. Create a fresh experience that encourages the consumer to view the egg as an essential food for improving their quality of life and attaining well-being.

In this mindset, in 2017, Avícola Rolon opened the first Fitness Nutribar location. Avícola Rolon and OVOPLUS products are sold at these locations. Plus, clients can taste a range of products geared towards

wholesome, healthy foods, and other foods that combine well with the nutritional benefits of eggs, such as quinoa, oats, flax and fruits and vegetables.

The Rolon Group continually improves the quality of its products, developing its OVOPLUS lines of pasteurized egg whites and breads, in turn creating growth opportunities for Avícola Rolon in Bolivia.

Dr. Ronald Trenchi





RIO BRAVO AGRICULTURAL

Rio Bravo Agricultural Productions is a family-run business founded in 1959 by Pánfilo Cuadrado in Chíncha Alta, Peru. The company has always dedicated its activities to agricultural production, more specifically table eggs. Today, the company is managed by the founder's sons, who have continued developing and expanding throughout Peru.

1993 Launch of own hatchery

1993 was a pivotal year in Rio Bravo's development, thanks to the launch of its own hatchery. This initiative enabled the company to become self-sufficient by developing its own product, a key manoeuvre in successfully positioning itself on the Peruvian market.

2010 egg grading and distribution factory

In 2010, nearly two decades later, this same approach prompted the opening of an egg grading and distribution factory. These facilities were built in compliance with national and international standards for hygiene and performance. Simultaneously, in 2010, the company embarked on a new adventure by adding Brown Nick commercial layers from H&N International, a subsidiary of the EW Group. This series of actions demonstrates Rio Bravo's vision to position itself as one of Peru's leading egg producers.

Leading position

Javier Cuadrado Roldan's passion and commitment spearheaded the company's ascension to the top. Today, Rio Bravo





From left to right: Amir Niño de Guzman, Rio Bravo Operations Manager, Dr. Daniel Parí Cuadrado, David Caveró Managing Geneticist at H&N International, Engineer Ricardo Cuadrado Roldan, Rio Bravo Ag. Productions Director, Ronald Trenchi H&N Latin America.

is a leader in table egg production, innovation, food safety and quality. Without a doubt, Mr. and Mrs. Cuadrado Roldan's legacy is still an integral part of the company. Currently, Rio Bravo is managed by the engineer Ricardo Cuadrado, along with his brothers and nephews.

Automated systems for rearing and production

The company has demonstrated an admirable resilience, remaining one of the strongest companies in the country in terms of production, performance, employee treatment and innovation. Showing its clear vision for the future, the company focuses on automated systems for rearing and production. These investments have improved production methods, increasing efficiency and product quality.

In order to effectively manage feed requirements at different poultry stages, the company built a micro pellet factory to meet the dietary needs of chicks. Additionally, there are more efficient facilities for producing layer feed.

As the market evolves, it demands different types of egg packaging for the retail sector. Correctly identifying consumer needs helped the company develop different packaging solutions. Here at H&N, we are delighted to move forward with the company at this phase and provide all the support needed for their success. Rio Bravo Ag. Productions ensures its future, tackling global challenges to improve Peru's egg production market.

Dr. Ronald Trenchi, Maurice Raccoursier





THE EFFECT OF STORAGE ON HATCHING EGGS QUALITY.

Storage of hatching eggs is a common and necessary part of the commercial incubation mainly due to an imbalance between hatching egg supply and market demand. Demand requires that at times fertile eggs be held for differing periods prior to setting in the incubator (Hamidu et al., 2011).

Egg storage prior to incubation has been reported to have both detrimental as well as beneficial effects. Excessively long storage (beyond 7 days) prior to incubation is accompanied by some negative effects: decline in hatchability, increase in incubation length, a decline in chick quality and a deterioration in post hatch performance. These negative effects of egg storage are likely to be explained by the decline in egg quality, and especially albumen quality, cells mortality, and others.

In contrast, eggs stored for a few days have been reported to hatch better than those set in an incubator with less than two days of storage (Benton and Brake, 1996).

Maintaining the quality of hatching eggs is imperative because eggs provide

both physical protection and nutrition for the growing embryo. For this reason, to reduce the effect of egg storage on hatchability the eggs are kept below the

physiological zero (25-27°C), dormancy of the embryo is maintained and fertile eggs can be stored without major loss of hatchability (Butler, 1991; Wilson, 1991). The opti-

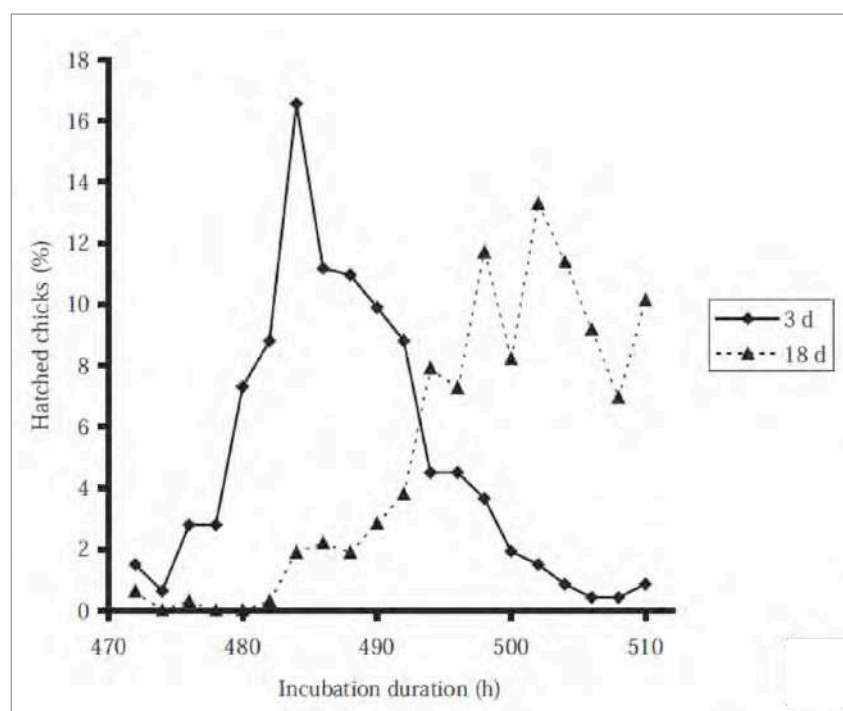


Figure 1: Hatching curve in relation to the incubation duration and storage time (Tonal et al., 2003)

Incubation parameters	Storage time	
	3 d	18 d
Total incubation duration of 50% hatched chicks	486 ^b ± 0.22	502 ^a ± 0.43
Duration of internal pipping (IP)	5.33 ^b ± 0.44	10.93 ^a ± 0.71
Duration of external pipping (EP)	12.5 ± 0.45	13.81 ± 0.87
Duration from IP to emergence	17.83 ^b ± 0.37	24.74 ^a ± 0.50
Duration from setting to IP	468.17 ^b ± 0.20	477.26 ^a ± 0.30

^{a,b}Values sharing no common letters are significantly different according to the storage time ($P < 0.05$).

Table 1: Hatching parameters in relation to the storage time.

mal temperature for 3 to 7 days storage of chicken eggs is 16-18°C which could drop to 15-16°C for eggs stored more than 7 days (Butler, 1991; Wilson, 1991). The relative humidity should be maintained at 75-80%.

The main purpose of this article is trying to explain the changes that occur in the hatching egg during storage that impact on hatchability and chick quality.

Albumen

The blastoderm is intermediately positioned between the yolk and albumen and therefore changes in yolk and albumen influence embryo early development (Lapao et al., 1999).

Albumen is the most critical component influencing embryo quality. It is known to play two major roles in embryonic development, these roles are protection of the yolk and embryo from pathogenic microbes and provision of a supply of nutrients necessary for proper growth and development to the embryo (Benton and Brake, 1996).

Albumen viscosity is maximal at oviposition with a pH of about 7.6. The chalaza, in combination with the generally high viscosity of the albumen, holds the yolk in a central position away from the eggshell, where possible contamination may arise (Board and Fuller, 1974). The role of albumen then expands to include providing water, proteins, and a variety of nutrients to

the developing embryo. Within a few days of storage, albumen viscosity decreases substantially and reaches an alkaline plateau of about 9. This process, known as albumen liquefaction, facilitates the movement of various nutritive substances from the albumen towards the embryo (Burley and Vadehra, 1989). Liquefaction might also reduce any physical barrier to gaseous diffusion of oxygen that the albumen may present (Meuer and Baumann, 1988). In addition to these roles, water from egg albumen also forms the subembryonic fluid, which appears to be essential to proper embryonic development (Benton and Brake, 1996). Albumen quality (viscosity) is also influenced by storage (Walsh, 1993) and flock age (Romanoff and Romanoff, 1949). Researchers found that the lower the albumen quality at oviposition, the more rapid its decline during storage (Hurnik et al., 1978). Associated with this decline during storage is a loss of weight due to the evaporative loss of water (Romanoff and Romanoff, 1949). These changes that occur within the albumen probably have profound effects upon the developing embryo (Benton and Brake, 1996).

In addition, periods of egg storage allow the albumen to degrade excessively. This degradation causes the blastoderm to move into close proximity to the eggshell, so that early embryonic mortality could

result from dehydration during the early stages of incubation (Brake et al., 1993).

In theory, the more viscous the albumen the greater the barrier it presents to gaseous diffusion of oxygen to the blastoderm (Meuer and Baumann, 1988). The research from Benton and Brake (1997) demonstrated that fresh eggs begin incubation with an albumen height significantly higher than that observed for stored eggs. Such a high viscosity might prevent an adequate supply of oxygen from reaching the embryo, thereby resulting in mortality prior to any appreciable formation of blood. By 24 hours of incubation, such a diffusive barrier would no longer exist, as albumen height decreases to a height equivalent to that of eggs stored for 4 days or more.

The inevitable increase in albumen pH during storage and incubation may have a unique role in embryogenesis. The asymmetry in pH between yolk and albumen established by the albumen pH increase access of the blastoderm to oxygen, establishes essential gradients, and support the acquisition of nutrients by the early chick embryo during the first days of incubation (Benton and Brake, 1997; Meuer and Baumann, 1988). Incubation of fresh eggs, prior to these changes, may result in insufficient oxygen or metabolite acquisition to meet the metabolic demands of the early chick embryo, which may result in increased early and late mortality, extended incubation, and poor chick quality.

Thyroid hormone levels, corticosterone level, oxygen uptake and incubation length

Tona et al. (2003) research described the effects of storage on gas exchange, thyroid hormone levels, and physical hatching parameters during the last days of incubation have been investigated. Prolonged incubation for eggs stored for long periods has mainly been associated a delayed start of internal pipping (IP) (table 1).

Developmental stage	Storage	Corticosterone	T ₃	T ₄	Ratio of T ₃ /T ₄
Internal pipping	3	16.00 ^a ± 1.18	3.98 ^a ± 0.19	8.92 ± 0.73	0.74 ^a ± 0.08
	18	13.62 ^b ± 1.19	3.07 ^b ± 0.20	7.85 ± 0.56	0.59 ^b ± 0.05
Newly hatched chicks	3	15.95 ^b ± 1.02	3.57 ^b ± 0.08	6.00 ^b ± 0.27	0.92 ^a ± 0.05
	18	18.14 ^a ± 1.31	3.95 ^a ± 0.10	7.70 ^a ± 0.39	0.76 ^b ± 0.05

^{a,b}Values sharing no common letters are significantly different according to the storage time ($P < 0.05$).

Table 2: Corticosterone, triiodothyronine (T₃), thyroxine (T₄) and T₃/T₄ ratio in embryos at internal pipping stage and in newly hatched chicks in relation to the storage time.

Day of incubation	Wet embryo weight ¹ (g)			Dry embryo weight ² (g)		
	4 d	14 d	SEM ³	4 d	14 d	SEM ⁴
4	0.04 ^a	0.03 ^b	0.01	0.004	0.003	0.001
5	0.14 ^a	0.12 ^b	0.03	0.008 ^a	0.007 ^b	0.002
6	0.30 ^a	0.25 ^b	0.05	0.018 ^a	0.016 ^b	0.003
7	0.59 ^a	0.52 ^b	0.19	0.037 ^a	0.033 ^b	0.006
8	1.01 ^a	0.88 ^b	0.11	0.07 ^a	0.06 ^b	0.01
9	1.59 ^a	1.44 ^b	0.20	0.11 ^a	0.10 ^b	0.02
10	2.31 ^a	2.19 ^b	0.30	0.17 ^a	0.15 ^b	0.02
11	3.32 ^a	3.05 ^b	0.46	0.26 ^a	0.23 ^b	0.04
12	5.13 ^a	4.71 ^b	0.78	0.43 ^a	0.40 ^b	0.08
13	7.62 ^a	6.99 ^b	1.30	0.73 ^a	0.65 ^b	0.18
14	11.47 ^a	10.52 ^b	1.22	1.18	1.16	0.30
15	14.94 ^a	13.57 ^b	1.07	2.04 ^a	1.77 ^b	0.27
16	18.59 ^a	17.37 ^b	1.76	3.06 ^a	2.74 ^b	0.40
17	22.85 ^a	21.40 ^b	1.33	4.00 ^a	3.74 ^b	0.40
18	27.24	26.37	1.34	4.94	4.77	0.38
19	30.10 ^a	29.80 ^b	1.23	5.72 ^a	5.45 ^b	0.30
20	34.00 ^a	31.81 ^b	1.54	6.42	6.24	0.35
21	37.53 ^a	35.89 ^b	1.47	7.91 ^a	7.33 ^b	0.31

^{a,b}Means in the same column with different superscripts differ significantly ($P \leq 0.05$).
¹Least squares means of wet embryo weight after breaking open 30 eggs (15 eggs/storage) daily.
²Least squares means of dry embryo weight after drying the samples in oven for 4 d at 65°C.
³Standard errors of the means belonging to different treatments within each day and wet embryo weight.
⁴Standard errors of the means belonging to different treatments within each day and dry embryo weight.

Table 3: Effects of the duration egg of storage on wet and dry embryo weights

Embryos from egg stored longer than 10 days present lower production of Corticosterone and the T3 thyroid hormone (both hormones are related to metabolic rate in the embryo), at 18 days of incubation indicating that embryos at this stage are weaker compared to those stored for less than 7 days. This delay in the increase of T3 may be a major factor in the prolongation of hatching time and wider hatch window in eggs stored for long periods before setting (see figure 1). Moreover, the corticosterone and T3 levels after internal pipping in newly hatched chicks from egg with long storage, increase while the short storage chicks remained unchanged (table 2). This late increase in corticosterone and T3 levels may be an indication of the more stressful event of hatching of embryos from egg stored longer and result in subsequent higher mortality and reduced growth speed (Tona et al. (2003). In addition, it is described that longer storage impact the function of the embryo heart rate influencing the oxygen uptake and increasing the late embryo mortality (Haque et al., 1996).

Differences in oxygen, T3 and corticosterone levels in incubating eggs produce differences in hatchability, chick quality, and growth potentials between embryos stored for short or long period.

Immune system

The flock's performance is also influenced by the bird's cellular and humoral immunocompetence. Newly hatched birds are initially protected from infections by maternal antibodies present in the egg yolk. Day-old chicks possess a functional but naive immune system and must therefore be immunized to raise protective immune responses against major pathogens. Researchers suggest that prolonged egg storage could compromise the birds' immunocompetence to acquire good humoral response (antibodies production) and thus their ability to raise protective immune responses following immunizations for example, booster vaccination (Goliomytis et al., 2015).

Glycogen

Data indicates that growth is slowed in surviving embryos from eggs stored for longer periods. Growth and survival rates were related to abilities to maintain growth of supply and demand tissues (Fasenko, 1996). Embryos from egg stored less than 7 days can maintain greater glycogen (source of energy) concentrations in muscle and heart tissues than those from more than 12-14 days (Christensen et al., 2001). Carbohydrates become a vital ener-

gy substrate during pipping and hatching and embryos from long stored eggs have diminished ability to metabolize adequate carbohydrates for growth and function of organs and muscles therefore you could see higher late embryo mortality (Christensen et al., 2001).

Cells mortality.

In chickens, a healthy embryo (blastoderm) contains on average 60,000 embryonic (blastodermal) cells after oviposition (Petitte et al., 1990; Etches et al., 1996). It has been hypothesized that a minimum number of healthy blastodermal cells may be required to initiate normal embryonic development (Fasenko et al., 1992).

Egg storage produces a reduction in blastodermal cell numbers (Foulkes, 1990; Hamidu et al., 2010). A reduction in embryonic cell numbers could limit the number of cells available to take up oxygen for metabolic activities. The reduction in cell numbers is due to an increased number of cell deaths from apoptosis (programmed cell death) and necrosis (Hamidu et al., 2010) and could possibly be the reason for decreased embryo quality and poor embryonic performance in eggs stored for a longer duration (Hamidu et al., 2011).

Physiologically, a reduction in blastodermal cell numbers may also reduce the amount of oxygen that each embryo can take up for metabolic activities. A reduction in embryonic metabolism may suggest that the embryos do not have enough cells to make effective use of the available oxygen to break down carbohydrate, fat, or protein molecules to release the needed energy for embryonic growth and could result in increase embryo mortality and lower chick weight (Table 3) compare to storage of less than 7 days (Hamidu et al., 2011; Bakst and Akuffo 1999).

Conclusion

I hope this article will work to help you realize that when hatching eggs are stored before incubation there are several factors

that impact to decrease both, hatchability and chick quality. It should also encourage you to invest in structure, equipment and improve processes designed to take the best care of the hatching egg. There is no doubt that is one of the most valuable assets in a breeder company and deserves our maximal care.

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