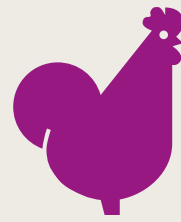


Sustainable and profitable egg production

PRODUCTS & SERVICES FOR LAYERS





MEGATREND: Population growth

THE UNITED NATIONS ESTIMATES THAT THE WORLD'S POPULATION WILL REACH 8 BILLION IN 2025, AND THAT ROUGHLY 1.8 BILLION PEOPLE WILL BE LIVING IN COUNTRIES OR REGIONS WITH ABSOLUTE WATER SCARCITY (FOOD AND AGRICULTURE ORGANIZATION OF THE UN, 2017).

As the population grows, the world's per capita consumption of meat, fish, eggs and dairy products rises with it. This trend is further driven by increasing affluence in developing countries. Although agricultural production efficiency has vastly improved over the past few decades, its environmental impact in terms of emissions to

land and air from increased animal protein production have become unsustainable.

Eggs, the world's most affordable consumed animal protein, will continue to play a huge role in meeting this protein demand, but more egg farmers need to adopt sustainable methods.

WORLD EGG PRODUCTION IN 2018

74.5

million tons

WORLD EGG PRODUCTION EXPECTED IN 2050

102

million tons

MEXICO IS THE LARGEST EGG CONSUMER

368

Eggs per capita

Source: International Egg Commission, 2019

Eggs are among the most important foods on the planet. Their versatility, perfect amino acid, vitamin and mineral profile, make eggs the first choice for a nutritious and healthy diet.

EGG DEMAND

With a total annual production of 74.5 million tons of eggs worldwide in 2018, and 102 million tons of eggs expected to be produced by 2050, it is estimated that at least 50 million additional layers per year are needed.

Global egg consumption per capita will grow 20 pieces per person to reach 220 eggs in 2030, but there is still space to grow. For example, in Mexico and Japan they eat 368 eggs and 337 eggs respectively per capita, per year. There are culinary reasons for such high consumption, but the trend of searching for natural and healthy food is positively raising the demand worldwide.

RIISING TO THE CHALLENGE

There are many challenges in order to be competitive on a global scale, the most obvious being production costs (Figure 1). However, other pressures, such as the need to reduce the environmental impact of production, will become more acute. In addition, there is a growing regulatory and consumer demand for production processes that are sustainable, considerate of animal welfare and result in healthy animals.

Current layers demand the highest management measurements along with the best nutrition. Extended laying cycles bring opportunities, but also challenges, and only with knowledge and science will egg producers be able to capitalize on the benefits of the egg business.

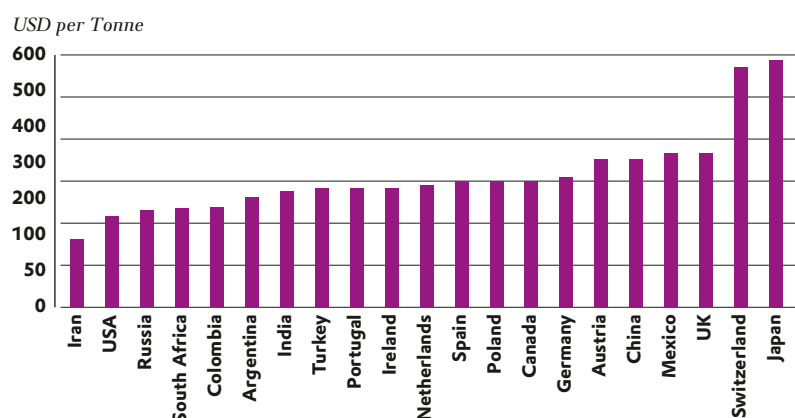
To meet market necessities while at the same time maintaining or increasing productivity, egg farmers need to look

for new and innovative methods and technologies. High-performance feed additives, and solutions that leverage digitalization and big data management, can be highly effective in this context.

NEW TRENDS IN THE EGG VALUE CHAIN

Consumers traditionally expect a healthy, natural and safe product. Producers have delivered that and even more, such as enriched nutrient eggs, however apparently this is not enough. Increasingly consumers want to know exactly what they are eating, how it was produced, and where it came from. In the case of eggs, this also means knowing whether they were produced according to consumers' values and beliefs, for example, whether eggs come from a cage or non-cage system, if birds preserved their beak during production or more recently, how the industry is handling the male chick culling issue.

Figure 1: Layer feed cost at farm gate



Source: International Egg Commission, 2019



Evonik invested in the start-up In Ovo, backing a quick and reliable solution to gender determination of chicken embryos in the egg, avoiding the need to kill male chicks.

CHALLENGES AND SOLUTIONS in farming laying hens

HOLISTIC

NUTRITION

**IS THE KEY TO
HEALTHY AND
EFFICIENT EGG
PRODUCTION.**

IDEAL PROTEIN DIETS

Reducing nitrogen excretion and ammonia emissions to the environment is a top priority in egg production. A high level of dietary crude protein (CP) is the main cause of excessive nitrogen excretion in laying hens.

Formulating ideal protein diets with reduced dietary CP levels supplemented with crystalline amino acids provides an adequate balance regarding amino acids and energy. It is an effective way to reduce nitrogen excretion, without compromising performance, optimizing feeding cost and reducing soy bean meal dependency. In addition low protein diets improve yolk pigmentation in corn-based diets.

Increased availability of amino acids such as methionine, lysine, threonine, tryptophan, valine and isoleucine allow laying hen nutritionists to reduce dietary CP levels even further. On average, a 1 %-point CP reduction results in about 10 % reduction in nitrogen excretion, which significantly contributes to the reduction of ammonia emissions and decrease in drinking water intake. This translates into lower moisture in the manure, diminishes foot pad lesions and dirty eggs incidence, improving animal welfare as well as conditions for employees and the environment.

A further reason to avoid high CP diets is that increased undigested protein that reaches the hindgut can promote proliferation of pathogenic bacteria such as *E. coli*. Bacterial fermentation of undigested protein produces potentially toxic substances such as ammonia and amines that can increase incidence of dirty eggs.

IDEAL PROTEIN DIETS FOR LONGER CYCLES

Recently, Evonik challenged its amino acid recommendations and ideal amino acid profile for laying hens, for egg weight, number of eggs and egg mass. Amino acid recommendations and ideal profile granted the best performance for the new hen's genetic potential. Feeding longer productive cycle layers demands precise nutrition. Deficiencies are counterproductive for maintaining egg persistency in old layers, however a surplus of protein increases egg size, aggravating eggshell issues, hence more broken and cracked eggs. On top of this, excess levels of nutrients overload the liver functionality. The liver provides all basic elements needed for egg formation. A healthy liver is key for a successful long productive cycle.

A HEALTHY GUT GRANTED MORE SALABLE EGGS

A balanced protein diet with supplementing amino acids can reduce the production of harmful microbial metabolites plus the inclusion of insoluble fiber enhances nutrient digestion and modulates behavior.

Feeding layers with coarse particles, helps to develop the muscles of the gizzard, increasing feed retention time, dropping pH, which has a bactericidal effect. Larger feed particles have a longer transit time through the gut, that improves the length of microvilli and increases the absorptive surface area in the intestine, and thereby positively affects digestibility and nutrient absorption.

Together with advanced feeding concepts, the use of additives such as probiotics keeps and restores balanced gut microflora and has beneficial effects in the digestive tracts of the layers.

Probiotics encourage the best performance during challenging moments in rearing and production (Table 2 and 3). A good start always makes the difference, pullet development has great impact in egg production and egg size. A lot has been linked with body weight in the rearing period, but the key aspect is the correct nutrient absorption, which is only granted by balanced microflora.

At onset of egg production while production peak is achieved, it is common to see a tough period for the layers. Stress in production is often associated with low feed intake, lower egg size and liquid feces. The best way to support hens during stressful periods is to develop an outstanding nutrient absorption capacity, a balanced and strong microflora, warranting proper immune response.

The young intestine bacteria colonization is effectively described as better flock uniformity and body weight in the rearing period. Additionally in a matured intestine in production, a balance microflora supports and keeps optimal feed intake, maintaining egg production persistency and egg weight, with lower incidence of liquid feces and dirty eggs.

Table 2: Effects of GutCare® on the egg quality in laying hens under commercial conditions

TREATMENT	NEGATIVE CONTROL	GutCare®
Albumen height (mm)	9	9.1
Yolk color	7.6	7.7
Haugh unit	93	93.7
Egg weight with egg shell (g)	56.51	56.79
Weight of egg white (g)	39.02	39.53
Weight of yolk (g)	17.5	17.25
Ration of yolk: albumin	26.71	26.34

Table 3: Effects of GutCare® on the performance of laying hens under commercial conditions

	LAYING RATE (%)	EGG WEIGHT (g)	FCR (FI/EGG MASS)	EGG MASS (g/DAY/BIRD)
Standard	91–88%	61.7–64.8		
Negative control	89.89	64.47	2.158	57.93
GutCare®	92.16	64.51	2.096	59.46
Positive control	87.06	64.49	2.227	56.14

PRODUCTS & SERVICES

For efficient, transparent and sustainable egg production



The key: A precisely balanced diet. The correct amino acid composition optimizes both livestock performance and feed production. Evonik has developed an array of sophisticated, yet easy-to-use, tools to support our partners in achieving this balance and making production more efficient. Start optimizing your feed formulation now by following these steps.

Steps to profitable and more sustainable egg production

1

SET NUTRITIONAL TARGETS

The nutritional requirements of layers can be affected by many factors including age, body weight, breed, health and environment. Setting an adequate nutritional target is the starting point of any cost-efficient feed formulation. Protein is one of the most expensive components in any diet and deserves specific attention. Evonik's AMINOHen® software takes out the guesswork and lets you quickly and easily derive the right amino acid recommendation for your hens. It provides SID amino acid and recommendations for laying hens in different phases to meet your production conditions.

AMINOHen®

2



EVALUATE YOUR RAW MATERIALS

Once you know what your hens need for optimum egg production, you can combine your feed ingredients in suitable amounts to meet those nutritional requirements. The AMINODat® database records the amino acid profile of more than 140

raw materials from around the world. Using these data, you can identify the optimum amount of each ingredient for your feed formulation.

To take this precision to a higher level and account for variability of raw materials between batches, Evonik offers AMINOLab® and AMINONIR®. Our AMINOLab® service provides raw-material analysis using wet-chemistry methodologies at one of our quality-controlled facilities around the world.

AMINONIR® uses near infrared (NIR) technology to deliver fast, onsite and offsite analyses of your input material.

AMINODat® 5.0

AMINOInsight®

AMINOLab®

AMINONIR®

3



BALANCE THE DIET

Laying hens need the right balance of amino acids for optimum egg production and profitable performance. Methionine is the first limiting amino acid in typical laying hen diets: if the dietary methionine level is deficient, other amino acids cannot be utilized to full potential. The amino acid imbalance leads to lower deposition of protein and higher nitrogen excretion, contributing to increased environmental pollution. Optimum laying hen performance can be achieved by supplying all amino acids in the feed according to the ideal protein concept.

MetAMINO®

Biolys®

ThreAMINO®

TrypAMINO®

ValAMINO®

AMINONIR® RED

HEAT-RELATED NUTRIENT VARIABILITY

To deactivate anti-nutritional factors (ANFs), heat is applied during the processing of protein feed-stuffs. However, heating can destroy and reduce availability of amino acids due to the Maillard reaction. The standardized ileal digestibility (SID) of amino acids may overestimate their availability in over-processed ingredients. In response, Evonik has developed the rapid NIR-based method

to estimate the degree of heat damage as well as to correct the SID of amino acids in selected feedstuffs, including soy and corn dried distillers grains with solubles (DDGS). Using the corrected SID values for heat-damaged soybean meal in diet formulation can help you avoid impaired egg production performance.

4



BOOST PERFORMANCE WITH PROBIOTICS

Efficient livestock production is a balancing act of nutrition, gut health and animal welfare, especially when reducing or eliminating the use of antibiotics as growth promoters. Challenges related to prevalence of pathogens, unfavorable environmental conditions and poor ingredient quality can negatively impact the intestinal microbial balance in animals, leading to poor gut health and reduced performance. Exposure to subclinical levels of disease, diarrhea incidence and poor digestive capacity of poultry can impair feed utilization efficiency, growth and welfare.

Evonik has developed probiotic solutions that restore balanced gut microflora and improve gut health. Our probiotic portfolio includes Ecobiol® (*Bacillus amylo-liquefaciens* CECT5940), GutCare® (*Bacillus subtilis* DSM 32315) and GutPlus® (*Bacillus subtilis* DSM 32540).

Evonik's probiotics have been proven in research and commercial facilities. The result: enhanced overall health and performance.

Ecobiol®

GutCare®

GutPlus®

5



ENSURE PRECISION IN DOSING AND FEED HOMOGENEITY

Efficient handling of amino acids from bags, big bags or bulk silos in the feed mill is essential in producing consistently high-quality feed. Weighing and transport processes need to be fine-tuned to achieve short batch cycles and high output. Well aligned, state-of-the-art hardware and software solutions can enable the required precision in micro-ingredient handling and dosing.

Evonik provides comprehensive engineering and commissioning support to ensure you achieve these goals. The AMINOSys® equipment range includes flexible solutions for fully automated direct dosing or for conveying from bulk silos to existing micro-ingredient systems. The result: efficient production and a homogenous final feed product.

AMINOSys®

AMINOBatch®

AMINOBatch® WPT



RELY ON THE LAYER EXPERTS

Evonik is an active and proud member of the International Egg Commission (IEC), supporting a more sustainable egg industry. Experts from Evonik Animal Nutrition have been conducting scientific research and developing innovations in close contact with livestock producers, universities and research institutes since the 1980s. The knowledge created is shared in technical publications such as AMINONews® and Facts & Figures, in scientific papers and customer training formats. Evonik also regularly publishes recommendations for supplementing with amino acids as well as standardized ileal digestibility of amino acids in raw materials in poultry feeds.

Evonik's poultry nutrition and health specialists support egg producers around the world with technical consultations on applying the most advanced nutritional concepts. These include low CP, amino acid-fortified diets and utilizing the synergistic effects of low CP diets with probiotics and other feed additives. With products and services from Evonik, egg farmers achieve more efficient and sustainable production and maximum profitability.

ALWAYS UP TO DATE

Beastly good information at your fingertips: AMINONews® provides you with the latest findings in the science of animal nutrition and is now also available for mobile use. Just scan the QR code and access it.



EXPERIENCE that matters

Customers ordering our products receive more than just feed additives – we also offer a combination of customized solutions, services and digital tools. Our experts are available onsite with specialized knowledge and experience to help unlock the full value of your business.

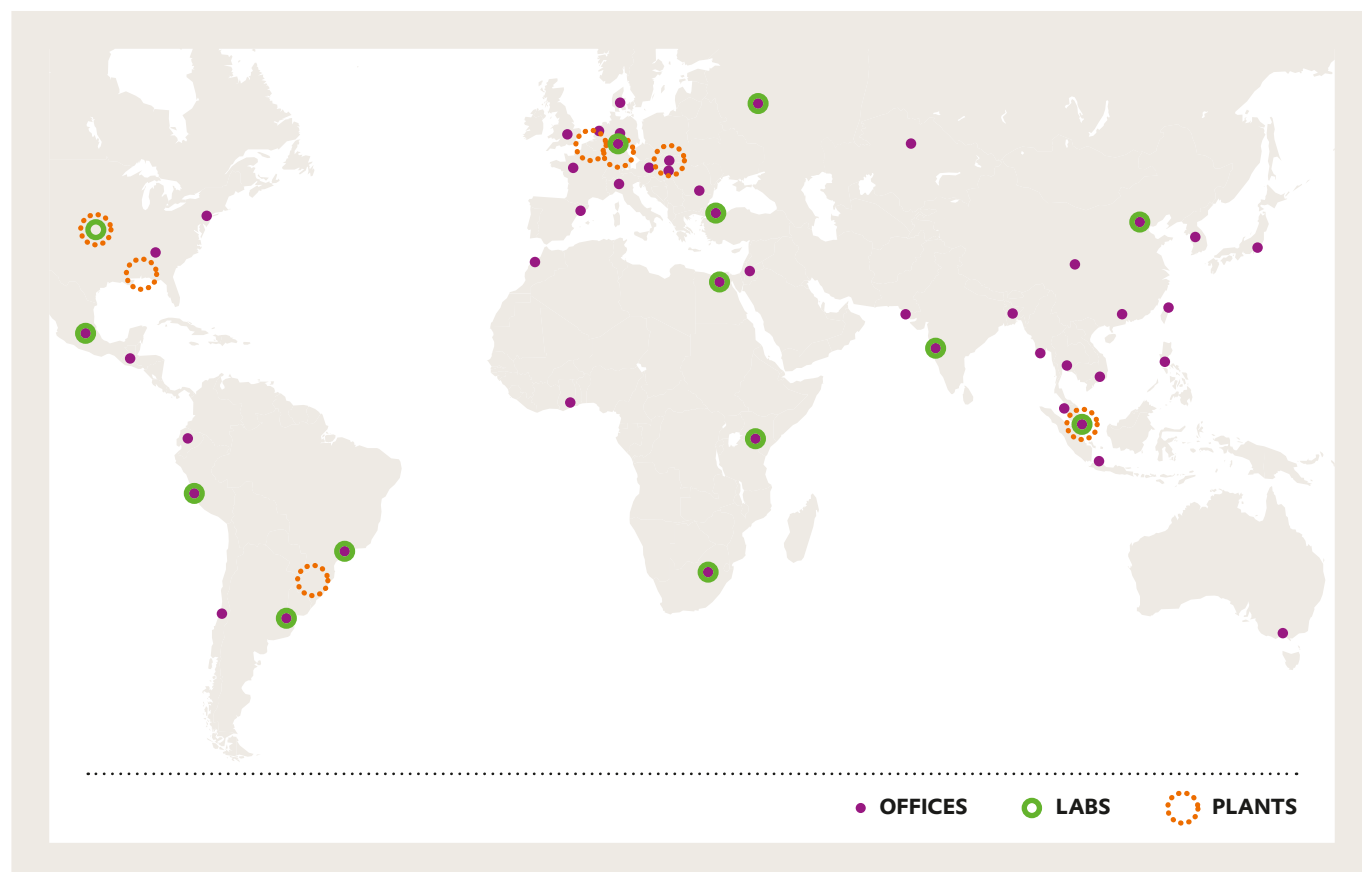
With offices in more than 50 countries, we ensure maximum responsiveness and service quality, guaranteeing availability of our products to customers in over 100 countries.

We have more than 10 labs on five continents that provide NIR and wet-chemistry services, placing leading analytical capacity for amino acids and other nutrients at your disposal. This ensures quick turnaround and accurate assessments of your raw material quality, enabling you to formulate consistently

high-quality and cost-efficient feed. With our portfolio of essential amino acids and other advanced nutrition solutions, we place you in a position to implement more efficient and sustainable diet concepts, such as ideal protein, and support you in your antibiotic-free strategy.

To avoid waste of relatively costly micro-ingredients, we have developed handling solutions that maximize dosing accuracy. You can reduce safety margins while still guaranteeing sufficient amounts of amino acids to meet livestock needs.

With manufacturing plants on three continents and over 50 warehouses worldwide, we can deliver reliably – on time and in the right quantity. Count on us, not only for an excellent product, but for a whole package that adds up to best results.



Evonik at a glance

Evonik is one of the world leaders in specialty chemicals. The company is active in more than 100 countries around the world and generated sales of €13.1 billion in 2019. Evonik goes far beyond chemistry to create innovative, profitable and sustainable solutions for customers. More than 32,000 employees work together for a common purpose: We want to improve life, today and tomorrow.

The focus of the business of the Nutrition & Care division is on health and quality of life. It develops differentiated solutions for active pharmaceutical ingredients, medical devices, nutrition for humans and animals, personal care, cosmetics, and household cleaning. The Animal Nutrition business line is one of Evonik's key end markets.

EVONIK ANIMAL NUTRITION

Evonik Animal Nutrition is a highly reliable, globally operating provider of science-driven products and services for sustainable and efficient production of meat, fish, eggs and milk. The organization is marked by scientific excellence and sensitivity to the needs of our customers and society.

OUR MISSION

We use science to improve sustainability, health and efficiency along the food chain to feed growing populations with animal protein for generations to come.

WHAT WE STAND FOR

Our unique combination of scientific excellence and customer-centered products and services sets us clearly apart. Our customers know they can count on us, because everything we do is firmly rooted in proven science and implementation expertise.



IN DIALOG

So many ways to reach us – whether via e-mail, telephone or a personal visit. We look forward to serving you.



Check out our LinkedIn company page for the latest news.

#EvonikAnimalNutrition

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