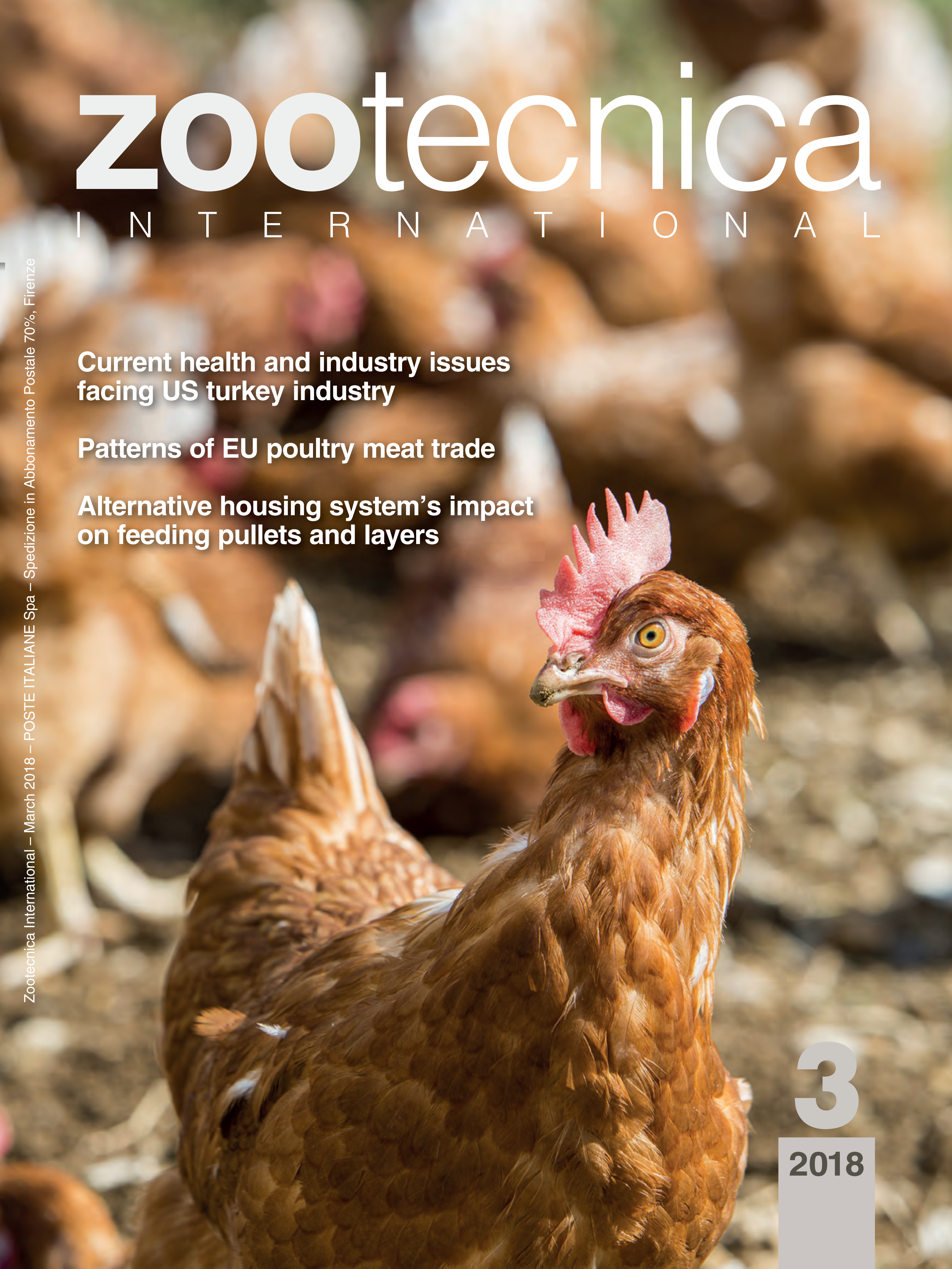


zootecnica INTERNATIONAL

Current health and industry issues facing US turkey industry

Patterns of EU poultry meat trade

Alternative housing system's impact on feeding pullets and layers

3
2018

Zootecnica International – March 2018 – POSTE ITALIANE Spa – Spedizione in Abbonamento Postale 70%, Firenze


CODAF

EDITORIAL

In advanced economics realms, there can no longer exist decision-making that is separate from scientific knowledge. There can be no strategic plan, which does not consider the socioeconomic aspects of the international scene which acts on behalf of individual needs and various situations, be they short, average or long term.

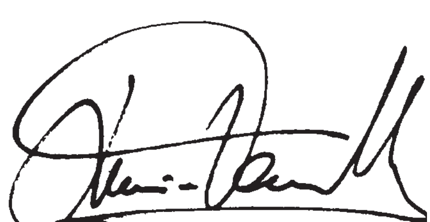
Within a company management atmosphere, the backing-up of decision-making process with the knowledge of all that takes place on the outside while keeping track of the socioeconomic tendencies and characteristics unfortunately does not oftentimes occur. Similarly so, and equally as infrequent an occurrence is the association of research with the task of gathering, promoting and coordinating the efforts of individual researches, teams and research institutes of various types which crusade, even though in different contexts, towards a consistent means of regulating the evolution of the socioeconomic ambient.

A business should no longer be just a “production site” for merchandise, but rather a dynamic system – an articulated system. Besides the production operations, a whole other series of services acquire their importance: development research, methods and product innovation and identification and understanding of new markets.

Today every production system is introduced in a difficult and complex market place. This complexity is due to the different socioeconomic ambients; difficulties are created by the fast-paced rate of change, which no longer, nor solely, originates from the competitive mechanism but from numerous interrelations, as well as from those links since established with the external social environment. Said environment, in the vastest sense of the term, means: employment market, pure research sites and its practical application, educational and informative structure and so on.

In this multi-dynamic situation where various forces overlap and put pressure on the single enterprise, an organization needs to shape itself according to flexibly designed models, which allow for continuous revision of the balance between the internal organizational situation and the external world. This ever-growing need on the part of the organizations to be able to adapt to the changes in ambient implies a particular analysis and study of the various social realities.

The identification and study of these realities should be translated in useful decision-making time aimed at building company strategy. In order to accomplish all that it would be necessary that private and institutionalized, as well as the various industrial system, find a common ground and that decision-making be the fruit of a sound integration among the various research centers on the university and private levels and among those political and private enterprise institutions.

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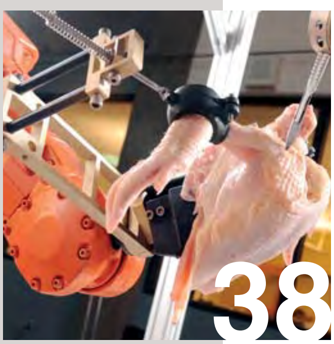
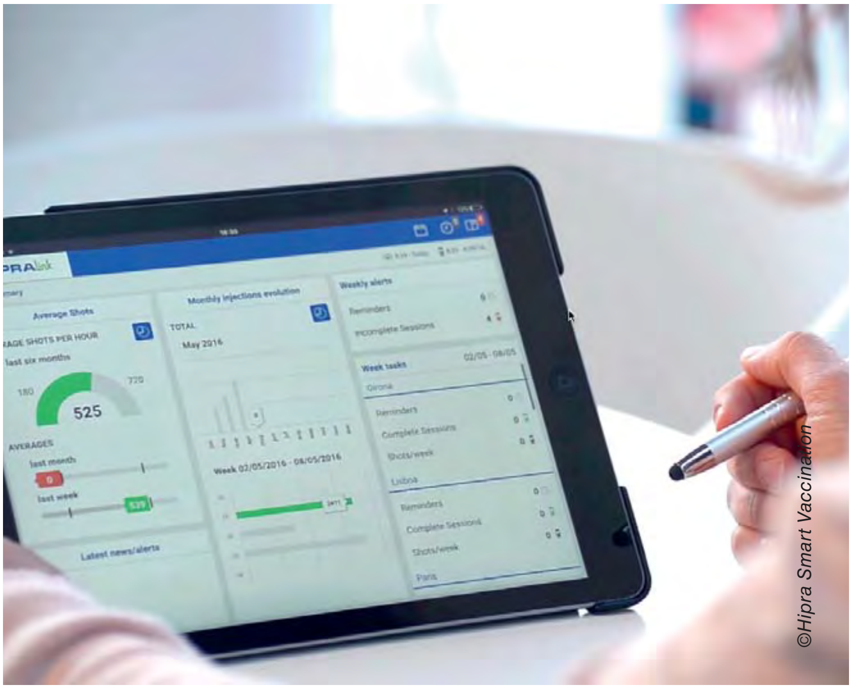
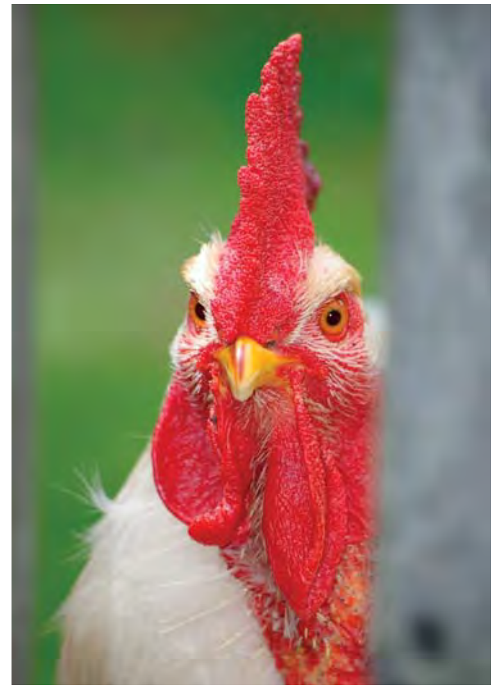
SUMMARY







New vaccine technique targets multiple poultry diseases

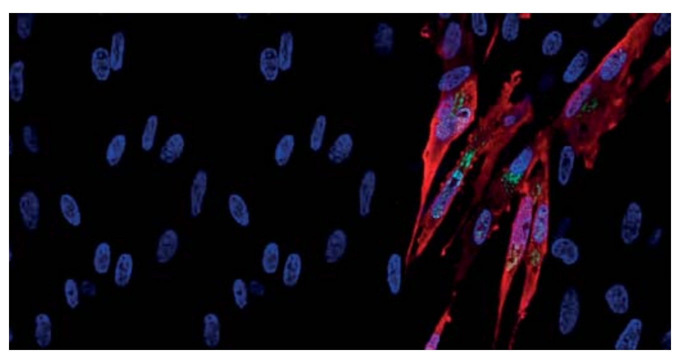
Researchers at The Pirbright Institute have created a new method of genetically modifying the Marek's disease vaccine so that it is able to protect against another destructive poultry virus called infectious bursal disease (IBD), and potentially others such as Avian Influenza and Newcastle disease. This approach could lead to a reduction in the number of vaccines that need to be administered to each bird.

For the first time, Pirbright scientists have been able to use a gene editing system called CRISPR/cas9 to add a gene of the IBD virus into a current Marek's disease vaccine virus. The added genetic material protects poultry against IBD in addition to the protection already offered by the Marek's disease vaccine, meaning that bird owners would only need to use one vaccine instead of two.

Other vaccines exist that achieve a similar result, but by using the CRISPR/cas9 system the Pirbright team have been able to insert the IBD gene far more quickly, easily and accurately than the methods that have been used before. This will significantly reduce the time needed to generate new vaccines, which will help to protect poultry quickly against outbreaks of new strains.

Professor **Venugopal Nair**, joint leader of the research at Pirbright said: "*The method we have created with CRISPR/cas9 really increases the scope of how we edit the Marek's disease vaccine to include other virus components. Now we have shown that our edited vaccine protects against both Marek's disease and IBD, we are looking at inserting more genes from other viruses.*"

The team intend to create a vaccine that will be able to protect against multiple avian diseases and will next target two high consequence poultry viruses - Avian Influenza virus and the Newcastle disease virus. The flexibility of the new method also means that as the viruses evolve, the vaccine virus can be easily edited to include new genes, which protect against emerging strains.



Cells infected with the Marek's disease vaccine virus, HVT, (green) expressing the inserted infectious bursal disease virus gene, VP2 (red). Cell nuclei are shown in blue.
Image by Dr Na Tang, Viral Oncogenesis group.

There has been huge commercial interest in using this technology to develop novel vaccines, so Pirbright scientists intend to partner vaccine manufacturing companies to bring CRISPR/cas9 edited vaccines to market.

This scientific paper can be found in the Vaccine journal and was funded by the Biotechnology and Biological Sciences Research Council (BBSRC); grant numbers BB/P016472/1 BB/L014262/1.

6th Mediterranean Poultry Summit

The 6th Mediterranean Poultry Summit is going to be held in Turin, Italy, from June 18-21, 2018. The Italian Branch of WPSA will host this summit which is being held at the University of Turin, one of the oldest universities in Europe with excellent facilities for the size of the meeting.

Professor Laura Gasco and Professor Achille Schiavone will coordinate arrangements with the University. The organizing committee is chaired by Ghassan Sayegh. Dr. Martino Cassandro, President of the Italian Branch, is heading the scientific committee while topics have already been proposed by members of the committee.

The Mediterranean Poultry Network (MPN) of World's Poultry Science Association (WPSA) was established in 2008. The MPN of the WPSA presently operates directly under the umbrella of Working Group (WG) 11 (Education and Information) of WPSA's European Federation.

It's constitution aims:

- To promote WPSA activities in all the countries of the Mediterranean region with special emphasis on the Eastern and Southern parts.
- To help expand membership of the WPSA in all countries of the Mediterranean region by creating new contacts with people involved in the poultry sector.
- To promote the spread of knowledge in the field of poultry science through encouragement for research, education and extension.
- To coordinate future Mediterranean Summits of WPSA by offering technical advice and know-how to the organizers to ensure the staging of appropriately focused and well-organized meetings.

For more information:
Email: torino2018@mpn-wpsa.org
Website: www.mpn-wpsa.org

A strong CAP with simple rules

FEFAC welcomes the overall orientation in the CAP Communication to favour more sustainable and environmentally-friendly farming methods in the future CAP, which will enable farmers to meet the commitments to the Sustainable Developments Goals and the COP21 climate change objectives.

The Future of Food & Farming Communication

FEFAC fully supports the call from Copa-Cogeca for a strong, competitive, market-oriented CAP with common and simple rules across the EU following the European Commission publication on "The Future of Food & Farming Communication", outlining the challenges and opportunities of the Common Agricultural Policy (CAP) post 2020.

A pragmatic approach

FEFAC welcomes in principle the EU Commission's intention to take a pragmatic approach and apply more flexibility taking into account the diversity of EU agriculture. FEFAC members, however, share concerns about potentially unintended consequences, which could give rise to market distortions and jeopardize the level playing field between Member States. In FEFAC's view, the European Commission needs to strengthen its role as guardian of the Treaty, thus preventing a further widening of the scope for national derogations and exemptions, which could undermine the CAP. FEFAC recalls its preliminary position on the CAP post 2020, which called for a rebalanced CAP strengthening the economic viability of the EU livestock sector.

Towards a more sustainable production

To obtain more sustainable and environmentally-friendly farming procedures, FEFAC calls for more publicly funded research, including animal nutrition science projects, to further reduce livestock-related GHG emissions while identifying effective mitigation strategies.

The European feed industry has heavily invested in a common methodology at EU and global level (PEFCR for feed & GFLI Feed LCA database project) to measure the environmental performance of feed production and is ready to provide assistance to livestock farmers to reduce their environmental footprint while improving animal performance and resource efficiency.

In addition, FEFAC is also committed to support the European Commission in the development of the new European Protein Plan, expected by the end of 2018. FEFAC recommends to EU policymakers to take a fully comprehensive approach that covers the strategic need to maintain market access to highly concentrated protein sources, which are essential to promote sustainable feeding strategies in Europe.

Compound feed production estimates for 2017

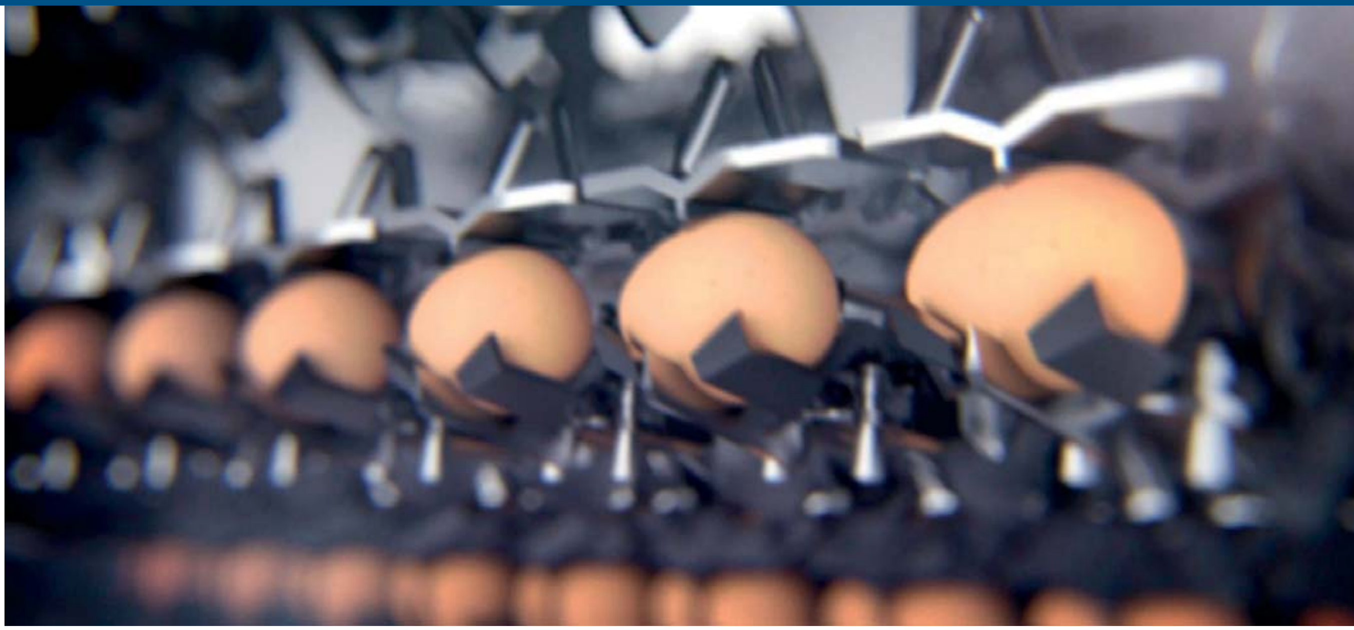
The industrial compound feed production for farmed animals in the EU-28 in 2017 reached an estimated level of 156.7 mio. t. i.e. 0.2% more than in 2016.

Concerning poultry feed production, the Avian Influenza outbreak severely impacted some poultry producing regions of Europe. A number of EU countries saw their poultry feed production stabilise and even slightly decrease, with the noticeable exception of Poland, which recorded a 7% growth for the third year in a row. All in all, EU poultry feed production remained almost stable and is still the leading segment of EU industrial compound feed production, well ahead of pig feed.

For the fourth year in a row, Poland was the best performing country, with annual growth of total compound feed production of +7.5%, boosted by the demand for poultry feed but also dairy feed. Among the largest compound feed producing countries, Germany, the Netherlands and Italy maintained their production of compound feed, whereas France and Spain recorded a drop of resp. -1% and -3% and UK increased its production by almost 2%. Germany strengthened its position as leading EU country in terms of total compound feed production, ahead of Spain and France.

Market outlook for 2018

Market experts are relatively optimistic concerning industrial compound feed production in 2018. While poultry exports will continue to be affected by restrictions in third countries due to Avian Influenza, the persistent trend to increase in consumption of poultry meat in the EU is expected to support a demand in poultry feed, leading to an increase of 1% in 2018. However, this could be constrained due to a trend in certain western countries to reduce stocks density in poultry holding triggered by animal welfare concerns. Overall, this would lead to a moderate 0.5% increase in compound feed production in 2018 vs. 2017.



Joint Venture between Giordano Poultry Plast S.p.A. and Sanovo Technology Group

The Joint Venture between Giordano Poultry Plast and Sanovo Technology Group will bring many opportunities for further development for both groups.

After several months of active contacts, the Giordano family accepted the request received from the Danish industrial group Sanovo Technology Group, world leader in the industrial technologies sector linked to eggs and egg-products, to enter with a minority share in the capital of Giordano Poultry Plast S.p.A.

The JV motivation stems from the awareness of the relevance of Giordano Poultry Plast production in many specific areas of activity in the poultry breeding sector and in the handling equipment for hatching and consumption eggs. Sector, the latter, of strategic interest for Sanovo Technology Group.

Both groups expect from a closer relationship between them the emergence of new and numerous opportunities for further development for both, with the immediate possibility of reaching new world trade areas through the structures and the people of Sanovo Technology Group, in addition to the concrete possibility to identify and put into production new products and technological solutions to give cutting-edge answers in the different sectors of the poultry and agro-industrial world.

Therefore, during the present week a strategic part of the share capital of Giordano Poultry Plast S.p.A. was transferred to a dedicated company belonging to the Danish group.

Mr. Oscar Giordano CEO of Giordano Poultry Plast said: *"We are particularly satisfied for the realization of this partnership with such a representative group as Sanovo Technology Group. It is a clear recognition of the leadership assumed by our products on the global market".*

"As Sanovo Technology Group, we pursue excellence in each sector of our chain of machinery and products for the food industry. The collaboration with Giordano opens new and significant opportunities in strategic sectors such as product logistics and in many other fields of poultry production" said **Michael Strange Midskov, CEO of Sanovo Technology Group**.

Nothing will be modified in the management and daily operation of Giordano Poultry Plast, which remains totally entrusted to the members of the Italian family Giordano.

For more information:

www.poultryplast.com - **www.sanovogroup.com**

GIORDANO POULTRY PLAST purely professional

SANOVO TECHNOLOGY GROUP

Two important events for Hy-Line International

The Ambassador Terry Branstad (on the left) speaking with Jonathan Cade, President of Hy-Line International

Hy-Line International meets with US Ambassador to China

Hy-Line International, the world leader in layer poultry genetics, recently met with U.S. Ambassador to China, Terry Branstad, during his visit to Des Moines, continuing a series of discussions urging the Ambassador to provide all possible assistance in opening the China market to imports of US poultry breeding stock.

"It is vital for the China market to open again to US poultry breeding stock imports. Our distributors in China must continue building on their success with Hy-Line varieties by receiving the latest in genetic advancements," said **Jonathan Cade, president of Hy-Line International**. "*Ambassador Branstad has a long history with and knowledge of Hy-Line investments in Iowa, of which he trusts the integrity. We trust he will persevere in his work with the Chinese government to resolve this issue. We thank him for his support.*"

Hy-Line International Global Distributor Conference

The successful two-day Hy-Line International Global Distributor Conference held in Beijing, China attracted more than 140 key leaders from nearly 40 countries. The keynote speaker was the US Ambassador to China, Terry Branstad.

The participants received the latest updates regarding Hy-Line, heard from top industry experts in the global feed and egg industries, and networked with fellow distributors.

"*It is vitally important to bring our valued Hy-Line customers, who are global leaders in the layer industry, together to learn, ask questions and gain resources to make their businesses even more profitable*," said **Jonathan Cade, president of Hy-Line International**.

Participants also enjoyed visits to the unrivaled Great Wall and Forbidden City in the 3,000 year- old dynamic capital of China.

Founded in 1936 by Henry A. Wallace, Hy-Line was the first poultry breeding company to apply the principles of hybridization to commercial layer breeding.

Today, Hy-Line International continues to be a pioneer as the first company with its own in-house molecular genetics team leading the industry in application of DNA-based technology to its breeding and genetics program.

Hy-Line Global Distributor Conference
October 9-11, 2017 | Beijing

Hy-Line produces and sells both brown and white egg stock to more than 120 countries worldwide and is the largest selling layer in the American egg industry and around the world.

For more information:
www.hyline.com

Hy-Line

Ovoset Pro: a gentle workhorse

Tony Norris and his wife Susan started Norris Farms, a broiler breeder egg farm, 12 years ago near Swansea, South Carolina. Norris Farms consists of three barns with approximately 12,000 layers per barn. The eggs they produce are destined for a hatchery at Columbia Farms in South Carolina.

Back in 2005, Tony made the big decision to further automate his farm. He purchased a Prinzen PSPC 7 and, as he tells it, there were initially a few skeptics worried about 'cracked eggs' in an automated system.

Last year, Columbia Farms upgraded their existing hatchery. In doing so, they introduced a new size of hatching tray Norris Farms would need to use going forward. To facilitate the new tray, the PSPC 7 was replaced with a Prinzen Ovoset Pro, complete with Trolley Loaders.

"Many machines try to mimic the Ovoset, but this packer is the best. If you are going to pay for quality, no other machine is this hearty," noted Tony Norris, CEO of Norris Farms. *"Day-in and day-out the durability of this packer has shown through, and I work it eight hours a day and operate it about 300 days a year."*

Beyond being a workhorse, the Ovoset Pro is also gentle. *"All breeder egg producers know that hatchability is key. This packer's egg transfer system gently places eggs onto setting trays, limiting hairline cracks. Prinzen packers are also renowned for their accurate points-down setting, which is 3% higher when compared to hand-setting eggs,"* pointed out Josh Thompson, General Manager of Vencomatic.

A Prinzen packer's accurate points-down setting of 99.7% translates into an increased hatchability of up to 5% over hand-setting. The packer's preloaded software also provides farm operators with flexibility by allowing them to select from a variety of predetermined tray types and then adjusting the hardware to match.

The Trolley Loader option on the Ovoset Pro automatically lifts and places egg trays onto the trolley, resulting in a more productive and safe work environment.

"The Trolley Loader is amazing. Our trays are 162 eggs and you can't ask someone to lift a tray like that hundreds of times a day," said Norris. *"The Trolley Loader helps to alleviate my concerns about worker safety."*

The fully-automated Ovoset Pro reduces labor throughout the egg handling process. In fact, with the addition of Prinzen packers, Norris Farms was able to reduce their staff from seven to two. In addition, its compact and flexible design, stainless steel construction, and easy access to all vital parts for quick and thorough cleaning and maintenance makes the Ovoset Pro a welcome addition to any egg handling room.

Vencomatic Group
Agro Supply – Prinzen – Vencomatic

Meyn solding the 300th Rapid breast deboner at IPPE 2018

Meyn, the market leader in poultry processing solutions, has sold its 300th Rapid breast deboner to Perdue, one of the leading food and agribusiness companies based in North Carolina, USA.

The Meyn Rapid and Meyn Rapid plus were launched almost a decade ago and from the start have been a great success, thanks to the unrivalled performance from 4,000 to 6,000 front halves or breast caps per hour in relation to the highest yield in the market.

The Rapid series M4.0 is carefully designed to minimize installation time and optimize the footprint/capacity ratio. Poultry producers worldwide can enjoy low total cost of ownership while saving up to 57 full time employees per shift.

At IPPE 2018 in Atlanta a hand-over ceremony was held with Mr Rodd Flag, Vice President Perdue and Mr Robert Bertens, Director Sales & Projects Meyn America.

Commenting on the importance of this milestone, Robert Bertens, Director Sales & Projects Meyn America said, "*Perdue is a great company and a long-time customer. We are honored that we can support them in becoming very successful in a highly competitive market"*.

meyn
Poultry Processing Solutions

Visit to Eurosilos Sirp

Eurosilos Sirp is a state-of-the-art production company, created in 1972 by Mario Telefri with their headquarters in Isorella, Brescia, Italy. Specialized in the production of high quality fiberglass silos for the conservation of raw materials; feed-stuffs; cereals; fertilizers; products for industry; chemical ingredients and products, Eurosilos Sirp is part of the Telefri Group, together with other affiliated companies such as Zincatura Bresciana; Italmix (producer of livestock feeders); Silos France in France, and Fontana in Slovakia.

Today, the company is owned by Dayana and Luigi Telefri, the sons of Mario, who have continued the family tradition by intensifying their activity, greatly expanding the range of their activities, and thereby making Eurosilos Sirp a solid and well-established production enterprise.

During our visit to their modern plant in Isorella, Guglielmo Zappini, Sales Promoter of the Export Office, showed us the production structure housed in a covered area of 12,000 square meters, organized in different warehouses dedicated to the production of fiberglass; metal parts; augers and tank wagons.

"The silos and containers are made in various sizes and are available in numerous versions; they are designed to be shipped overseas in containers with capacities ranging from 2 up to 42 tons. Then there are the monolithic silos, single body design mainly directed to the Italian market that are delivered by our company trucks, lifted by crane and placed on site by specialized personnel. We also supply several series of jointed vertical or horizontal silos with support rings, which allows several units to be transported in a single truck.

All our fiberglass silos comply with international static regulations. The company has been certified by the Deutsches Institut für Bautechnik Dibt Z-40-17-503 since the early 1980s and the international EN 1090 certification for the fabrication of metal structures.

Fiberglass silos have different properties which provide clear advantages over traditional metal or aluminum silos namely high resistance to corrosion; minimum maintenance (apart from conventional cleaning); minimum installation costs; excellent thermal insulation; minimum condensation sensitivity; resistance to extreme temperatures and mechanical resistance.

It can be customized with the company logo or with that of the purchasing company. This is not a simple sticker on the silos, which could break off over time, it is a logo carefully impregnated in the fiberglass with a duration equal to that of the silo itself.

To compliment our range of silos we also supply innovative tailor-made solutions for the conveyance of material to and for the filling and unloading of the silos. We also manufacture rigid and flexible cochlea systems that calibrate dosage; transport and management of distribution systems in feed storage layouts in livestock production operations.

The company also manufactures fiberglass boxes for housing calves in three dimensions: from the smallest that houses one animal up to the largest for 16 calves.

We also sell feed box systems with a capacity of 2 or 3 cubic meters. They are very practical structures, movable using forklifts trucks and easily transportable. These are ideal especially for those companies with disadvantaged truck access. They are easily filled from above and have shutter drainage. The capacity can range up to 2 tons.

In the last two years we have also specialized in the supply of tank wagons for the handling of feed from the feed mill to the company. They have a capacity range of 35 to 200 quintals, and can cover every need.

The company has an entire department dedicated to logistics and equipment delivery and our network covers 40 countries. Exports stand at 80% of turnover, with the remaining 20% being sales to our Italian customers."

Dayana Telefri then gave us an overview of the company's philosophy and future prospects.

"Our activities are based on the concepts of quality and innovation. The path taken to achieve and develop these goals started a long time ago, and we have seen progressive growth up to our current specialization. Producing with quality means providing a product that lasts over time and has high performance levels. This also implies significant investments in economic and productive terms.

Fiberglass is the best storage material for its intrinsic qualities that are ideal for keeping feed in optimal conditions. The high thermal insulation prevents bacterial proliferation, which affects the nutritional qualities and negatively influences animal feeding. This is essential guarantee for the entire supply-chain up to the final consumer – ***from the feed stuffs to the table.*** *The characteristics of resistance, non-conductivity and perfectly smooth surfaces represent a guarantee for the healthy quality of the product stored, with a positive and continuous response also on the welfare of the livestock.*

Zincatura Bresciana *of Verolanuova also contributes towards guaranteeing an excellent product at every level. Famous for its partnership in the creation of the Tree of Life symbol of Expo in Milan and for the coverage of the Stavros Niarchos Foundation of Athens, which was founded by us about 20 years ago. The company operates at a very advanced technological level having a production facility equipped with a galvanizing tank that is among the largest in Europe (14.20 x 2.70 x 3.40) and employing about 100 employees.*

Italmix *joined the Group a few years ago. It produces mixer wagons and, in a few years, it has grown considerably, going from 20 to 30 units per year to 150 today with sales not only in Europe but also in Japan, Iran and many other countries.*

Our own future objectives are directed at expanding into new markets, publicizing and promoting our high levels of quality while illustrating the advantageous characteristics of fiberglass, especially in those countries where the climate negatively affects the quality of stored product.

It is essential to understand that a more advanced technology involves both greater productivity and unquestionable practical advantages from the point of view of health, ecology and sustainability – issues that today we are all particularly sensitive to."

Maria Gabriella Maggini, Sales Manager of the Export Office, talked to us about the vertical control of the entire production chain and the importance of guaranteeing a product designed for the specific needs of each market.

"Everything is produced within our company facilities, which allows us to follow and to satisfy the diverse requirements of the market place. We are able to respond to everyone in a particular and appropriate way regarding the structure of the equipment, the make up of the metal parts and in the various components of the silos, augers, unloading and loading and food distribution equipment. New applications are developed every day.

We concentrate all the production at the Isorella headquarters, in order to have maximum control over all the processes. Each step is followed by a highly qualified and experienced team, combined with the usage of the latest generation of machinery and robots.

Galvanizing is a fundamental part of production. As Fiberglass is a quality material it demands that the metal parts of the silos are equally produced to a high standard to ensure lengthy durability.

For silos in areas close to the sea, which are characterized by high levels of salinity, further processing is required namely ***passivation*** *– which protects the brilliance of the galvanization for longer.*

Investing in quality is essential to optimize performance and to increase company competitiveness.

Feeding is the highest cost in any type of livestock production and feed is a valuable asset for farmers. Today, feeds are increasingly integrated and sophisticated, have a significant economic value in terms of efficiency, profitability and safety and require extreme care in storage. With our silos, growers are sure to get the best storage performance."

EURO SILOS

S I A P


zootecnica
Dermanyssus gallinae, a wider concern for poultry production

Incubation and the role of Carbon Dioxide (CO_2) in embryo development

The practice, or "art", of artificially incubating the avian egg dates back some 3,000 years to the ancient Egyptian mud/brick oven type rooms designed in an attempt to incubate eggs from native fowl. Since those very early attempts at artificial incubation, the general goal of those incubators, as well as the incubators of today, is to mimic "nature's incubator" or the mother hen.

JAMESWAY

Dr. Keith Bramwell
Senior Technical Advisor
for Jamesway Incubator
Company Inc.

However, with all the modern research technology available to us today and with the modern equipment developed to implement this knowledge and information, we still have much to learn to provide the embryo with the optimum environment to develop properly. In addition to the innate ability, the hen has to respond to ambient environmental changes for the benefit of the embryo, she provides warmth to the eggs mostly through direct contact of her skin to the egg with little, if any, forced air movement around the incubating eggs. Therefore, this might explain why information that tells us that the mother hen provides temperatures warmer than most artificial incubators may not be as helpful when trying to mimic the hens daily incubation profile. Nevertheless, the attempt to copy "Nature's Incubator" remains the primary objective for commercial hatcheries and incubation design and operations.

Artificial incubation

While modern incubation equipment has the ability to control conditions within the machines better than ever, the same basic principles of incubation still apply. Namely, we must control temperature, humidity, ventilation (air or gas exchange), and turning of the eggs. How well these conditions are met may vary with equipment age and type as well as their upkeep and maintenance to keep them working in the manner in which they were designed. Once these conditions are met, the incubation process is then often thought to be a separate event from the grow-out phase of broiler production. However, in reality, embryo growth and the basic physiological development of the embryo should be considered to be the first three weeks of the broiler grow-out phase. In other words, the first three weeks of the broiler grow-out should be considered as occurring in the egg and in the hatchery. Therefore, as we know that the first few days of life of the hatched chick can have a lasting effect on the performance of the broiler; it stands to reason that incubation conditions can affect the physiological development of the embryo in a manner that can affect the performance of the chick long after hatch. Taking this into consideration, there is much to be learned regarding the long term affects of the environment we subject developing embryos besides hatchability and 7 day livability.

Room for change?

One area receiving considerable attention recently is the affects of carbon dioxide on embryo growth during the incubation process. The long held beliefs about ventilation or air/gas exchange during incubation, was that a setter should work to *remove* carbon dioxide from the machine and replace it with oxygen. The belief was that CO_2 was harmful to the developing embryo and that fresh air and plenty of oxygen was needed for optimum chick development and hatchability. However, with atmospheric CO_2 levels typically around 400 ppm, and with averaged measured CO_2 under the hen at around 4,000 ppm, it is obvious that the hen incubates her eggs to maintain a certain level of CO_2 above what is found in the ambient environment. While this level under the hen is obviously dependent upon the age of the embryo and the frequency in which she leaves the nest, the idea is that she does incubates her eggs at CO_2 levels substantially higher than atmospheric levels. At present most incubator manufacturers accept the need to control and monitor

"While the overall goal of incubation is still to provide optimum conditions for embryo growth, technology has allowed for better control of these conditions therefore allowing 'fine tuning' of the environment we create for developing embryos"

CO_2 levels not just in an effort to replace it with oxygen, but to maintain a certain level of CO_2 for periods of time early in the incubation process. It is known that as the embryo grows its level of CO_2 production continues to increase exponentially after the first six days of incubation. Therefore, at around six days of incubation CO_2 is typically monitored in an effort to control peak levels attained inside the incubator with a general belief that elevated CO_2 levels late in incubation is detrimental to embryo livability. At the cellular level of the developing embryo, O_2 and CO_2 exchange is occurring rapidly and as the embryo grows in size and structure the O_2 demands and CO_2 production are increased as previously mentioned. Therefore, the measure of gas exchange for the developing embryo is simply a magnification of what is happening at the cellular level.

While the overall goal of incubation is still to provide optimum conditions for embryo growth, technology has allowed for better control of these conditions therefore allowing 'fine tuning' of the environment we create for developing embryos. Additionally, with improved single stage incubation designs this has allowed our management programs to incubate eggs more closely to what is needed for optimum growth of specific embryo's and not for 'the average'.

As a biological entity, the chicken embryo is designed to grow and develop in an effort to survive. Could it be that now that we can more precisely control the environment in which we incubate chicken eggs that altering various conditions, such as CO_2 levels during incubation, would cause physiological changes in the developing embryo that might persist after hatch? As the embryo develops in a situation that is suitable for growth but may also cause the basal physiological development to be altered in an effort to survive, could we produce broiler chicks that are better prepared for the sometimes stressful conditions in which they are reared? There is still much to learn about the developing embryo; and the possibilities of what we can do during the incubation process to prepare chicks for the last phase of growth outside the shell is still largely not understood.

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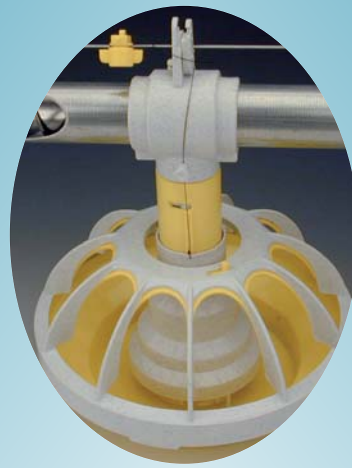


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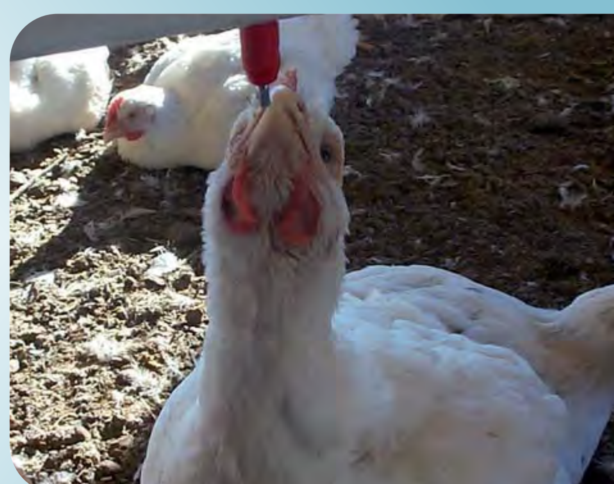

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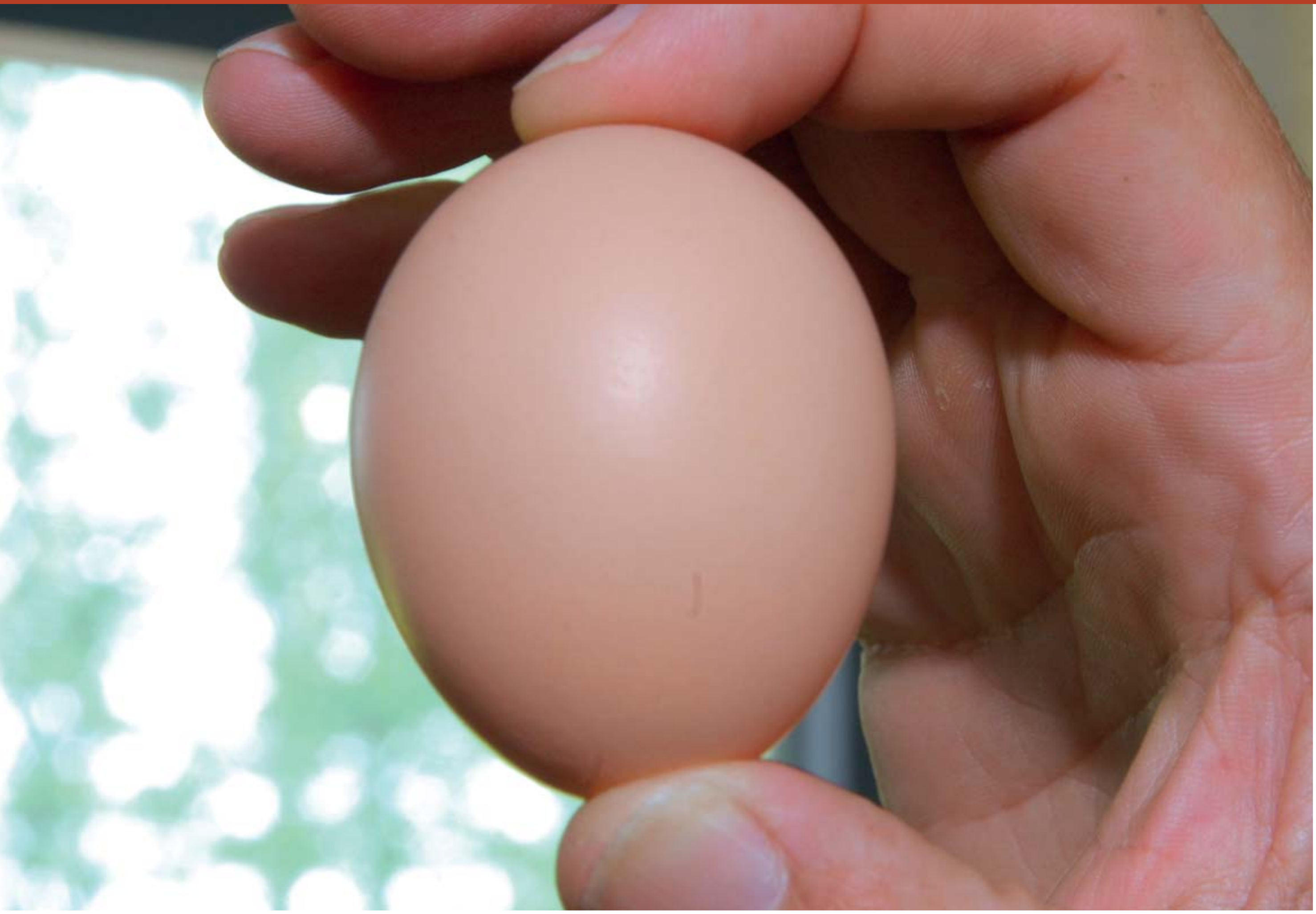

Hatching egg quality

Hatchability and chick data are the most important references for optimising incubation management. The age of the flock, number of storage days and incubation program are typically included in the analysis and optimization of hatchery results, but very often, insufficient attention is paid to the quality of the hatching eggs. While external quality is usually considered, there is much debate regarding internal quality control on a regular basis.

Pas Reform
Hatchery Technologies

Dr. Marleen Boerjan

Egg quality in the broadest sense has been affected by genetic selection, for production traits like growth, feed conversion, number of eggs and egg shell quality. Breeding companies generally pay less attention to egg parameters related to hatchability and chick quality, which has led to increasing variability between batches of hatching eggs.

Ongoing research shows that genetic selection for production traits makes high demands of breeder management with respect to feed composition and feed restriction management. Genetic selection has influenced egg size, the yolk:albumen ratio and shell quality. Feed restriction management influences the development of the reproductive tract and the nutrients available to the growing embryo from yolk and albumen. In addition, with the management of breeders becoming more complicated, the risk of stress, aggressive males and overcrowding has increased with inherent consequences for egg (embryo) quality.

In conclusion, if specific protocols for optimizing incubation management are used, it is necessary to evaluate hatching egg quality on a routine basis. A brief summary of internal and external parameters is presented hereafter.

Egg shape

A good quality hatching egg has a blunt side containing a small air cell and a clearly recognizable sharp end. Too many abnormal, or misshapen eggs signifies immaturity of the shell gland, young parent stock, disease, stress and overcrowding in the flock.

Egg shell

High quality hatching egg shells are smooth, without ridges or small lumps of calcified material (pimples). The colour of eggs within a batch is uniform. Young flocks produce eggs with thicker shells and when the flock ages, the shell becomes thinner and the incidence of abnormal shells increases. Insufficient calcium or vitamin D3 content in feed will produce thin egg shells. Saline drinking water and high levels of chlorine will also cause shell quality problems. Abnormal white, thinshelled eggs may indicate a variety of diseases (IB, NCD, EDS).

Albumen

Good quality hatching eggs contain a higher proportion of thick, viscous albumen with less thin albumen. The volume of thick albumen reduces with increased flock age and after storage. Good quality albumen is translucent with a greenish or yellow cast indicating the presence of riboflavin. Meat or blood spots point to stress or overcrowding in the flock.

Yolk

The size of the yolk increases with flock age and thus the ratio of yolk to albumen increases. In good quality hatching eggs, the yolk has a uniform colour without any blood or meat spot. Mottled yolk points to stress in the flock.

Embryo

The embryo floats on top of the yolk. In the un-incubated egg, the embryo is visible as a doughnutlike opaque ring with a translucent centre. A good quality embryo is 35 mm in diameter.

Advice

- Do not take egg quality for granted when optimizing hatchery economics.
- Use specific egg quality forms to record the quality of each batch of eggs received at the hatchery.
- Record the number of good quality eggs and the number of eggs not fulfilling required standards for every batch of eggs received.
- Take a minimum sample of 10 eggs to record the quality of the embryo, albumen and yolk.
- Communicate openly with your egg supplier regarding egg quality, with the mutual aim of improving and/or maintaining quality.

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PETERSIME
INCUBATORS & HATCHERIES

Better hatch and post-hatch performance

Hatchability, chick quality and post-hatch performance improve substantially when embryo-response parameters are actively controlled during incubation.

By Roger Banwell

Petersime Hatchery Development Manager, Belgium

The BioStreamer^{TM} concept, developed by Petersime, continually monitors an embryo's behaviour and adapts the incubation environment to its specific needs. Petersime has put considerable effort into researching optimum incubation profiles. Some of the most striking results are presented in this article.

Fig.1 - OvoScan™ monitors the actual eggshell temperature on-line and continuously adjusts the incubator temperature in order to achieve the required eggshell temperature trajectory.

During incubation, a chick embryo has no self-control mechanisms. So, the environment should adapt to the requirements of the embryo, and not vice-versa. Since each batch of hatching eggs is unique, it requires a unique incubation environment achieved in real-time conditions. Traditional single-stage incubation systems use averaged incubation parameters, ignoring differences in egg age or size, flock age, shell porosity, genetics, and other important variables.

Constant interaction with the embryo

Petersime's *Embryo-Response Incubation™* process constantly and interactively optimizes the incubation environment. The process controls ventilation, humidity and temperature according to the embryo's particular needs. Scientific research and extensive field tests have proven that hatchability and chick quality, as well as post-hatch performance, benefit greatly from active control of bio-response parameters during incubation.

Real-time eggshell control: top quality day-old chick

Embryo temperature is another, and perhaps the most important key parameter in reaching optimal hatchability and chick quality. Deviations from the optimal temperature may negatively influence the development, growth and maturation of the embryo. During the first stage of the incubation process, heat must be transferred from the air to the egg. After approximately one week, the embryo's metabolic heat production rises, and incubators have to start cooling instead of heating. So, air temperature, humidity, and air velocity in the incubator have to be adjusted continuously to maintain the right embryo temperature. But how to measure the embryo's temperature? Invasive measuring is the surest method, but it is destructive and unsuitable for real time measurement in commercial hatcheries. Measuring the temperature of the eggshell with contact-less infrared sensors solves the problem.

Petersime's patented OvoScan™ system (*Figure 1*) continuously adapts the incubator temperature to the eggshell temperature. Petersime conducted experiments to assess the effect of OvoScan™ on both hatch and post-hatch performance. In a setter not monitored by OvoScan™, the eggshell temperature typically diverges from the required level during the exothermic stage of incubation. With OvoScan™ control, the eggshell is rigorously kept at the pre-set temperature of 100°F. The observed results in detail:

- Gain in hatchability: 0.4% (average).
- Gain in day-old chick weight: 1.8 g (average).
- Gain in day-old chick length: 1.4 mm (average).
- Gain in end weight: 60.2 g (average).

Dynamic weight loss: 1.88% gain in hatchability

One important parameter is the weight loss of the eggs in the setter. For optimal hatchability, eggs need to lose up to 14% at point of hatch (typically 10-12% at transfer) of their weight (in the form of water vapour) during incubation.

Petersime developed and patented the *Dynamic Weight Loss System™* (*DWLS™*) to control the humidity level in the incubator and thus manage this water-weight loss. The DWLS™ measures the eggs' weight during each incubation stage and automatically adjusts the incubator's humidity level to achieve the optimum weight-loss trajectory.

But what is the optimum weight-loss trajectory? To solve this, Petersime introduced a new single-stage incubation concept: the non-linear weight-loss principle (see *Figure 2*). Field tests, comparing this dynamic weight-loss principle with traditional single-stage and multi-stage incubation, were conducted on nearly 4 million eggs and showed an overall gain in hatchability of 1.88%.

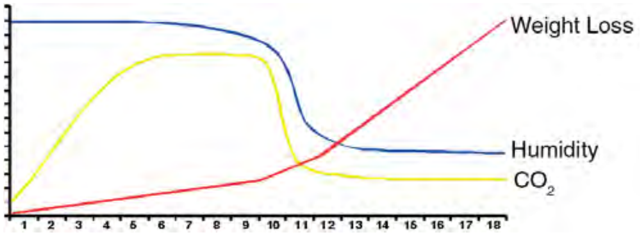


Fig. 2 - The revolutionary non-linear weight-loss principle results in a 1.88% overall gain in hatchability compared to traditional incubation.

CO_2 control: improved embryo growth

The third essential parameter that is meticulously controlled in the BioStreamer™ concept is gas exchange. The patented

CO_2NTROL™ (a real-time CO_2 management device) controls the CO_2 level in the setters, which has a beneficial effect on the development of blood vessels and embryo growth and works hand in hand with the DWLS™ principle which emulates much closer the natural incubation conditions experienced by the egg in the nest. In addition, precisely timed CO_2 stimulation in hatchers leads to simultaneous pipping and hatching as well as improved chick quality.

Post-hatch performance improved as well

With a series of field tests (over 2.5 million eggs in total) in a commercially-integrated site, the non-linear weight-loss method clearly and consistently induced a pattern of initially depressed growth, followed by a catching-up or compensatory post-hatch growth (see *Figure 3*). This pattern leads to an overall gain in end weight, meat yield and feed conversion rate, as well as lower post-hatch mortality. The following results were observed:

- Reduced post-hatch mortality: -0.23% (average).
- Enhanced post-hatch growth: 64 g per 39.4 days (average).
- Improved feed conversion rate: average -0.019 (average).
- Improved meat yield: 1.2% of slaughter weight (estimated 0.9% of live weight).

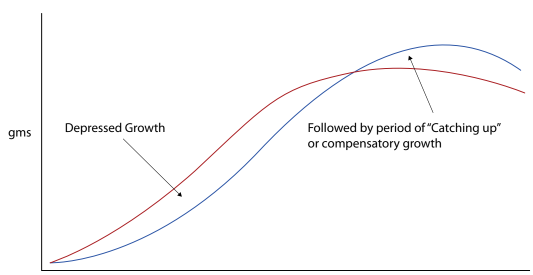


Fig. 3 *- Enhanced growth compensates for the initially depressed post-hatch growth, leading to an overall gain in end weight, meat yield and FCR.*

Narrowing the hatch window and improving chick quality

Working with world-renowned universities, Petersime is continuously searching for ways to optimize other promising embryo-response parameters and further optimize the incubation profile. An approach that has resulted in the recent addition to the Petersime embryo response control parameter Synchro-Hatch™. A system that further emulates the nest interaction between parent bird and the hatching egg by sensing the point at which the chick moves towards the air cell and ultimately externally pipping and escaping the confines of the shell and achieving full lung action.

The results of working with new technologies are significant. Synchro-Hatch™ reduces the hatch window with four to six hours. The narrower the hatch window, the more uniform chicks are, enhancing both productivity and welfare.

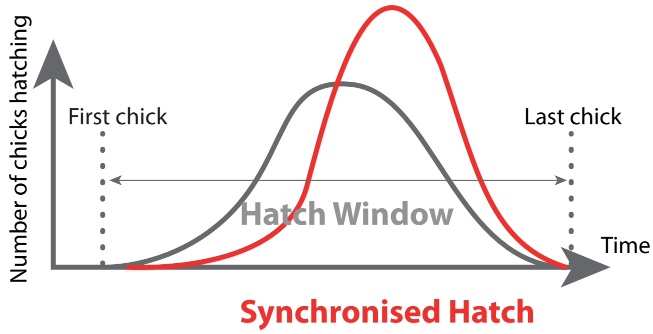


Fig. 4 *- Synchro-Hatch™ narrows the hatch window.*

Extensive in-house trials and research in commercial hatcheries show that day-old chicks

- are significantly more uniform,
- are generally calm, but active and responsive when stimulated,
- have a stronger and more robust appearance,
- higher body weight,
- better feed conversion ratios,
- lower postnatal mortality rates,
- better efficiency in slaughterhouses,
- total higher meat output in the end.

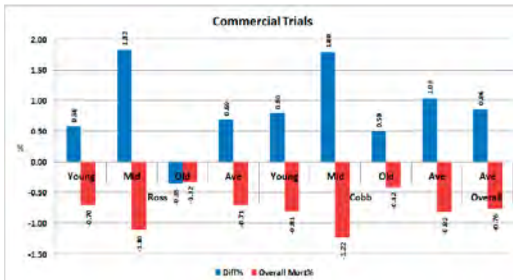


Fig. 5 *- Synchro-Hatch™ lowers overall post-hatch mortality of chicks in farms*

How does Synchro-Hatch™ work?

Synchro-Hatch™ gives the embryos the same signals and stimuli as it would experience from the attentive mother bird in nature and offers optimal hatching conditions. In nature, the parent bird does not sit back and watch the hatch happen. She intervenes and interacts during the entire process. During the hatching phase, she returns to the nest and sits on the eggs for the majority of the time to guide the chicks to hatch. This affects the rate of gas diffusion, the moisture exchange and the heat dissipation during the four stages of hatch.

It is wrong to say that Synchro-Hatch™ delays and/or forces the hatch to occur. Correct is to say that Synchro-Hatch™ gives the encapsulated chick the same signals and stimuli and guides the chicks in the same way as it would naturally expect in the nest from the parent bird. It thus offers the optimal and most natural hatching conditions.

The technology uses two detection principles to detect the evolution of the hatch and how far the hatching has progressed:

- the moment of internal pipping and,
- the detection of the humidity peak.

What happens during hatch?

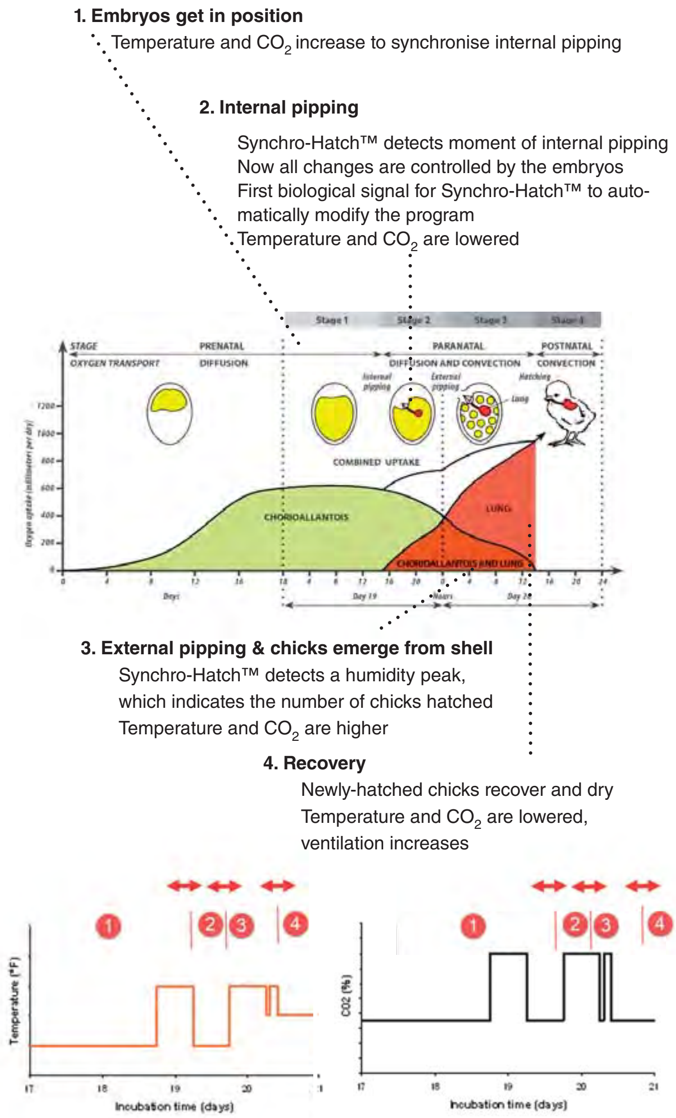


Fig. 6 - Synchro-Hatch™ automatically adapts the temperature and CO_2 levels to guide the chicks through hatch. Time schedules can vary and are controlled by the hatching chicks.

Natural treatments during sensitive stages

By having a better understanding of the hatching process and the interaction between mother hen and the embryos, we are able to provide natural treatments to the embryos during sensitive stages which have a long-lasting effect. Letting the chicks decide when they are ready to move forward to another stage of hatch with modern sensors and technology has proved to be the most consistent and certain way to achieve a narrow hatch window and uniform chicks of optimal quality. We are now able to provide the optimal conditions for guiding chicks during hatch that are not controlled on time base, but on the real biological signals emitted by the batch of chicks.

Embryo-Response Incubation™, Petersime's patented technology, optimizes incubation conditions by listening to the natural needs of the embryo. It helps hatchery managers gain even more insight into the incubation process and enables them to more closely approximate the desired incubation profile in the setter. To make sure hatchery managers get the maximum out of their BioStreamer™, Petersime provides professional training and advice. For questions or more information regarding training please contact Petersime's training coordinator at training@petersime.com

Checklist for optimal use of Synchro-Hatch™

- ✓ Keep batches of eggs as uniform as possible, with limited difference in breed, flock age, storage times and fertility
- ✓ Assure good homogeneous storage conditions
- ✓ In case of prolonged storage, restore the fertility of the eggs with BioStreamer™ Re-Store, which will also increase uniformity
- ✓ Check if eggs come from a farm with good management, such as having appropriate collection times and good storage conditions
- ✓ Use single breed for optimal performance
- ✓ Use a setter with highly uniform conditions, e.g. Petersime BioStreamer™
- ✓ Follow the correct loading and transfer pattern to group batches of eggs
- ✓ A fully loaded machine ensures an optimal airflow

About Petersime

Petersime provides world leading incubators, hatchery equipment and turnkey hatcheries aligned with the expertise and support to maximize return on investment. Through the Operational Excellence Programme™ Petersime provides best practices support on every operational level and becomes a partner for life for its customers. Headquartered in Belgium with offices in Brazil, China, Russia, Malaysia and India, Petersime commits to a dedicated customer service worldwide. With a sales network in more than 60 countries, a local and global expertise is covered.

Health and industry issues facing the US turkey industry

Dr. Steven R. Clark[1,2*]
Poultry Veterinarian Devenish Nutrition, LLC Fairmont, Minnesota Victoria Ahlmeyer Scientific and Regulatory Affairs Coordinator National Turkey Federation (NTF) Washington, D.C., USA

[1]Turkey Health subcommittee chairman of the United States Animal Health Association Committee on Poultry & Other Avian Species.

[2]Clark, et.al. Turkey Industry Annual Report available since 2000 www.usaha.org

In preparation for this report to the USAHA Committee on Poultry & Other Avian Species, the subcommittee chairman, Dr. Clark, surveyed turkey industry professionals and veterinarians representing (n=23) the US turkey production regarding the health status of turkeys produced in August 2016 through August 2017. The turkey industry reports several disease challenges for this 12 months varying by geographic regions within a state and across the United States. This report will list, Table 1, the challenges by disease and issues. Of particular interest in 2017 are issues with lack of efficacious drugs, colibacillosis, ORT, clostridial dermatitis, coccidiosis, Bordetella, and blackhead.

The “**lack of approved efficacious drugs**” continues to be the top health issue (*Table 1*). The withdrawal of the NADA (New Animal Drug Application) for enrofloxacin in 2005 for use in poultry leaves the industry with no adequate therapeutic response to ***colibacillosis*** (ranked #2, up from #3 since 2009-2015), or **fowl cholera** (ranked #12 from #11). In July 2011 the sale of roxarsone was suspended; September 30, 2013, the FDA marketing authorization NADA was withdrawn. The sponsor of Penicillin-100 Type A medicated article (in feed administration) withdrew the approval (NADA) June 30, 2015. Nitarsone (see **blackhead**) approval was withdrawn December 31, 2015. Issues over the use of antibiotics in animal agriculture remains a major concern for the turkey industry and for all of animal agriculture.

Clostridial Dermatitis (CD), also referred to as ***Cellulitis***, remains a major disease issue across all geographic regions; as the survey average changed slightly to a score of 3.4 (from 3.3 in prior year) and slipped to a #4 rank (from #3 in 2016 and #2, 2008-2015). CD is most commonly seen in, but not limited to, commercial male turkeys nearing market age. *Clostridium septicum, C. perfringens* type A, or *C. sordelli* is isolated from fluid or affected tissue samples of affected or dead birds. Affected turkeys present with two or more of the following clinical signs: subcutaneous emphysema (crepitus); serous or serosanguineous subcutaneous fluid; vesicles on the skin, especially on the breast/inguinal area; moist, dark, wrinkled skin, especially breast/inguinal area; cellular necrosis (microscopic); organ involvement (spleen/liver); vesicles on the skin, and/or moist, dark, wrinkled skin, on the tail area. The affected flock will have mortality greater than or equal to 0.5 dead per 1,000-birds, fitting the individual bird definition, for two consecutive 24-hour periods. Opinions vary as to risk factors and potential causes of the problem. Some of the key areas to control of CD include: early recognition; removal of mortality 2-3 times per day; medicating affected flocks with appropriate antimicrobials; promptly managing all water spills and wet litter, feed outages and do not compost litter within 200 feet of poultry barn. There has been limited success with vaccinating at-risk flocks with autogenous bacterins and toxoids.

ORT (*Ornithobacterium rhinotracheale*) ranked #3 versus #4 in 2016 (#7, 2015), is a highly contagious respiratory disease in poultry caused by a gram-negative pleomorphic rod-shaped bacterium. It has been isolated from chickens, ducks, partridges, and guinea fowl. It was originally recognized in Europe and South Africa. ORT was first confirmed in the U.S. from turkeys in 1993. Horizontal transmission (such as, bird-to-bird, contaminated people and equipment) by direct and in-direct contact is the primary route of spread. However, vertical transmission is suspected (Hafez, 2000). In the fall of 1995 it was a major cause of respiratory disease in midwestern states and since has become endemic across most of the USA. Management systems, such as brood-and-move have increased the exposure of ORT-naive birds to ORT in the finisher barns, resulting in respiratory disease and mortality in some operations. Biosecurity procedures must be taken. Proper water sanitation can minimize the severity and spread. Vaccination is limited and results are varied (toxoids, bacterins). Bacterins are used in breeders. Recently, controlled exposure efforts on individual flocks have shown value. ORT in turkeys is an identified research need.

Coccidiosis increased from #13 to #6 most likely reflects the industry increasing raised without antibiotics (RWA) and no antibiotics ever (NAE) market. RWA and NAE programs do not permit the use of ionophore anticoccidials and many programs prohibit FDA approved chemical anticoccidials, so anticoccidial programs consist of alternatives or vaccination. An effective coccidiosis control program in turkeys involves the use of anticoccidial medications and/or phytonutrients (alternatives) and/or live vaccines and the subsequent development of immunity.

Chemical anticoccidials account for 33% head and 4.5 months. Coccidia vaccination was limited to 7% head; the low incidence might be in part due to the limited availability of the only USDA approved commercial turkey coccidiosis live vaccine. Nutritional dietary supplementation with phytonutrients (alternatives) is becoming more popular, reported at 14% head, either via in-feed application or drinking water administration. Programs may utilize phytonutrients in addition to the current anticoccidial program, to potentiate the possible benefits. Some phytonutrients have purported activity against coccidia. Phytonutrients may include, plant extracts (yucca, etc.), prebiotics (beta glucans, yeasts), essential oils (oregano, carvacrol, thymol, cinnamaldehyde, capsicum oleoresin, turmeric oleoresin).

Turkey Reovirus Digital Flexor Tendon Rupture (TR-DF-TR) was recognized as a newly emerging disease in 2011. A

“In 2016, turkey production increased to 7,486,978,000 from 7,038,136,000 pounds (live weight). Overall, domestic per capita consumption for turkey products increased from 16.00 in 2015 to 16.50 in 2016, which is the highest level since 2010. Live production in 2016 increased to 244,000,000 head with an average live weight of 30.35 lbs. In 2015, 233,100,000 head were produced with an average live weight of 30.19 lbs”

Table 1. *Turkey health survey (August 2016 - 2017) of professionals in US turkey production ranking current disease issues (1= no issue to 5 = severe problem). n=23.*

Issue	Score Average (1-5)	Score Mode (1-5)
Lack of approved, efficacious drugs	4.8	5
Colibacillosis	3.8	5
Ornithobacterium rhinotracheale (ORT)	3.7	3
Clostridium Dermatitis (Cellulitis)	3,5	5
Coccidiosis	3,3	2
Leg Problems	3.2	3
Bordetella avium	3.2	2
Blackhead (Histomoniasis)	3.1	4
Salmonella	2.9	2
Poult Enteritis of unknown etiologies	2.8	3
TR-DFTR (Turkey Reovirus Digital Flexor Tendon Rupture)	2.7	1
Protozoal Enteritis (Flagellated)	2.7	1
Cannibalism	2.7	2
Late Mortality	2.6	4
Tibial Dyschondroplasia (TDC, Osteochondrosis)	2.5	3
Cholera	2.5	2
Osteomyelitis (OM)	2.3	2
Avian Influenza	2.2	1
Round Worms (Ascaridia dissimilis)	2.0	2
Bleeders (aortic, hepatic ruptures)	2.0	2
Shaky Leg Syndrome	2.0	1
Mycoplasma gallisepticum (MG)	1.9	1
Necrotic enteritis	1.9	1
Newcastle Disease Virus (NDV)	1.9	2
Breast Blisters and Breast Buttons	1.8	1
Heat stress	1.8	1
Mycoplasma synoviae (MS)	1.8	1
H3N2 (H1N1) Swine Influenza	1.8	1
Fractures	1.7	2
PEMS (Poult Enteritis Mortality Syndrome)	1.6	1
Turkey Coronavirus	1.4	1
Erysipelas	1.3	1
Spondylolisthesis (Kinky-Back)	1.3	1
Avian Metapneumovirus	1.2	1
Mycoplasma iowae (MI)	1.2	1
Mycoplasma meleagridis (MM)	1.0	1

unique reovirus has been isolated and identified as the cause of tenosynovitis and digital flexor tendon rupture in commercial turkeys. Clinical signs in young flocks are reportedly mild to nonexistent, but can develop into lameness and/or abnormal gait in older flocks, starting at about 12 weeks of age. Affected flocks may also report an increased incidence of aortic ruptures and poor flock performance (weight gain, uniformity). Research continues into pathogenesis, virus characterization, diagnostics and epidemiology. Research indicates that the turkey arthritis reovirus is distinct from the recently identified novel reovirus causing arthritis in chickens, and most similar to the turkey enteric reovirus. TR-DFTR was added to the survey in 2011 and ranked #11 (*Table 1*) with 106 *"confirmed"* cases or flocks (*Table 2*). In 2016 TR-DFTR ranked #11 with 182 cases; prior year it ranked #26 with 31 cases. A breeder company has implemented an autogenous reovirus vaccination program to induce the maximum production of antibodies and resulting transfer of maternal antibodies. Historic results originally showed a significant reduction in associated clinical signs in those poults placed from vaccinated flocks. A commercial turkey lighting program of 4-8 hours of continuous dark in a 24-hour period has also been recommended. The combined efforts of breeder vaccination, commercial farm biosecurity and flock management once appeared to be controlling this disease. Increased recognition of TR-DFTR in 2016 - 2017 suggest that the reovirus has again mutated. TR-DFTR is also called **Turkey Arthritis Reovirus (TARV).**

Dunn (2015) defines **Viral Arthritis in Turkeys** as lameness in mid to late grow turkeys in which diagnostic findings include gross and microscopic lesions of tenosynovitis that are consistent with a viral etiology (non-suppurative), significant seroconversion to reovirus has been demonstrated, and preferably, with confirmation by positive reovirus isolation from tendon

Table 2. *Turkey health survey (August 2016 - 2017) of professionals in US turkey production.*

**One respondent noted that their operation processed over 300 flocks with varying degrees of severity, but not included in the reporting of 2011 confirmed cases; Turkey Reovirus Digital Flexor Tendon Rupture (TR- DFTR). n=23.*

Cases (##) of	2017	2016	2015	2014	2013	2012	2011
Blackhead (Histomoniasis)	109	101	55	61	52	80	89
Mycoplasma synoviae (MS)	33	20	24	41	75	49	39
Turkey Coronavirus (TCV)	12	6	119	43	420	221	70
Turkey Reovirus Digital Flexor Tendon Rupture	182	31	146	150	39	131	106*
Mycoplasma gallispecticum (MG)	52	29	31	17	45	n/a	n/a

tissues, and characterization of the virus (serotypic and genotypic). Owen (2016) prioritized industry research needs:

1. Development of more accurate and less cumbersome diagnostic tests.
   a. ELISA based and serotype specific serologic assays.
   b. Genotyping that accurately reflects antigenic and pathotype differences in isolates.
2. Development of safe and cross protective live reovirus vaccines.
3. Develop a reliable and reproducible model for vertical transmission to enable study of pathogenesis, seroconversion, and persistence.
4. Impact of age on susceptibility.
5. Determine titers needed to prevent vertical transmission.
6. Determine impact of vaccination and exposure on antigenic changes.

Blackhead, also known as Histomoniasis, changed to position #8 (#9 prior year; #13, 2015). There were 109 reported cases of blackhead (*Table 2*) an increase from 101 the prior year, and more than the record 108 in 2010. Histomoniasis occurs regionally and seasonally in turkeys, and can result in significant mortality. Dimetridazole was extremely efficacious and previously approved for use in turkeys for the prevention and treatment of blackhead; it was banned in 1987. The lack of any legal treatment for histomoniasis is of concern, especially in the case of valuable turkey breeder candidate flocks. Losses to blackhead have been severe in several areas of Europe, and sporadic cases are occurring in North America. Nitarsone FDA approval was withdrawn December 31, 2015, leaving the industry with no drugs approved with indications against histomoniasis. Nitarsone was approved for the prevention of histomoniasis (blackhead disease) in turkeys and chickens, and was the only approved animal drug for this indication. Seventy-four percent (74%) of survey reported one or more cases of blackhead. Of the 109 cases reported at least 5% were destroyed to alleviate animal suffering and due to excess morbidity and mortality. Two recent peer reviewed publications of industry, include Clark and Kimminau[1] summary of current blackhead situation in the field and also Regmi[2] details FDA considerations for antihistomonal drug approvals.

Poult enteritis of unknown etiologies has changed in importance, to position #10 from #14. **Turkey Coronavirus** (TCV), as a defined cause of enteritis, was ranked #31 (*Table 1*), changed from #32 previously, with 12 reported cases, up from 6 the previous year (*Table 2*).

Protozoal Enteritis, attributed to flagellated protozoa, *Cochlosoma*, *Tetratrichomonas* and *Hexamita*, ranked #12, changed from #17; protozoal enteritis remained relatively unchanged over past years until 2016 and associated with the loss of nitarsone. Several types of protozoa are associated with enteric disease of turkeys. Protozoal enteritis can present with general signs, including dehydration, loss of appetite (off-feed), loose droppings (diarrhea) and watery intestinal contents. Flagellated protozoa include *Cochlosoma*, *Tetratrichomonas* and *Hexamita*. *Eimeria* and *Cryptosporidia* are non-flagellated protozoa. *Cochlosoma* and *Hexamita* are associated with enteritis, primarily in young turkeys, especially in the summer months. There are field reports of co-infections with *Cochlosoma* and *Tetratrichomonas*, or *Cochlosoma* and *Hexamita*, or flagellated protozoa and *Eimeria*.

Single age brooding has been implemented during the last several years to assist in managing diseases on turkey farms, especially enteric diseases. Historically, production systems included 2-3 different ages on a single farm site reared in separate barns, from day-old to market age. The trend is to isolated, specialized brooding facilities. All production is separate hen and tom rearing. The brooding phase for commercial turkeys is rearing about 0-5 weeks of age, then the flock is moved to specialty finisher or grow-out barns. Single age brooding may be termed all-in/all-out or single-age or brooder hub. Single age brooding systems can operate in two ways. One option rears the turkeys to slaughter age at the same farm site, without other ages on the farm. Another system of single age brooding involves farm sites dedicated to brooding, then at 5 weeks of age birds are moved to a separate site for finishing; some systems may move birds 0.25 miles up to 20 miles away. In 2017, 63% of brooding was single age, compared to 39% in 2009. Single age brooding is more common in the Southeastern US than the Midwest states. Conversion to single age brooding started in late 1990 following the emergence of PEMS in North Carolina; advantages became obvious and it has expanded to other areas of the US. **Tunnel ventilation** of finisher (grow-out) barns is becoming more popular method to minimize heat stress; in 2017, 29% of the industry finisher production is tunnel ventilated, compared to 12% in 2009.

Late mortality ranked #14 health issue and changed from #7 the prior year. Late Mortality may be defined as mortality, in excess of 1.5% per week, in toms (males) 17-weeks and older; mortality is not diagnosed to a specific disease or cause. Excess cumulative mortality of 5 – 10% in toms prior to slaughter has been reported. Late mortality may be associated with physiologic or biomechanical deficiencies following early rapid growth in heavy toms achieving genetic potential; aggressive behavior noted in mature toms; cannibalism; leg problems and/or hypertension.

Leg problems (#6, prior year was #5) are ranked among the top concerns of the turkey industry. Leg problems are a common complaint, such as, spiral fractures of the tibia or femur. Leg Problems may be defined as lameness, particularly in toms, several weeks prior to slaughter. Leg problems are attributed to various conditions (refer to *Table 1*), including, pododermatitis, fractured femurs, fractured tibia, osteomyelitis (OM), tibial dyschondroplasia (TDC), spondylolisthesis, "Shaky Leg", etc. The year 2017 was particularly noted increased incidence of valgus and varus leg deformities across much of the US industry due to undetermined etiology; the issue contributed to increased mortality in affected flocks.

"The turkey industry has been faced with numerous turkey health issues last year. As mentioned in the report, Turkey Arthritis Reovirus (TARV) and other leg issues have become an industry-wide concern throughout the 2016-2017 production year. In May, 2017, the National Turkey Federation distributed a Turkey Leg Health Survey to assess the need for research, the regional trends and the economic impacts of TARV on the industry"

Heat stress ranked #26 following a moderate summer, compared to #18 the prior year. Poult Enteritis Mortality Syndrome (**PEMS**) ranked #30 versus #29 previously. Avian Metapneumovirus (**AmPV**) ranked #34 versus #33, with a few atypical cases limited to the Midwestern US. ***Bordetella avium*** continued as a significant respiratory disease challenge in several geographic regions; bordetellosis ranked #7 compared to #8 the prior year.

Mycoplasma synoviae (**MS**, infectious synovitis) infections, ranked #27 (#27, prior year), are one cause of synovitis. It may be present in flocks 10-12 weeks of age with typically low mortality and low morbidity. There were 33 cases of MS reported (*Table 2*). The primary breeders have remained free of *M. gallisepticum* (**MG**), *M. meleagridis* (**MM**) and MS. Sporadic, but increasingly frequent infections with Mycoplasma, both MG and MS, often in association with backyard poultry and broiler breeder flocks is an ongoing concern, having the greatest impact when a breeder flock is infected and has to be destroyed. There were 52 cases of MG reported (*Table 2*).

Twenty of twenty-three participants responded to rank the **shortage of veterinarians** trained in the diagnosis and treatment of diseases, and welfare of turkeys. The issue ranked 2.9 and ranged from 1 to 5 (1= no issue to 5 = severe problem). It is duly noted that most post-DVM poultry medicine training programs have little to no exposure to the turkey industry.

Threat of the reoccurrence of **Highly Pathogenic Avian Influenza (HPAI)** continues to be a focus for the industry. Thankfully, prevention, detection and response for the virus has greatly improved since the devastating 2015 outbreak. During that outbreak, both H5N8 and H5N2 strains of HPAI affected turkey flocks in eight states, with H5N2 accounting for the majority of cases. In total, 153 farms commercial turkey or turkey breeder flocks were infected, resulting in the loss of over 7.75 million turkeys, in addition to over 40 million chickens (layers and broiler breeders). To date, USDA has classified this outbreak as the worst incident of animal disease in U.S. history.

In March, 2017, industry efforts prevailed as the HPAI virus was contained in Lincoln County, Tennessee. The North American wild bird lineage H7N9 - not to be confused with the China H7N9 virus that impacted poultry and humans in Asia - was detected on two commercial broiler breeder farms in Lincoln County. The industry worked closely with Tennessee's State Board of Animal Health, Tennessee's State Veterinarian, USDA's Animal and Plant Health Inspection Service (APHIS) and National Veterinary Services Laboratory (NVSL) to rapidly confirm, report and respond to these cases, as well as depopulate infected flocks. In combination to the two HPAI cases, subsequent cases of **Low Pathogenic Avian Influenza (LPAI)** were also reported beginning in March throughout south central Tennessee, northern Alabama, southern Kentucky and western Georgia. Six commercial broiler breeder operations and six backyard flocks were found positive with notifiable H7 or H7N9 LPAI. In total, approximately 253,000 birds died from disease or were depopulated to control the combined LPAI and HPAI incidents. Epidemiologic, genetic and wildlife investigations surrounding the outbreaks continue in order to provide a better understanding of factors associated with Avian Influenza virus transmission and its introduction into poultry flocks.

In addition to HPAI, the turkey industry has been faced with numerous turkey health issues last year. As previously mentioned in the report, **Turkey Arthritis Reovirus (TARV)** and other leg issues have become an industry-wide concern throughout the 2016-2017 production year. In May, 2017, the National Turkey Federation distributed a Turkey Leg Health Survey to assess the need for research, the regional trends and the economic impacts of TARV on the industry. The survey results were shared with industry members at numerous turkey-specific meetings. Moving forward, it was determined by key industry veterinarians and professionals that an additional survey be created to better evaluate TARV and other turkey-specific leg health issues as it related to U.S. and global turkey production. Aside from leg issues and TARV, **Blackhead** has had a significant prevalence this year in turkey flocks across the country.

The **Secure Turkey Supply (STS)** Plan is undergoing additional updates by industry members (www.secureturkeysupply.com). STS includes Federal and State Transport (FAST) Plan for Movement of Commercial Turkeys in a High Pathogenicity Avian Influenza (HPAI) Control Area, and Turkey Risk Assessment. Permit guidance for Turkey Hatching Eggs, Day-old Poults and Turkeys to Market were updated as of May, 2017. These guidance documents are the operational component of the more detailed science-based risk assessments. The current versions of the STS Plan continue to be utilized in regions affected by HPAI and LPAI, and have been instrumental keeping the movement and shipping of turkeys and turkey products underway. The purpose of putting the STS Plan in place is to facilitate business continuity and econom-

ic survival of participating non-infected turkey operations in a Control Area after a detection of HPAI, and to help make certain that that a continuous supply of safe turkey meat is available to consumers.

The health of turkeys remains to be of utmost importance to the industry. The ability to utilize approved, efficacious drugs, in a judicious manner has been heavily stressed in all aspects of the industry, especially considering the heightened amount of conversations and questions surrounding antibiotic resistance. The ability to control and prevent animal disease and/or treat those that are sick is critical to any animal's wellbeing. Increased outside pressure to reduce and even eliminate the use of antimicrobial drug use in animals continues, which poses a large threat to the industry in the case of a bacterial disease outbreak, similar to that of a viral disease outbreak (i.e. Avian Influenza). The industry has been working tirelessly in the realm of product innovation and research to reduce any consequences that could result from such an outbreak. NTF continues conversations with other protein associations to ensure that agency and practices and implementations align with the industry.

Antibiotic resistance, also referred to as AMR, in the context of antibiotic use in food-producing animals, has gravitated to a new level of attention in recent years. The "One Health" approach has been taken up by multiple agencies, including FDA/CVM and National Academies, in an increased effort to combat and reduce AMR. FDA Guidance that have recently gone into effect to address AMR include:

- Final Guidance #152, "**Evaluating the Safety of Antimicrobial New Animal Drugs with Regard to their Microbiological Effects on Bacteria of Human Health Concern**": The first animal related guidance, in regards to drug utilization, published in 2003.
- Guidance for Industry (GFI) #209 "**The Judicious Use of Medically Important Antimicrobial Drugs in Food-Producing Animals**": A GFI written to reduce and eliminate the use of antibiotics for the sole purpose of growth promotion, published in 2012.
- Guidance #213,"**New Animal Drugs and New Animal Drug Combination Products Administered in or on Medicated Feed or Drinking Water of Food Producing Animals: Recommendations for Drug Sponsors for Voluntarily Aligning Product Use Conditions with GFI #209**": A guidance that detailed how FDA expected to implement guidance #209, published in 2013.
- **Veterinary Feed Directive (VFD)**: A directive that established the rules and responsibilities for licensed veterinarians in prescribing and administering medically important antimicrobials in animal feed, published in 2015.

The National Turkey Federation supported the guidance documents listed above even though they questioned the underlying science indicating a direct link between animal use of antibiotics and human antibiotic resistance. Guidance #213 established procedures for phasing out the use of medically important antimicrobials for production purposes in alignment with Guidance for Industry #209 and proposed changes to VFD drug regulations. Final implementation of all changes took effect December 2016 and no drugs listed as "medically important" that are exclusively labeled for production purposes can be used moving forward. On January 1, 2017, the change from over-the-counter (OTC) to prescription (Rx) status for drugs administered through drinking water or to VFD for drugs administered in medicated feeds went into effect. Drug sponsors were expected to complete the necessary label changes of their affected products and distributors or retail establishments that handle these products were required to me*et all* applicable State and Federal regulations for Rx and VFD drugs when dispensing these products. Changes in drug use practices are now being discussed by FDA and industry groups.

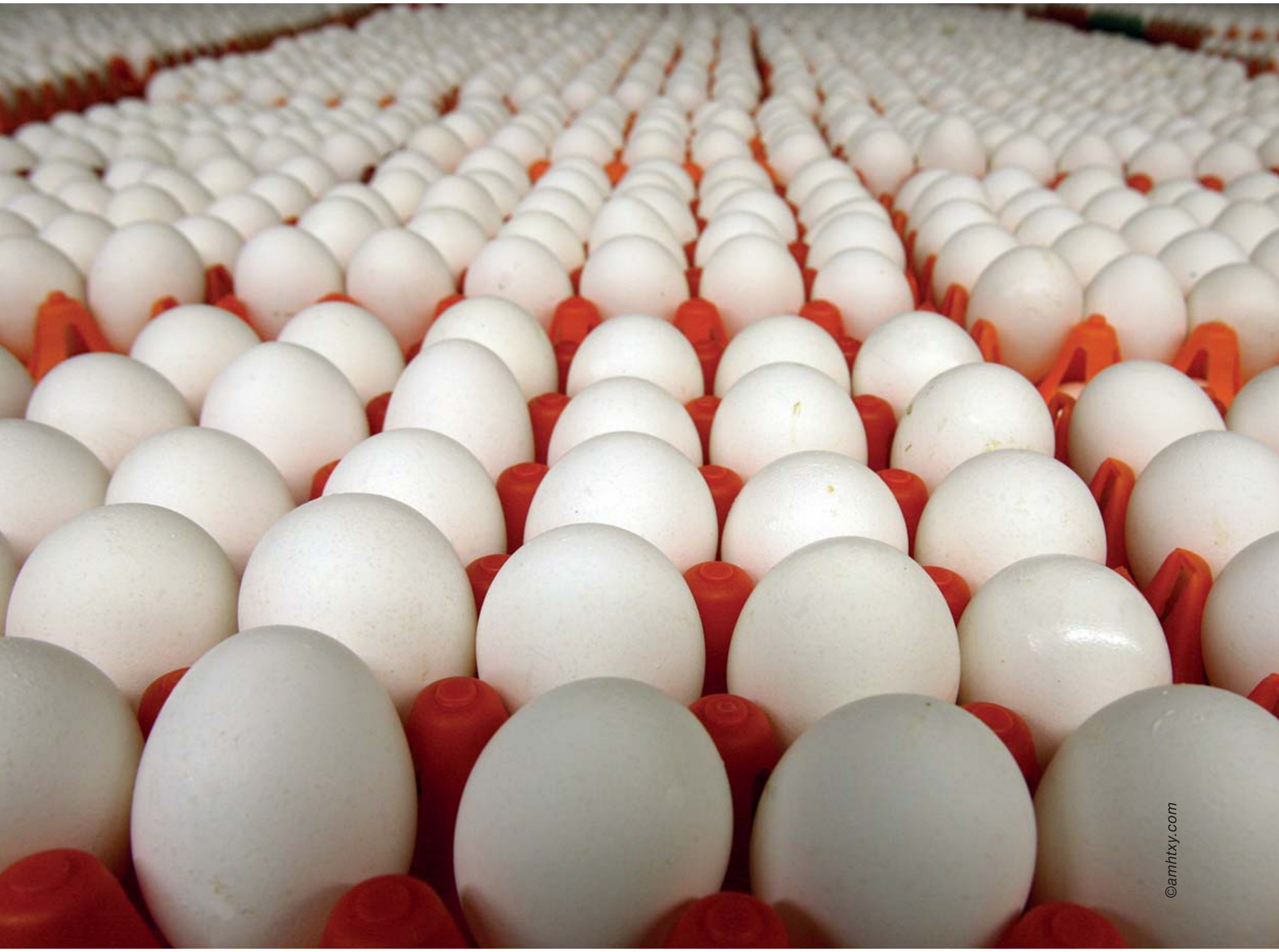
In an attempt to collaborate and address antibiotic resistance from the national level with the Presidential Administration and with USDA agencies, the **Presidential Advisory Council** run by Health & Human Services (HHS) in consultation with the Department of Defense, was established in 2015. The Obama-era White House released a **National Action Plan** to ultimately achieve (by the implementation date in the year 2020) five goals laid out by the Administration. USDA's Food Safety Inspection Service (FSIS), Agricultural Research Service (ARS) and Animal and Plant Health Inspection Service (APHIS) continue to work with FDA/CVM to collect better data to inform these goals as each year passes. Discussions surrounding what data should be collected and exactly how the data will be collected have been continuing at the industry level. In May, 2017, the **Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB)** held its 6th public meeting which was dedicated to the topic of infection prevention and control as it relates to animal health. It was emphasized that limiting the judicious use of antibiotics could have a negative impact on animal welfare, and as such, should not be the sole focus of the effort. Additionally, a key theme expressed in both human and animal health, was the need for funding to incentivize and support the approval of alternatives.

In the international domain, the World Health Organization's (WHO) **Global Action Plan (GAP)** was endorsed in 2015 as a cross-sectoral approach to address antimicrobial resistance (AMR). Political leaders in the United Nations General Assembly further endorsed the plan in September 2016. As a reminder, the GAP sets out responsibilities for national governments, for the World Organization for Animal Health (OIE), Food and Agriculture Organization (FAO), and WHO, and for other national and international partners involved in the global response to AMR. To ensure action is being taken, and to assess whether those actions are having the intended results the "One Health" tripartite organizations - WHO, FAO and OIE - have come together to develop a proposed approach for the Monitoring and Evaluation of the GAP. The proposal includes reporting back to the global health community, including the governing bodies of WHO, FAO and OIE, and the Interagency Coordination Group (IACG) on AMR that was established by the UN General Assembly. Currently, a web-based consultation has been posted by the WHO to seek feedback from Member Countries and other stakeholders, including human health, animal health, plant health and environmental health sectors, with comments due the end of September, 2017. NTF is working in various coalitions to ensure the turkey industry perspective is included.

Working on the congressional front, NTF, along with many other key groups and associations, pioneered the **Animal Pest and Disease Prevention Program (APAD)** with the hopes of its inclusion in the 2014 Farm Bill. The program was modeled after the Plant Pest and Disease Management and Disaster Prevention Program and will revolutionize animal disease prevention and response. Mandatory funding for the program will ensure the sufficient development and timely deployment of all tools to prevent, identify and mitigate animal disease outbreaks and to limit the impacts of foreign diseases on American livestock and poultry producers.

In 2016, **turkey production** increased to 7,486,978,000 from 7,038,136,000 pounds (live weight). Overall, domestic per capita consumption for turkey products increased from 16.00 in 2015 to 16.50 in 2016, which is the highest level since 2010. **Live production** in 2016 increased to 244,000,000 head with an average live weight of 30.35 lbs. In 2015, 233,100,000 head were produced with an average live weight of 30.19 lbs.

Reference: National Turkey Federation Sourcebook, pending publication October 2017



Mexico's egg industry

New AI outbreaks and Peso devaluation endanger recovery

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The massive outbreaks of Avian Influenza in the centres of Mexico's poultry industry between 2012 and 2016 caused a considerable decrease in the production volumes and supply problems, especially with shell eggs.

In total more than 26 mill. birds either died from the infection or had to be killed to prevent a further dissemination of the virus during the outbreaks between 2012 and 2014. The monetary loss was estimated at more than 900 mill. US-$.

With federally supported vaccination programs it was tried to stop the outbreaks. New outbreaks in the first half of 2016 showed, however, that the virus is still a threat. In total, 3.5 million laying hens and breeders died either from the infection or had to be killed. The monetary loss of the 19 outbreaks was estimated at 120 mill. US-$.

In this paper, the dynamics of egg production between 2010 and 2016 will be analysed. It will show that the industry was able to increase production considerably and to overcome the supply crisis.

The egg industry, an important sector in animal production

Eggs contributed almost one third to the value of poultry production in 2016, chicken meat two thirds (*Table 1*). A comparison of the volumes and values of the chicken meat and eggs reveals that the value per tons of chicken meat is much higher than that of eggs. Eggs shared 29.4% in the value of Mexico's animal production (cow milk excluded), chicken meat 34.3 %.

Poultry products play an important role in the supply of the population with animal proteins. About 17% of the protein consumption of Mexico´s population is contributed by eggs, almost the same share as that of cow milk and beef. Chicken meat is, however, the most important protein source with a share of 38%.

Table 1 - *Production of Mexico's poultry industry in 2016 (Source: UNA 2017)*

Product	Volume (1,000 t)	Value (Mill. US-$)	Share (%)
Chicken meat	3,275.2	4,646.4	66.6
Eggs	2,765.4	2,287.3	32.8
Turkey meat	12.0	46.7	0.7
Total	6,062.6	6,980.4	*100.0

**Sum does not add because of rounding*

Laying hen inventory and egg production have recovered from the AI outbreaks

The data in *Table 2* shows that the laying hen inventory in 2012 was 8.7 mill. birds lower than in 2011 but increased again in the following years and was even 11.7% higher in 2016 than in 2010.

It is noticeable that the decrease in the laying hen inventory in 2012 was much lower than the number of hens which either died from the AI infection or were killed to prevent a further spread. The difference finds an explanation in the fact that besides laying hens large numbers of broilers either died or were killed.

The reduction of the laying hen flocks is reflected in the development of egg production. Between 2011 and 2012, the production volume also decreased by 6.1%. The growth rates in egg production between 2012 and 2015 were considerably lower than in the number of hens. This is due to the fact that until 2015 many young flocks with lower laying rates were in production.

Table 2 - *Development of the laying hen inventory and of egg production in Mexico between 2010 and 2015 (Source: UNA 2017; IEC Annual Review 2017)*

Year	Inventory (1,000 hens)	Index (2010 = 100)	Egg production (1,000 t)	Index (2010 = 100)
2010	142,101	100.0	2,475.4	100.0
2011	145,702	102.5	2,538.1	102.5
2012	137,002	96.4	2,386.6	96.4
2013	148,044	104.2	2,509.4	101.4
2014	152,146	107.1	2,571.3	103.9
2015	153,633	108.1	2,622.7	106.0
2016	158,658	111.7	2,765.4	111.7

The regional concentration of egg production in Mexico is very high (*Figure 1*). This can be an advantage regarding the organisation of the egg industry in vertically integrated companies with lower production cost, but it was on the other hand a big disadvantage regarding the AI outbreaks because of the resulting problems in controlling the further dissemination of the highly infectious disease. The concentration of broiler production and breeder flocks in the same States was further adding to the problems in controlling the disease.

***Figure 1 -** The main egg producing States in Mexico (2016) (Source: UNA 2017, own design)*

Remarkable decrease of the per-capita-consumption as a result of increasing egg prices

The decrease of the laying hen inventories resulted in a considerable shortage of shell eggs. The consequence was a drastic increase of consumer prices. In some months, the prices doubled and in several cities up to 3 US-$ (= 39 Pesos) had to be paid for 1 dozen of large eggs. This situation led to massive protests of the consumers and the high egg prices very soon

became the limiting factor for the nutrition of the lower income classes. This may be surprising at first glance, but in a family with 6 persons, which is very often the case in the lower income classes, a per capita consumption of 360 eggs per person would mean a yearly demand of 2,100 eggs. A doubling of the egg prices would have the consequence that the family would not be able to bring up the necessary money. This explains why especially in such families the per capita consumption decreased drastically. The importance of shell eggs as a protein source for the population is documented by the fact that in average every person eats more than one egg per day.

With such a per capita consumption, Mexico ranks far ahead of almost all industrialised and developing countries with the exception of Japan, where the average consumption is 331 eggs per person and year. *Table 3* shows that in 2016 the per capita consumption was 6 eggs higher than in 2010 due to the decreasing egg prices.

Table 3 - *Development of the per capita consumption, the self-sufficiency rate and the egg prices in Mexico between 2010 and 2016 (Source: UNA 2017; IEC Annual Review 2017)*

Year	Per capita consumption (eggs/year)	Index (2010 = 100)	Self-sufficiency rate (%)	Shell egg price (US-$/dozen)
2010	365	100.0	100.0	0.97
2011	358	98.1	100.0	0.83
2012	335	91.8	99.5	1.44
2013	347	95.1	89.2	1.68
2014	352	96.4	99.0	1.63
2015	357	97.8	99.0	1.29
2016	371	101.6	99.2	0.98

Increasing imports as a way to meet the egg shortage

To meet the egg shortage and make eggs again affordable for the consumers, the Mexican government was forced to agree to large egg imports, especially from the USA (*Table 4*). But with the AI outbreaks in the USA, imports of eggs, chicks and parent stock were prohibited. The decision is understandable regarding the economic impacts of the AI outbreaks in Mexico. The banning of imports of parent stock also hit the broiler industry.

Despite the expansion of the laying hen flocks and the increase of egg production, Mexico was not able to reach full self-sufficiency in 2016 so that considerable amounts of shell eggs and egg products had to be imported. Mexico lifted the import ban on eggs, egg products and living chicks or parent stock in early 2016. The imports of shell eggs reached a volume of 22,226 t, 30.8 % more than in 2015. This reflects the impacts of the new AI outbreaks in 2016.

Table 4 - *Development of Mexico's egg imports between 2010 and 2016; Data in tons (Source: UNA 2017; USDA FATUS GATS)*

Year	Total Imports	Imports from the USA
2010	715	1,285
2011	410	982
2012	12,082	6,151
2013	45,254	13,720
2014	26,061	13,720
2015	16,988	7,762
2016	22,226	6,831

Imports reached a maximum in 2013 and 2014 during the peak of the AI outbreaks, and then decreased again (*Table 4*). But in 2016, the imports of liquid egg products were still almost three times higher than in 2010. On the other hand, imports of dehydrated products fell continuously until 2015 before they increased again in 2016 (*Table 5*).

From surplus to deficit. The dynamics of the trade balance

In the first years of the decade, Mexico's trade balance with eggs and egg products was positive. With the AI outbreaks and the necessity to import large amounts of shell eggs and egg products the trade balance became negative and reached a maximum with 69,124 t in 2013. Although the situation has improved, the deficit was still as high as 24,000 t in 2016 (*Table 6*).

The main results of the preceding analysis can be summarized as follows:

- Laying hen inventories and egg production have recovered from the massive economic impacts of the AI outbreaks between 2012 and 2016.
- To meet the domestic demand, higher imports of eggs and egg products from the USA became necessary. The fast increasing egg prices resulted in a lower per capita consumption.

Table 6 - *The development of Mexico's egg and egg products imports and exports between 2010 and 2016; data in tons (Source: UNA 2017)*

Year	Imports	Exports	Balance
2010	11,974	24,362	+ 12,388
2011	11,800	24,120	+ 12,320
2012	29,704	25,292	- 4,412
2013	74,972	5,848	- 69,124
2014	55,915	1,151	- 54,764
2015	31,191	2,682	- 28,509
2016	40,718	6,665	- 24,053

- While the balance of trade with eggs and egg products was positive until 2011, the impacts of the AI outbreaks caused high deficits in 2013 and 2014 and the balance was still negative in 2016.
- Although the dissemination of the AI virus could be stopped by vaccination for a while, the outbreaks in early 2016 showed that it still a threat for the poultry industry.

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Table 5 - *The development of Mexico's imports of liquid and dehydrated egg products imports between 2010 and 2016; data in tons (Source: UNA 2017)*

Year	Liquid products	Index (2010 = 100)	Dehydrated products	Index (2010 = 100)
2010	1,665	100.0	1,032	110.0
2011	1,331	79.9	1,471	142.5
2012	4,864	292.1	986	95.5
2013	10,985	658.1	272	26.3
2014	10,080	605.4	169	16.4
2015	5,860	352.9	39	3.8
2016	4,690	281.7	404	39.1

Patterns of EU poultry meat trade. A 2016 status report

In contrast to trade with shell eggs, which is dominated by the EU, the share of EU member countries in global poultry meat trade is much lower. About 8% to 9% of the global exports are contributed by the EU and between 4% and 5% of the imports are shared by EU member countries. The reason for the much lower share is as well the dominating role of Brazil and the USA in poultry meat exports and the high production volume in the EU.

In this paper the patterns of trade will be analysed in detail for the year 2016.

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Patterns of poultry meat trade with non-EU countries

The data in *Table 1* shows that poultry meat exports increased faster than imports between 2012 and 2016, due to the fact that production grew faster than consumption. While exports increased by 185,000 t, imports only grew by 33,000 t. The result was that the self-sufficiency rate increased moderately by 0.5%.

In *Tables 2* and *3* the trade relations with non-EU countries are documented.

Table 1 - *The development of the EU poultry meat balance between 2012 and 2014; data in 1,000 t. (Source: MEG 2017, EU Commission)*

	2012	2014	2016	Increase (%)
Gross production	12,691	13,268	13,766	8.5
Exports	1,431	1,504	1,616	12.9
Imports	867	846	900	3.8
Consumption	12,210	12,725	13,180	7,9
Self-sufficiency (%)	103.9	104.3	104.4	0.5

Table 2 shows that the export volume increased by almost 185,500 t between 2012 and 2016 despite the banning of imports by Russia. The exports to the seven leading countries of destination grew by 120,000 t.

A closer look at the ranking reveals some interesting changes. In 2012, Saudi Arabia, Benin and South Arica ranked in the first three positions, sharing 29.4% of the total export volume.

In 2014, South Africa, Benin and Hong Kong held these three positions, contributing 33.5% to the overall poultry meat exports. Saudi Arabia only ranked in fourth place. In 2016, the composition and ranking changed again. South Africa was still in first place, followed by the Philippines and Hong Kong. The import volumes of South Africa, the Philippines and Ukraine increased considerably in comparison to 2014, Russia was replaced by Ghana.

The composition of the main countries of destination documents that exports are focused on Africa, Western and Eastern Asia and Eastern Europe. The high export volumes to Africa are often criticized with the argument that they impede the development of a domestic poultry industry in these countries because of the low prices of the exported products.

Table 3 documents that poultry meat was mainly imported from only six countries with Brazil and Thailand in a dominating position. In 2016, the two countries shared 88.1% in the total import volume.

It is worth mentioning that the USA, the second most poultry meat exporting country on a global scale, is not permitted to export any poultry meat to the EU because of the chlorine treatment of the meat. If this ban would be lifted, the USA would definitely become one of the leading countries of origin. Between 2012 and 2016, the import volume increased by 33,000 t or by 3.8%. The data differs from that in *Table 1* because of a different source.

A closer look at the composition and ranking reveals some interesting changes. Brazil was in a top position over the whole time period but lost 11.4% of its share; the import volume decreased by almost 80,000 t. In contrast, Thailand´s export into the EU grew by 92,200 t. This was possible despite frequent AI outbreaks because exports changed to cooked meat. Ukraine became one of the major countries of origin from 2014 on and ranked in third position in 2016. Argentina lost almost half of its export volume into the EU, while imports from China and Chile remained fairly stable. *Figure 1* shows the positive development of the trade balance. The trade surplus increased from 563,250 t in 2012 to 725,560 t in 2016.

Table 2 - *Poultry meat exports to selected non-EU countries in 2012, 2014 and 2016; data in 1,000 t. (Source: EU Committee 2017)*

	2012			2014			2016	
Country	Exports	Share (%)	Country	Exports	Share (%)	Country	Exports	Share (%)
Saudi Arabia	149,310	10.4	South Africa	203,412	13,5	South Africa	270,157	16.7
Benin	139,817	9.8	Benin	163,844	10,9	Philippines	126,741	7.8
South Africa	131,832	9.2	Hong Kong	136,177	9.1	Hong Kong	123,766	7.7
Hong Kong	126,072	8.8	Saudi Arabia	123,574	8.2	Saudi Arabia	121,645	7.5
Russia	113,134	7.9	Ukraine	80,084	5.3	Benin	116,882	7.2
Ukraine	103,427	7.2	Russia	68,363	4.5	Ukraine	114,899	7.1
Ghana	69,156	4.8	Philippines	57,641	3.8	Ghana	77,159	4.8
7 countries	832,748	58.2	**7 countries**	833,095	*55.4	**7 countries**	951,249	*58.9
Total	1,430,554	100.0	**Total**	1,503,984	100.0	**Total**	1,616,031	100.0

** Sum does not add because of rounding*

Table 3 - *Poultry meat imports from selected non-EU countries in 2012, 2014 and 2016; data in 1,000 t. (Source: EU Committee 2017)*

	2012			2014			2016	
Country	**Imports**	**Share (%)**	**Country**	**Imports**	**Share (%)**	**Country**	**Imports**	**Share (%)**
Brazil	583,449	67.3	Brazil	507,355	60.0	Brazil	503,291	55.9
Thailand	197,962	22.8	Thailand	251,158	29.7	Thailand	290,186	32.2
Chile	42,192	4.9	Chile	25,815	3.1	Ukraine	48,080	5.3
China	15,698	1.8	Ukraine	19,958	2.4	Chile	28,875	3.2
Argentina	13,766	1.6	China	19,761	2.3	China	16,946	1.9
Switzerland	3,817	0.4	Argentina	10,996	1.3	Argentina	6,463	0.7
6 countries	856,884	98.8	**6 countries**	835,043	*98.7	**6 countries**	893,841	*99.3
Total	867,303	100.0	**Total**	845,743	100.0	**Total**	900,470	100.0

** Sum does not add because of rounding*

Patterns of EU poultry meat trade at country level

In a second step poultry meat exports and imports by EU member countries will be analysed in detail. Trade date at this level include intra-EU trade.

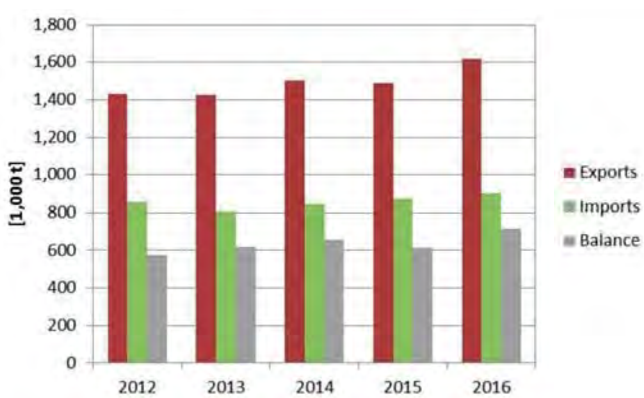

***Figure 1** -The development of EU poultry meat trade with non-EU countries between 2012 and 2016 (Source: EU Committee 2017. Design: A. Veauthier)*

The data in *Table 4* shows that poultry meat exports were highly concentrated in 2016. The two leading countries, the Netherlands and Poland, shared 45.1% of the total export volume. Germany, Belgium and France followed in ranks three to five. The then leading countries contributed 93.1% to the EU poultry meat exports. Most of the exports were destined at other EU member countries; only 1.6 mill. t or 32.1% to non-EU countries (see also *Table 2*).

In 2016, EU member countries imported 3.4 mill. t of poultry meat. This includes the intra-EU trade. Most of the imports originated from other EU member countries, for only 900,000 t were imported from non-EU countries (see also *Table 3*). The imports are also highly concentrated.

The four leading countries shared 55.9% in the total import volume, Germany alone 19.9%. The regional concentration in 2016 was lower than in exports, for the ten leading countries shared only 80.1% in the overall imports compared to 93.1% in exports. This documents that in contrast to exports which are concentrated on a few countries with a high surplus, imports are more evenly distributed although also in imports the volumes reflect the population with the exception of the Netherlands.

It is expected that between 2017 and 2025 consumption of poultry meat will grow faster than production. While the production volume is projected to increase by about 500,000 t, consumption is expected to grow by 1 mill. t, due to the increase of the per capita consumption from 23.8 kg in 2017 to 24.9 kg in 2025. This will result in higher import volumes.

Table 4 - *The ten leading EU member countries in poultry meat exports* in 2016. (Source: MEG 2017)*

Country	Exports (1,000 t)	Share (%) in total exports
Netherlands	1,248	24.8
Poland	1,024	20.3
Germany	507	10.1
Belgium	482	9.6
France	433	8.6
Un. Kingdom	296	5.9
Spain	230	4.6
Hungary	211	4.2
Italy	179	3.6
Sweden	76	1.5
10 countries	**4,686**	****93.1**
EU total	**5,036**	**100.0**

** Includes intra-EU trade ** Sum does not add because of rounding*

Table 5 - *The ten leading EU member countries in poultry meat imports* in 2016. (Source: MEG 2017)*

Country	Exports (1,000 t)	Share (%) in total imports
Germany	648	19.9
Un. Kingdom	434	12.7
France	426	12.5
Netherlands	370	10.8
Belgium	228	6.7
Spain	159	4.7
Romania	137	4.0
Czech Rep.	117	3.4
Austria	113	3.3
Bulgaria	102	3.0
10 countries	2,734	**80.1
EU total	3,413	100.0

** Includes intra-EU trade*
*** Sum does not add because of rounding*

Conclusion

Poultry meat production in the EU has increased constantly over the past years. This is mainly a result of the high absolute and relative growth rates of broiler meat.

Turkey meat production has grown much slower and seems to have reached a level which cannot be surpassed in the coming years. This is a result of the stagnating per capita consumption, while that of broiler meat has grown considerably in the analysed time period.

Despite the considerable growth in per capita broiler meat consumption in the past, much slower growth rates are projected for the coming decade, resulting from a stagnating or even decreasing total meat consumption.

Poultry meat exports increased faster than imports between 2012 and 2016, due to the fact that production grew faster than consumption.

The composition of the main countries of destination documents that EU poultry meat exports were focused on Africa, Western and Eastern Asia and Eastern Europe.

Poultry meat was mainly imported from only six countries with Brazil and Thailand in a dominating position. In 2016, the two countries shared 88.1% in the total import volume.

Poultry meat exports of EU member countries were highly concentrated in 2016 when including the intra-EU trade. The then leading countries contributed 93.1% to the overall EU poultry meat export volume.

In 2016, the regional concentration in poultry meat imports was lower than in exports. This documents that in contrast to exports which were concentrated on a few countries with a high surplus, imports were more evenly distributed among the member countries.

The EU Commission projects that between 2017 and 2025 consumption of poultry meat will grow faster than production. This will result in higher import volumes.

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Omaz launches OMAZ Controller Plus for the intelligent control of poultry house equipment and engineering

OMAZ, an industry leader within this business sector with over sixty years of experience, is a company always attentive and ready to innovate with new products and processes.

At a time when we are talking more and more about Italy's "Industrial National Plan 4.0", a process that encourages the use of industrial automation to improve the production quality within operations, OMAZ has launched its new automatic management system for poultry farms namely the **OMAZ CONTROLLER PLUS**.

It is a product that allows one to manage the smart automation of the equipment within a building. All this has been created with a user-friendly interface and with the possibility of remote operation via apps for smartphones, tablets etc., from worldwide locations, thus facilitating remote assistance and control. **An OMAZ equipped farm becomes increasingly interactive and innovative.**

This new system is able to manage: - lines of ventilation or inverter modulation systems; - inlets operated according to temperature, negative pressure or those positioned with potentiometer sen-

sors; - double level alarms with “call management systems” via telephone dialing and alarm mail despatch; - LED lighting controls for the management of house lighting in tune with livestock growing periods; - the management of the feeding equipment and the loading and the unloading from the silos of the weighed feed; - egg management (number of good eggs, egg displacement and collection); - water management and usage; - daily reports of feed consumption and conversion ratios; - recording from sensors of the minimum and maximum values of temperature, humidity, CO_2, NH_3, NH_4 readings; - cleaning system management.

“The markets of today and of the future require and demand a poultry industry more and more in step with the times”– these are the words of **Giuseppe Quadrini, the President of OMAZ** – *“an industry operating with systems that are capable of being extremely useful. The OMAZ CONTROLLER PLUS allows one to manage the plant, even remotely, ensuring better welfare conditions for the livestock. A prerogative, which in the end, benefits not only the bird but also leads to high quality production”*.

Following this philosophy, OMAZ is also very satisfied with the results from its innovative aviary ‘Open Space’ lines, for both layers and pullets. These are the latest developments from the Marche-Italy-based company, which focus on certain models that are complimentary with the new space control system under the FCS aviary (an exclusive OMAZ patent). The poultry industry marketplace requires above all technologies that are adaptable to the rearing of birds in alternative systems.

The OMAZ name is renowned for the quality of the raw materials used in their equipment and the field results, confirmed by the principal Italian poultry groups, have approved the Open Space aviary systems with flying colours.

For more information:
www.omaz.com

Alternative housing system's impact on feeding pullets and layers

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In order to satisfy consumer demands for their food to be produced a more "humane" manner the retail outlets are pushing the egg industry to change housing systems. The shift in the egg industry to more extensive housing systems such as Enriched Colony Cages, Aviary/Cage-Free and Range are having impacts far beyond the housing management. This is also affecting how replacement pullets grow and utilize the nutritional resources we provide them, which carries over into the production phase and how we need to evaluate the phase feeding programs used.

As the egg industry evaluates nutritional programs for the pullets and layers there are more variables to evaluate other than skeletal development, and body weight, nutritionists now have to deal with the increased activity levels in the cage free systems, greater environmental temperature variation, and smaller body weights of laying hens to name a few.

Pullet rearing

Replacement pullets are a key to having a high performing laying flock. This means that pullet growers have to pay closer attention to the growth and development of these birds and simultaneously be aware and responsive to the factors which today can change rapidly with potentially negative impacts on pullet quality.

The question today is: how do we feed the pullet in different environments? This is not a presentation on diet formulations, but it is rather an insight into potential problems in rearing and production that if we don't keep these in mind can cause bigger problems negatively impacting growth and/or production.

The Author has been working with some of these issues for about 9 years now within the NC Layer Performance and Management Test (NCLP&MT). The Author and his colleagues have transitioned to alternative rearing and production systems to evaluate how current laying stock responds. The first issue is feeding the pullet in 3 different rearing systems in order to achieve the breeder body weight guidelines. Pullets in cages grow differently and as such have varying needs from those in the cage-free and range at the same ages. This can become challenging since part of the objectives of this extension program is to evaluate the strains under the same variables or conditions. Since the Author utilizes a 3 Phase Rearing Dietary Regimen, it can be challenging especially when the rearing environment temperatures can vary as much as 20 degrees after the brooding and the different space allocations used.

Monitoring the body weights become more important especially as Author and his team try to reach breeder guidelines under highly variable conditions. Transitioning from the starter through to the developer feeds becomes challenging especially with 19 different strains. What Author and his team have seen from the Grow Reports of 39^{th} to the 40^{th} NCLP&MT is the impact of the environmental influences on protein and energy consumption.

Some key aspects in feeding pullets and what to monitor:

1. Remember feed changes take 3 to 4 weeks to show up in body weight changes;
2. Never restrict the amount of feed provided to the pullet;
3. Body weights taken at least bi-weekly;
4. Evaluate the uniformity of the flock with the goal being 90% of the pullets weigh within ± 10% of the mean weight.

cess if not accounted for in the formulation process can negatively impact the hen's productivity.

In both the cage free and range systems you have to account for the increased activity of the hen. Then in the range system there is even greater activity, feather replacement and cooler temperatures. All of these variable components can lead to a pause in production due to the lack of nutrients and energy provided to the hens as they progress through the first peak in production. In a conventional system hen is consuming 110 g/day of a 19% crude protein diet, (21g of protein), 57% is devoted to egg production, 17% to growth and 21% to environmental needs with the balance of 5% to extraneous needs and waste.

In both the White and Brown Egg Layers in the 38th NCLP&MT the conventional cage hens consumed the most protein and energy over the course of a single cycle production cycle.

The productivity was not significantly different across the different production systems for the average production and feed conversion of the white and brown egg strains. However, in the 39th NCLP&MT the cage free hens consumed the greatest amount of protein and energy followed by the enriched colony cage and then the range hens.

"Pullet growers have to pay closer attention to the growth and development of these birds and simultaneously be aware and responsive to the factors which today can change rapidly with potentially negative impacts on pullet quality"

Depending on what you see diet changes, reformulations, or other husbandry practices may need to be implemented at different points in the rearing phase.

Laying hen production

Bringing pullets into lay is a very stressful period for the bird. The pullets are still growing as they come into production in both skeletal and muscle. In addition, the hormone profile of the bird is changing and development of the ovary and oviduct are accelerating prior to the onset of egg production then add in the fact that we are changing the diet to meet protein and Ca needs. It has been documented that when diets are changed the birds will have a level of feed aversion until they become accustomed to the new diet and 4 days prior to the first egg feed intake drops by about 20%. This is followed by rapid feed intakes right after the onset of production then continuous feed increases throughout the production cycle.

The nutritional needs of the laying hen are of primary importance. The diets we feed must provide for the continued hen growth and production, however, bird activity and outdoor ac-

There was a difference in production traits with the poorest performance in the enriched colony cage system, primarily due to the high mortality levels. The other production systems were similar in production traits and mortality levels.

Conclusion

We are embarking on a major transition in the egg industry with the transition from cages to cage free and to range production in the case of organics. Nutritionists need to keep in mind the impact of the environment contributing to the physical activity of the hen, and ambient temperatures on nutrient utilization and partitioning taking place in the hens.

Can companies react quickly enough in these situations to meet the needs but not overfeed protein and energy in the hens? Challenges are many and they will continue to evolve as we progress through this transitional period.

References are available on request

From the Proceedings of the 2017 Midwest Poultry Federation Convention

Effect of two different fibre sources on growth and immune function in grower layer-pullets

This study was conducted to evaluate the effect of two different fibre sources on pullet growth, gut immune tissue, and lymphocyte proliferation of strain pullets fed three different diets from 10-18 weeks of age.

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The European Union banned the use of antibiotics as non-therapeutic growth promoters for poultry in 2006 and in other countries, including Australia, there have been restrictions placed on their use. As a result, there has been increased interest in finding alternative growth promoters and immunomodulators.

Finding new alternatives to antibiotics aimed at improvement of the immunity and productivity of poultry is important, especially for economic and sustainable production. As an effective alternative to antibiotics, different types of fibre have been suggested for use in the diet of layer pullets. Various types of dietary fibre have been shown to enhance body weight gain, growth of lymphoid tissue and lymphocyte proliferation of broilers and ducks. It has also been reported that a commercial insoluble fibre (Arbocel® RC fine, JRS Co. Inc., Rosenberg, Germany) and a commercial mixed soluble and insoluble fibre (Opticell[C5], Agromed Austria GmbH) added to the diet of four-week old layer strain pullets for four weeks can enhance innate immune function.

The aim of this study was to investigate whether supplementing the diet of 10 to18 week old layer-strain pullets with either an insoluble (IF) or a mixed soluble and insoluble fibre (MF) product would improve their body growth, gut lymphoid organ growth and lymphocyte proliferation.

Materials and methods

Fifty-four 10-week-old grower pullets were weighed and randomly placed, three per pen, in slatted floor pens (1.8 x 0.9 m, length x width), six pens per treatment.

The three dietary treatments were Control, a commercial grower pullet feed (Pullet Grower, Barastoc - Ridley Agriproducts) with no additive; Group IF (insoluble fibre), given the control diet with 1.5g/100g of a commercial lignocellulose supplement containing 65 – 70% crude fibre high in cellulose and 20% lignin (Arbocel® RC fine). Group MF (mixed fibre), given the control diet with 1.5g/100g of a commercial lignocellulose supplement containing 85% soluble and insoluble fibres, 30% lignin (Opticell[C5]).

After seven weeks on the diets, blood samples were taken from the brachial vein of eight pullets per treatment, 1-2 pullets/pen for isolation of lymphocytes using a modification of the method of Lavoie and Grasman. After separation of lymphocytes using Histopaque® 1077 (Sigma-Aldrich) the number of viable cells was determined by staining with trypan blue.

The lymphocytes were then plated into a sterile, clear, flat bottom 96-well plate (Falcon™, Becton Dickinson Labware). Mitogen induced proliferation of T- and B- lymphocytes was stimulated by adding either Concanavalin A (Con A, 2.5 µg/ml, Sigma-Aldrich) or lectin from lipopolysaccharide (LPS, 3.125 µg/ml, Sigma-Aldrich) to the incubation medium. Proliferation of lymphocytes unstimulated by mitogens acted as a proliferation control. After 2.5 days incubation at 37°C and 5% CO_2 in a humidified incubator, AlamarBlue® (BUF012B, AbD Serotec) was added to each well according to the manufacturer's directions and after 8 hours absorbance of the reduced dye was measured.

In order to determine cell proliferation, the absorbance for mitogen stimulated T- and B- lymphocytes was calculated as a percentage of the absorbance of the unstimulated lymphocytes.

At 18 weeks of age all pullets were weighed and killed with intravenous pentobarbitone sodium. Specimens of small intes-

"The aim of this study was to investigate whether supplementing the diet of 10 to18 week old layer-strain pullets with either an insoluble (IF) or a mixed soluble and insoluble fibre (MF) product would improve their body growth, gut lymphoid organ growth and lymphocyte proliferation"

tine (*jejunum* and *ileum*) were taken from eight pullets per treatment, opened lengthwise and stained with polychrome methylene blue (Amber Scientific, Australia). Then the number of Peyer's patches (Pp) ≥1mm^2 were counted and the area of Pp and the small intestine areas were measured using AutoCAD Software (Autodesk AutoCAD). The total area of Pp in each pullet relative to the areas of their *jejunum* and *ileum* was calculated (relative Pp area). The experiment was approved by the La Trobe Animal Ethics Committee. Data were analysed using one-way analysis of variance (ANOVA, SPSS, 22, USA) and statistical significance between means of different treatment groups was compared by Tukey's test at $P<0.05$.

Results and discussion

At 18 weeks of age, live body weight was significantly ($P<0.05$) increased in pullets receiving the IF dietary treatment compared to the control group but there was no difference between IF and MF pullets or between MF and Control pullets (*Table 1*).

Proliferation of T-lymphocytes (Con A stimulated) and B-lymphocytes (LPS stimulated) of both IF and MF fed pullets were significantly ($P<0.05$) greater than those of the Control group (*Table 1*). The observed increase in lymphocyte proliferation indicates that both IF and MF have the potential to enhance the number of lymphocytes in brown pullets. Dietary fibre, both insoluble and soluble, from other sources has been shown to improve lymphocyte proliferation in poultry.

The area of Peyer's patches (Pp) relative to area of small intestine was significantly ($P<0.05$) higher in pullets fed the diet supplemented with IF compared to the control and MF groups, and IF supplemented pullets had significantly ($P<0.05$) more Pp along the small intestine compared to the control group (*Table 1*). In mice, fibre in the form of fructo-oligosaccharides but not wheat bran has been shown to increase Pp number.

The positive effects on growth, Pp and lymphocyte proliferation may have been the result of an effect on reducing pathogens or changing microflora in the gut. It is also possible that improved activity of proteolytic digestive enzymes and digestibility of protein resulted in greater availability of protein to support immune system functions.

Conclusion

Addition of IF to the diets of pullets resulted in heavier body weights, higher T- and B- lymphocyte proliferation and increased numbers and sizes of Pp than observed in Control pullets: MF on the other hand only resulted in higher T- and B-lymphocyte proliferation.

Therefore, increasing the concentration of IF in the diet of 10 week old pullets prior to point of lay, may be a useful alternative to antibiotics both as a growth promoter and to generate a greater number of B- and T-lymphocytes.

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References are available on request
From the Proceedings of the
Australian Poultry Science Symposium

Table 1 - *Mean live body weight, lymphocyte proliferation, total number and area of Peyer's patches (Pp) relative to the area of the small intestine (jejunum + ileum), (mean and pooled SEM, N = 18 for live body weight and N = 8 for other parameters) of pullets fed different diets*

Treatment*	Live body weight (g)	Lymphocyte proliferation (%)[1]		Peyer's patches	
		T-cells	B-cells	Area (% small intestine area)	Number
Control	1506.52[a]	79.40[a]	106.58[a]	1.55[a]	7.13[a]
MF	1552.59[ab]	100.40[b]	122.42[b]	1.76[a]	8.00[ab]
IF	1607.46[b]	103.09[b]	128.97[b]	2.36[b]	10.00[b]
Poled SEM	11.05	3.69	3.12	0.099	0.477

**Control - Pullet Grower, Barastoc - Ridley Agriproducts, with no additive; IF (insoluble fibre), Control diet with 1.5g/100g Arbocel® RC fine, MF (mixed fibre), Control diet with 1.5g/100g Opticell[C5]*
[a-c] Values with different superscripts in the same column are significantly different (P<0.05)
[1] % increase of Con A and LPS stimulated cells relative to unstimulated cells

Does location and extent of starch and protein digestibility affect poultry productivity and health?

Formulation and production of feed has evolved extensively in the last century with the identification of required nutrients, and subsequent and continuing definition of the bird's nutrient requirements. This evolution has resulted in improved efficiency of poultry production as increasingly more precise methods of feeding are developed. The research associated with this paper focuses on the continuation of this evolution by examining aspects of precision feeding of poultry. In particular, this research focuses on the extent, rate and location of nutrient (energy, amino acids) digestion, and how this relates to bird production efficiency, health and welfare.

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drolysis of feed to absorbable nutrients occurs as a result of the actions of moistening, pH changes, presence of digestive enzymes, and other pancreatic, liver and digestive tract secretions. Much of the digestion and absorption of nutrients occurs in the anterior portions of the small intestine (SI), particularly the *duodenum* and *jejunum*, but absorptive capacity is also present in the terminal *ileum*. Nutrients are transported through the apical membrane into the enterocyte cytoplasm, where they can be metabolized or pass through the basolateral membrane to the portal blood system for systemic metabolism. Undigested material from the SI can either be excreted via the colon and cloaca, or content that is small and/or soluble can enter the caeca and be fermented by an extensive bacterial population. Water and mineral absorption, as well as products of fermentation [i.e. short chain fatty acids (SCFA)], are absorbed in the caeca.

The nutritional profile of feed can thus be broken down into those nutrients that are digested and absorbed in the SI, those having the potential to benefit or harm the host via fermentation, and undigested material lost as excreta. Nutrients absorbed in the SI can further be differentiated based on their first pass utilization by digestive tract tissue (DTT) or absorption into the portal blood system for distribution to the remainder of the body. Even further definition of nutrients can be based on the kinetics of nutrient digestion and the site of absorption in the SI.

"The evolution of feeding for poultry productivity, health and welfare in an era of reduced antibiotic use requires an enhanced understanding of not only how much of an ingredient is digested, but also how its digestion characteristics affect post-prandial metabolism and gastrointestinal tract function and health"

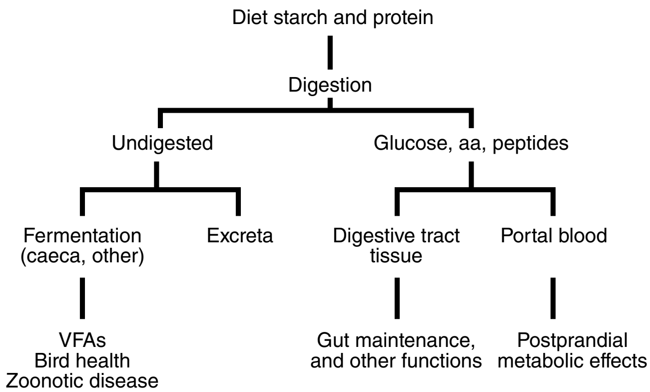
Traditionally, nutritionists have focused on ingredient and diet digestibility by measuring nutrients remaining in either the excreta or the contents of the terminal end of the small intestine. However, some research suggests that the kinetics of nutrient digestion and absorption are also important in efficient animal production. Furthermore, understanding the characteristics of what is not digested may also be important in bird wellbeing in the era of antibiotic free production. This paper will describe the potential consequences of site and extent of digestion on poultry production and give examples of the research completed in this area.

Site and extent of nutrient digestion and absorption why does it matter?

The fate of ingested feed is shown in *Figure 1* along with resulting potential effects. Rate and site of nutrient digestion impact the distribution of these effects. After consumption, hy-

Nutrients that are absorbed in the SI can either be used by DTT or absorbed into the portal blood system. Because of its high metabolic profile, DTT accounts for up to 25 to 35% of whole body protein turnover and energy expenditure despite its relatively small proportional size (4 to 6% of body weight). The high metabolic demand relates not only to its nutrient digestion and assimilation role, but also to its importance as a physical and immunological barrier against enteric toxins and the vast microbial community including pathogens. The location of first pass utilization is affected by rate of digestion and more rapidly degraded starch and protein would have more impact on DTT in the anterior portion of the SI (*duodenum* and *jejunum*). If digestion is rapid and relatively complete, this would reduce first pass utilization in the distal SI and result in this tissue relying on the arterial supply of nutrients.

The efficiency of nutrient use for DTT functions in first pass and arterial sources is not clear. It can be speculated that slowly degraded nutrients may benefit DTT metabolism in the distal



sections of the SI. In terms of energy for DTT maintenance, glutamate and glucose are both substrates, and although more effective together, this suggests that either slowly digested starch or protein could serve this role if present in the distal SI.

Nutrients absorbed into the portal blood system are distributed for use in a wide range of roles in the body. Absorption also results in a number of physiological effects designed to effectively use these nutrients. The degree of hormonal response to nutrients and consequential effects on bird metabolism is related to the speed of nutrient absorption and this effect is larger in meal fed birds like broiler breeders. Therefore, the kinetics of nutrient (glucose, amino acids) digestion and absorption in the avian gastrointestinal tract (gut) has the potential to impact the growth and reproduction of these animals via post-prandial effects.

Undigested components of the diet at the terminal *ileum* can either be directly voided or portions can be fermented in the *ileum*, caeca and colon. It is generally conceded that the caeca are the primary site of fermentation and only small and/or soluble particles will enter the caeca. Therefore, the degree of caecal fill will be determined by characteristics of the diet and resulting digesta. Although it is unlikely that the caeca make a large contribution to the energy requirements of commercial chickens or turkeys, the caeca are considered to play an important role in bird health and are also the predominant reservoir for *Salmonella* and other zoonotic organisms. The nature of fermentation in the caeca and elsewhere can affect the bacterial profile and activity in a manner which could control colonization by *Salmonella*. In the case of carbohydrate fermentation, the bacterial profile could be shifted in favour of beneficial species and/or increase the production or proportion of SCFA that lower pH, inhibit growth of *Salmonella* and other *enterobacteriaceae*, regulate expression of *Salmonella* virulence factors, and modulate mucosal immunity. As noted above, the nature of material entering the caeca will affect fermentation and it is well recognized that fermentation of carbohydrates and protein result in different end products.

A common belief is that slowly or poorly digested protein can lead to detrimental changes in the lower gastrointestinal tract due to its fermentation by putrefactive organisms. When used as an energy source, bacterial metabolism of amino acids from unabsorbed proteins yields a number of fermentation products (e.g. ammonia amines, phenolic and indolic compounds, H_2S, dimethyltrisulphide). In contrast to SCFA, protein fermentation products have been primarily associated with toxigenic and carcinogenic impacts on the intestinal epithelium including increased expression of inflammatory markers and reduced barrier function. Identification of a consistent means of affecting caecal function in a positive manner, to yield desirable end products capable of improving nutrient metabolism, barrier function and pathogen prevalence, would have significant implications for production and food safety for the poultry industry.

With the above background, the following sections will demonstrate areas of our research that relate to the rate and extent of digestibility in poultry.

Broiler breeders and slowly digested starch

Feed restriction is applied to broiler breeders during rearing and laying phases to maintain body weight target essential for good health and production. A common practice is to feed on an every other day basis (EOD, every 48 h) during the rearing phase to achieve body weight goals; as a consequence birds are hungry and without feed for considerable period of time, which might have a negative impact on growth and uniformity. The rate of starch digestion may affect hunger and therefore this experiment compared feeding diets containing equal starch content, but based on slowly (pea) or rapidly (wheat) digested starch to broiler breeder pullets. Diet had only a minor effect on growth indicating that the feeds were formulated to a similar nutrient content. However, uniformity was improved by feeding a pea-based diet. Digesta content and gut mass were also increased by feeding the pea-based diet over the 48 h period between feeding. After feeding, the post prandial glucose peak was lower for pullets fed the pea-based diet and these birds also had smaller livers and less fat content. In agreement with this finding, expression of liver enzymes involved in fat synthesis were reduced by feeding a pea rather than wheat based diet.

These finding indicate that feeding a pea-based diet (slowly digested) resulted in a reduced degree of nutrient storage and re-utilization in feed restricted broiler breeder pullets during the post-prandial phase. Pullets fed a pea-based diet expressed increased comfort and resting behavior, and reduced foraging and walking behavior during the off-feed day (24–48 h) and had reduced serum levels of non-esterified fatty acids and -hydroxybutyrate-HBA (indicators of fasting) after 26 and 28 h post-feeding, respectively. Overall, both physiological and behavioral indicators suggested increased satiety in feed restricted broiler breeder pullets when fed a pea-compared with a wheat-based diet.

Starch digestibility and *ad-libitum* fed poultry

Previous research has found that feeding a portion of slowly digested starch to poultry improves performance and in particular feed efficiency. In some cases, the results were confounded by the nature of the ingredient being fed. To avoid this situation, semi-purified rapidly (RDS - wheat) and slowly digested (SDS - pea) starches were used in diets formulated to be iso-caloric and iso-nitrogenous, and differ only in the proportion of the two starch types. Six ratios of RDS to SDS (100/0, 80/20, 60/40, 40/60, 20/80 and 0/100) were each fed to broilers and laying hens in separate experiments. For broilers, the best growth (numerically) and feed efficiency (statistically) were achieved by the 80/20 diet. All levels of SDS increased breast meat yield and reduced skin weight, an indication of reduced fat levels. In laying hens, increasing inclusion of SDS in diets increased feed intake linearly, while hen-day egg production, feed efficiency (g of feed/g of egg) and egg specific gravity responded in a quadratic fashion with highest, lowest and highest values achieved for the 80/20, 40/60 and 60/20 diets, respectively. Starch type did not affect egg weight or hen feathering.

Turkey research used diets containing four ratios of RDS to SDS (100/0, 85/15, 70/30 and 55/45). Hen body weight at 77 days of age was affected by diet with the highest weight for the 70/30 treatment; in contrast the best feed efficiency resulted from feeding the 100/0 treatment. Breast muscle yield was numerically highest for all treatments containing SDS, but in contrast to broiler chickens, fat level was also higher in these treatments. In

“Identification of a consistent means of affecting caecal function in a positive manner, to yield desirable end products capable of improving nutrient metabolism, barrier function and pathogen prevalence, would have significant implications for production and food safety for the poultry industry”

conclusion, starch digestion rate affected all classes of poultry, but the results were not exactly the same. The effect on meat yield fat content in broiler chickens and turkeys is of interest and may be related to a post-prandial effect on bird metabolism. How that occurs in birds that eat small meals frequently requires investigation.

Protein digestibility and level in broiler diets

Poorly digested protein has been suggested to result in poor broiler health and performance because of the negative effects of protein fermentation. To test this suggestion, we evaluated the effects of three dietary protein levels (24, 26 and 28%) each with low or high indigestible protein content (LIP, HIP) on broiler performance and health from 0 to 32 days of age. All diets met broiler grower nutrient specifications, contained no medication and were formulated to the same level of digestible methionine. Wheat was the cereal grain in all diets and protein sources in the LIP diets were soybean meal (SBM) and fish meal, while HIP diets used SBM, corn gluten meal, porcine meal and corn distillers dried grains with solubles. The floor housed broilers were vaccinated on feed and waterers with Coccivac-B52 (Merck Animal Health) on day 5 and kept under high humidity conditions to encourage the development of disease. Body weight at 32 d was affected by protein content (26>28 with 24% intermediate), protein indigestible fraction (LIP>HIP) and gender (M>F). Feed to gain ratio (mortality corrected) for the overall trial was affected by protein level (24>26=28) and protein indigestible fraction (HIP>LIP).

In conclusion, dietary protein level and the proportion of indigestible protein can affect performance when broilers are fed nutritionally adequate diets. Total flock mortality (10.75%) was divided into infectious, non-infectious heart associated, non-infectious skeletal, other, and unknown categories representing 7.38, 0.89, 0.12, 0.48 and 1.89% of broilers placed, respectively. Infectious mortality was grouped into yolk sac infection, *coccidiosis* (CO), necrotic enteritis, and systemic infection (SI) subcategories representing 0.55, 0.69, 2.04, and 4.09% of broilers placed, respectively. Diets with LIP increased infectious mortality (9.11 vs 5.69%), associated with increased CO (1.03 vs 0.39%) and SI (4.98 vs 3.23%) compared with HIP. More males died than females (13.84 vs 7.69%) from overall infectious causes (9.62 vs 5.18%), as well as CO (1.01 vs 0.41%) and SI (5.43 vs 2.79%). The results are counterintuitive in that it might be expected that LIP diets (high digestibility) would reduce mortality and the increased crude protein level would increase mortality. It would be premature to conclude that low protein indigestibility promotes disease. A more logical explanation is that the impact bird health is protein source dependent.

From the Proceedings
of the 11th Turkey Science and Production Conference

Major histocompatibility complex and genetic resistance to Infectious Bronchitis Virus

Infectious Bronchitis Virus (IBV) is an endemic disease of chickens responsible for considerable economic losses to the poultry industry worldwide. IBV replication leads to considerable viral genetic variability, and vaccine failures are commonly seen in the field. For this reason, new strategies to prevent infection and induce disease resistance must be investigated.

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Genetic resistance or susceptibility to infectious diseases have been largely associated with the avian major histocompatibility complex (MHC) genes.

UC Davis has congenic chicken lines that share the same genetic background and vary solely in their MHC haplotype.

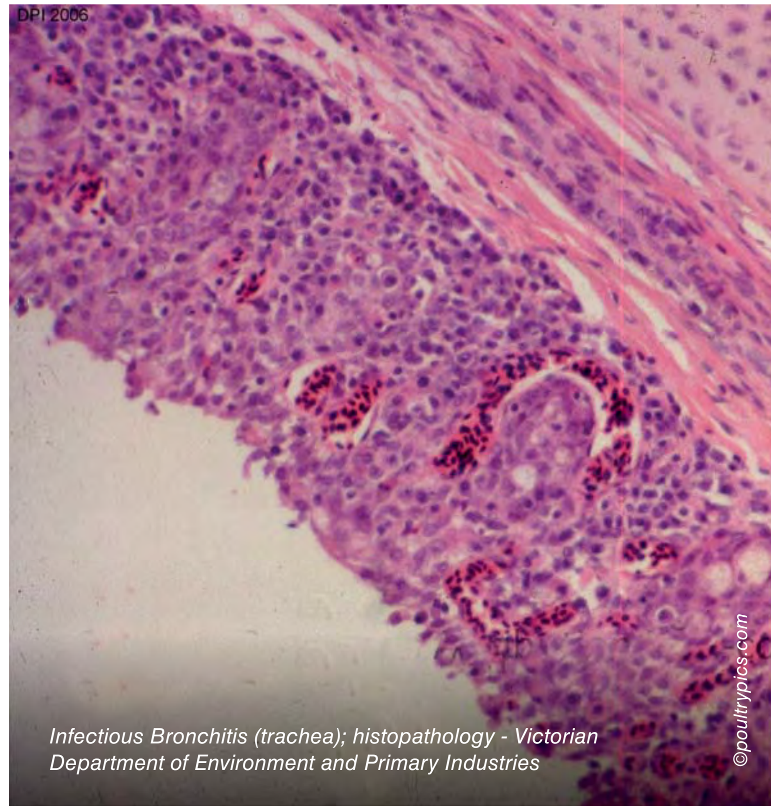
Authors challenged congenic chicken lines available at UC Davis with an IBV Massachusetts 41 (M41) strain to determine which lines are relatively resistant or susceptible to IBV infection. This was accomplished by comparing clinical signs, pathology and humoral responses after challenge.

The objective was to determine the relative resistance and susceptibility of the chicken lines to IBV, and establish a model to understand immunity against IBV and the relationship between the MHC and innate immune responses.

The Authors analyzed and compared immunological responses and the effect of challenge in different congenic and inbred chicken lines.

Materials and methods

Five MHC B haplotype congenic lines (253/B18, 312/B24, 331/B2, 335/B19 and 336/BQ), one inbred line (003/B17), and one commercial line of broilers were used in this experiment.



Infectious Bronchitis (trachea); histopathology - Victorian Department of Environment and Primary Industries

Table 1 - *Respiratory signs, histomorphometry of tracheal epithelia, deciliation of tracheas, viral load in tears, IgG levels in sera and IgA levels in tears in MHC B congenic chicken lines at 2, 6 and 14 days post-infection (DPI)*

Chicken lines	Respiratory signs 2 DPI	Respiratory signs 6 DPI	Histomor-phometry 2 DPI	Histomor-phometry 6 DPI*	Deciliation 2 DPI	Deciliation 6 DPI	Viral Load 2 DPI	Viral Load 6 DPI	IgG 14 DPI (S/P ratio)	IgA 14 DPI (OD 650 nm)
253/	1	3	4	1	6	9	2	2	0.3	0.
B18	3.33^{a}	1.67	12.6^{a}	156	0	3.33	5.34^{bc}	6.69^{a}	045^{ab}	1672^{ab}
077/	4	6	4	1	8	9	2	2	0.4	0.
B19	1.18^{b}	3.89	06.3^{a}	065	0	3.33	4.38^{c}	4.99^{b}	174^{ab}	1839^{ab}
Broilers	2	5	1	1	5	7	2	2	0.4	0.
	0.51^{ab}	2.38	047^{b}	180	3.33	3.33	6.41^{ab}	1.77^{c}	386^{a}	1192^{b}
312/	1	4	4	8	8	8	2	2	0.2	0.
B24	8.06^{a}	9.12	42.3^{a}	63.5	0	6.67	6^{ab}	5.57^{ab}	439^{ab}	118^{b}
331/	**1**	**3**	**3**	**8**	**6**	**8**	**2**	**2**	**0.2**	**0.**
B2**	**4.67^{a}**	**1.67**	**39^{a}**	**28.8**	**6.67**	**8.89**	**5.56^{b}**	**4.96^{b}**	**371^{ab}**	**2277^{a}**
335/	**9.**	**4**	**3**	**9**	**7**	**1**	**2**	**2**	**0.1**	**0.**
B19***	**72^{a}**	**0.35**	**31.6^{a}**	**40.3**	**3.33**	**00**	**6.54^{a}**	**5.5^{b}**	**939^{b}**	**1009^{b}**
336/	1	4	4	1	1	1	2	2	0.2	0.
BQ	3.04^{a}	0.74	10.5^{a}	146	00	00	6.33^{ab}	5.53^{ab}	028^{ab}	1704^{ab}

** No statistical differences observed between groups*
*** Relatively resistant chicken line in comparison to other lines tested*
**** Relatively susceptible chicken line in comparison to other lines tested*

Twenty-five day-old chicks of each line were raised in isolated rooms, totalizing 175 animals. Sera was collected at 21 days of age to detect maternal antibodies against IBV by ELISA.

At 23 days of age, all birds were challenged with a M41 strain of IBV via oculonasal route using a median embryo infective dose (EID_{50}) of $5x10^{7}$ in a final volume of 200 µL.

At two and six days post- infection (DPI), tears were collected from all chickens for viral load assessment by RT-qPCR. Respiratory signs were assessed and indexes were calculated based on the severity of respiratory disease. Five birds per group were euthanized at each time point, and tracheas were collected for histopathology and histomorphometry (tracheal epithelial thickness measurement). At 14 DPI, tears and sera were collected from all remaining birds for IgA and IgG measurement by ELISA.

Clinical signs, viral load, histomorphometry measurements, and antibody levels were analyzed individually and compared by one-way ANOVA followed by Tukey multiple comparisons test using GraphPad Prism software (GraphPad, La Jolla CA, USA). Statistical differences were considered at a significance level of $P<0.05$.

Results

All chickens presented respiratory signs after challenge. However, mortality was not observed after infection. At two DPI, the MHC B congenic chicken line 335/B19 showed the lowest respiratory sign index and the milder tracheal inflammation. On the contrary, clinical signs were more severe in 077/B19 inbred chicken line. There were no statistical differences among groups regarding respiratory signs and histomorphometry measurements at six DPI. Lines 077/B19 and 253/B18 showed the lowest viral load at two DPI while broilers and 331/B2 showed the lowest viral load at six DPI, suggesting reduced viral shedding and consequently decreased viral replication due to early viral neutralization. Broilers presented the highest levels of serum IgG. IgA in tears was significantly higher in 331/B2 in comparison to the other tested groups. All results are summarized in *Table 1*.

Discussion

Even though lines 335/B19 and 077/B19 present the same MHC haplotype, the results obtained in both lines were diver-

gent. The discrepancy is probably due to the fact that these lines do not share the same genetic background, thus other *loci* might be playing a role in genetic resistance against IBV in line 077/B19. Although there were no statistical differences between groups regarding clinical signs and tracheal inflammation at six DPI, there is a trend suggesting that line 331/B2 is more resistant than the others at 6 days after challenge. This trend can also be observed when considering the high levels of IgA detected in chickens from line 331/B2. As IBV preferred site of replication is locally at the upper respiratory tract, IgA levels are more likely related to protection against IBV than systemic IgG titers.

Relative resistance and susceptibility findings match what has been observed in previous experiments from the group and what has been described in literature, in which B2 and B19 present resistant and susceptible characteristics respectively. Susceptibility differences were observed early in infection, and are most likely related with differences in innate immune function. Authors' prospective studies will use the most resistant (331/B2) and the most susceptible (335/B19) congenic chicken lines as a model for understanding the mechanisms in which the innate immune system generates resistance to IBV in early infections.

The goal is to use molecular tools and functional assays to unveil how the chicken lines respond to different strains of IBV and what are the cytokines and molecules involved in protection against IBV infection.

References are available on request
From the Proceedings of the 66th Western Poultry Disease Conference 2017

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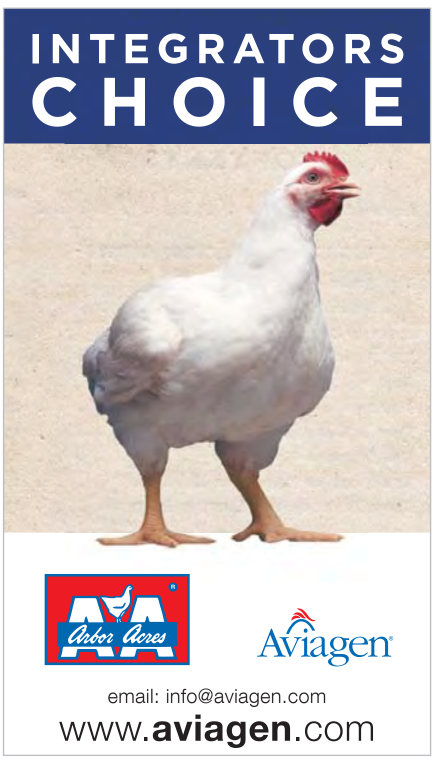

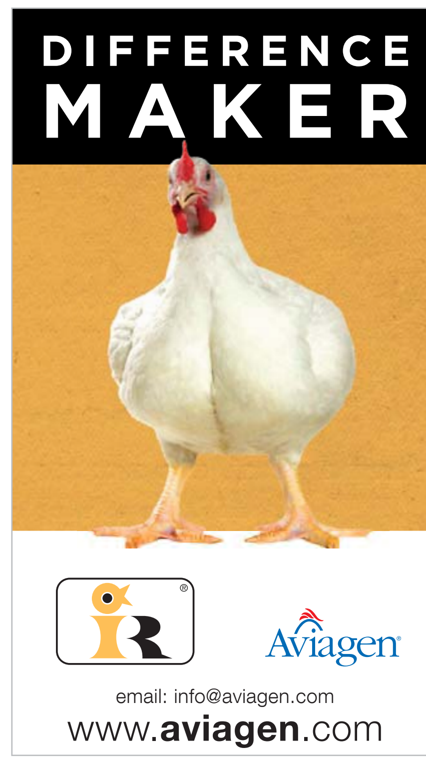

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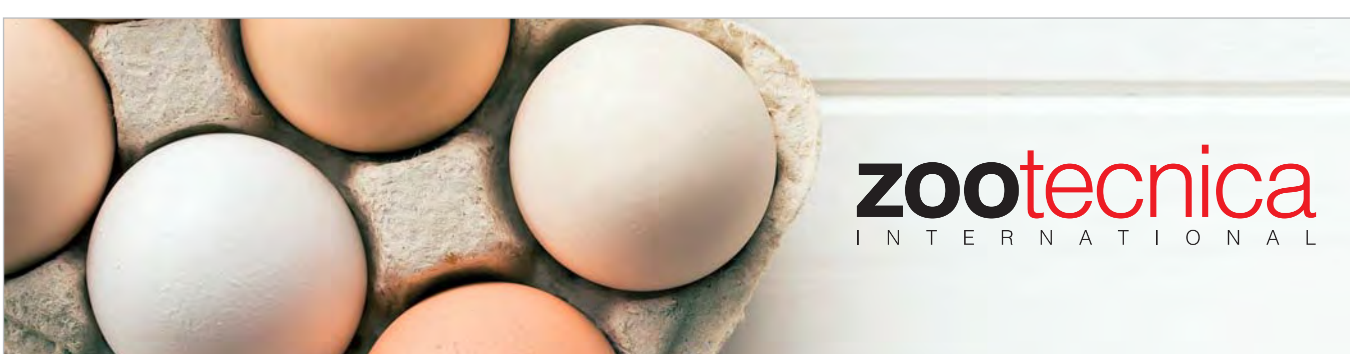

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