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Diversification of the egg production chain and opportunities for producers to expand their business

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Diversificação da cadeia produtiva de ovos e as oportunidades para os produtores expandirem seus negócios

RESUMO

A indústria de ovos é parte essencial da economia brasileira, uma vez que fornece uma importante fonte de proteína para a população. Além disso, esse é um setor responsável pela vasta geração de empregos e renda para grande parte da população. Entretanto, apesar de sua importância, a indústria de ovos no Brasil enfrenta vários desafios, em diferentes aspectos. Pensando na rapidez em que a produção de galinhas poedeiras vem progredindo, bem como a crescente demanda por proteína de alta qualidade, o setor deve continuar evoluindo para atender às novas demandas e desafios do mercado. Para isso, uma forma de garantir sua sustentabilidade e competitividade é por meio da diversificação da cadeia produtiva de ovos, principalmente a nível de mercado, negócio e produção. Desse modo, este trabalho objetiva analisar a diversificação da cadeia produtiva de ovos no Brasil com foco ao alinhamento com os Objetivos de Desenvolvimento Sustentável (ODS) estabelecidos pela Organização das Nações Unidas, em 2015. Para tal, foi utilizada uma metodologia de revisão de literatura, abrangendo artigos de periódicos revisados por pares, relatórios governamentais e trabalhos relevantes publicados. Apesar dos poucos estudos publicados em relação ao tema, analisando de forma integrada, pode-se notar que técnicas de diversificação tem se tornado boa opção para alavancar o mercado que visa a comercialização de ovos, uma vez que os consumidores estão cada vez mais exigentes e preocupados com a qualidade, saúde e impacto ao meio ambiente dos produtos e alimentos.

PALAVRAS-CHAVE: Dinâmica da Concorrência Mercados Segmentados. Produção Sustentável. Produção Vertical. Sistema Agroindustrial.

Diversification of the Egg Production Chain and Opportunities for Producers to Expand Their Businesses

ABSTRACT

The egg industry is an essential part of the Brazilian economy, as it provides an important source of protein for the population. Additionally, it is a sector responsible for generating significant employment and income for a large portion of the population. However, despite its importance, the egg industry in Brazil faces several challenges in different aspects. Considering the rapid progress in laying hen production and the growing demand for high-quality protein, the sector must continue evolving to meet new market demands and challenges. To ensure its sustainability and competitiveness, one way is through the diversification of the egg production chain, focusing on market, business, and production levels. Thus, this study aims to analyze the diversification of the egg production chain in Brazil, emphasizing its alignment with the Sustainable Development Goals (SDGs) established by the United Nations in 2015. A literature review methodology was adopted, encompassing peer-reviewed journal articles, government reports, and relevant published works. Despite the limited number of studies on the subject, an integrated analysis shows that diversification techniques have become a promising option to boost the egg market, as consumers are increasingly demanding and concerned about the quality, health impact, and environmental sustainability of products and foods.

KEYWORDS: Market Competition Dynamics. Segmented Markets. Sustainable Production. Vertical Production. Agribusiness System.

Diversificación de la cadena productiva de huevos y oportunidades para que los productores expandan sus negocios

RESUMEN

La industria del huevo es una parte esencial de la economía brasileña, ya que proporciona una importante fuente de proteína para la población. Además, es un sector responsable de generar una vasta cantidad de empleos e ingresos para gran parte de la población. Sin embargo, a pesar de su importancia, la industria del huevo en Brasil enfrenta varios desafíos en diferentes aspectos. Considerando el rápido progreso de la producción de gallinas ponedoras y la creciente demanda de proteínas de alta calidad, el sector debe continuar evolucionando para satisfacer las nuevas demandas y desafíos del mercado. Una forma de garantizar su sostenibilidad y competitividad es mediante la diversificación de la cadena productiva de huevos, enfocándose principalmente en los niveles de mercado, negocio y producción. Por lo tanto, este trabajo tiene como objetivo analizar la diversificación de la cadena productiva de huevos

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en Brasil, destacando su alineación con los Objetivos de Desarrollo Sostenible (ODS) establecidos por la Organización de las Naciones Unidas en 2015. Se utilizó una metodología de revisión de literatura que abarca artículos de revistas revisadas por pares, informes gubernamentales y trabajos relevantes publicados. A pesar de la escasez de estudios publicados sobre el tema, un análisis integrado revela que las técnicas de diversificación se han convertido en una buena opción para impulsar el mercado orientado a la comercialización de huevos, dado que los consumidores son cada vez más exigentes y están preocupados por la calidad, la salud y el impacto ambiental de los productos y alimentos.

PALABRAS CLAVE: Dinámica de Competencia de Mercados Segmentados. Producción Sostenible. Producción Vertical. Sistema Agroindustrial.

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1 INTRODUCTION

Brazil occupies a prominent position among the world's largest egg producers. According to data from the Brazilian Institute of Geography and Statistics (IBGE), the national egg production reached a record high in 2022, totaling 4.06 billion dozen chicken eggs. This figure represents a 1.2% increase in relation to 2021, when another record had also been set (IBGE, 2023). Brazil's vast territory and favorable climatic conditions contribute to the expansion of animal production (GUIMARÃES, 2012) and, consequently, egg production. With an expressive domestic demand and a growing presence in the global market, the country has consolidated its position as an important player in the poultry industry, strengthening the economy and solidifying its reputation on the international stage (SOARES; XIMENES, 2023).

However, although egg farming holds great importance in Brazil, the sector faces several challenges, such as disease outbreaks that affect production yields, as well as growing concerns about animal welfare and the environmental impacts associated with large-scale production systems. Faced with these challenges, the Brazilian egg industry must diversify its production to achieve long-term sustainability. Diversification implies adopting innovative practices and technologies to minimize disease risks, implementing animal welfare measures to ensure adequate breeding conditions, and seeking environmentally responsible solutions to problems (AMARAL, 2016). Diversification of the egg production chain can provide relevant contributions to economic and social development. For example, investments in the research and development of new egg products and derivatives can boost the industry, creating business opportunities and jobs. Thus, it is essential that the Brazilian poultry sector be aware of current challenges and strive to develop innovative solutions, with the aim of achieving economic, social, and environmental sustainability. The adoption of responsible practices and diversification of the production chain are important steps in solving current challenges and ensuring a promising future for this key sector of the Brazilian economy.

To achieve these goals, the Brazilian egg production chain must be aligned with the SDGs outlined in the 2030 Agenda. For example, Zero Hunger (SDG 2) and Good Health and Well-Being (SDG 3) can be achieved by promoting egg consumption as a healthy and affordable protein source, improving egg quality and safety, and increasing awareness of the nutritional benefits of egg consumption among the population. Similarly, Decent Work and Economic Growth (SDG 8) requires the promotion of decent working conditions, fair wages, and productivity improvement along the egg production chain. Responsible Consumption and Production (SDG 12) and Climate Action (SDG 13) can be achieved through the adoption of sustainable agricultural practices, such as the use of environmentally friendly inputs and the reduction of greenhouse gas emissions.

In view of these observations, this article aims to analyze the diversification of the Brazilian egg production chain. A literature review was conducted on the theme. Despite the numerous economic, social, and environmental advantages of diversifying egg production, there are still few scientific articles and academic investigations addressing themes related to production diversification. Furthermore, most of the articles selected for the construction of this bibliographic research address the theme in a non-comprehensive manner, that is, without integrating market, business, and production perspectives. The following sections of this article

present the methods, research development, findings of the literature review, discussions, and some final considerations on the studied topics. This research is expected to provide relevant contributions to scientific, academic, professional, and technical communities that have been committed to improving the performance of the egg production chain. It is believed that the diversification of egg production and marketing strategies can benefit both small- and large-scale producers.

2 METHODS

This study adopted a descriptive approach to gain an in-depth understanding of the diversification of the egg production chain. Descriptive studies assess data and facts extracted from a local reality, encompassing the observation, recording, and analysis of phenomena (CERVO; BERVIAN; SILVA, 2007). This article followed the so-called narrative or traditional literature review method, whereby pertinent references are selected to construct a comprehensive reasoning on the subject. According to Tranfield *et al.* (2003), this method allows the researcher to map and evaluate the existing intellectual territory and serves as a basis to formulate research questions that help further develop the knowledge base. This method is also capable of capturing collective perceptions by theoretical synthesis in different fields and subfields of knowledge. The goal of this research is also descriptive, as it aims to expose facts and establish correlations between variables of interest (PRODANOV; FREITAS, 2013).

Articles were searched on databases, virtual libraries of research funding agencies, and digital libraries, such as SciELO, Scopus, Web of Science, Google Scholar, Periódicos CAPES, and Biblioteca Digital UNESP. As explained by Volpato (2008), the search process in this type of research involves database searches for relevant keywords, with setbacks and advances, where the subjects are represented by scientific articles, books, and journals selected according to their scientific relevance and relationship with the studied theme (VOLPATO, 2008). This article was constructed via an exploratory, investigative, and qualitative analysis based on a review of current and relevant literature, focusing, within the large field of agribusiness and development research, on competition dynamics in agribusiness markets.

3 RESEARCH DEVELOPMENT

This section presents a literature review of the Brazilian egg production chain, as well as aspects related to its diversification from a business, market, and production perspective.

3.1 Brazilian egg production chain: A brief contextualization

The Brazilian agroindustrial production chain is renowned and respected worldwide for its competitiveness, efficiency, and high yields (CAMARGO *et al.*, 2019). The same applies to egg production (SOARES; XIMENES, 2022). The country currently occupies a prominent position among the world's largest producers, showing the capacity to meet domestic demands and contribute to the global supply of eggs (SILVA *et al.*, 2022).

The egg production sector has made important advances owing to continuous efforts directed mainly at increasing internal consumption (STEFANELLO, 2011). The increase in

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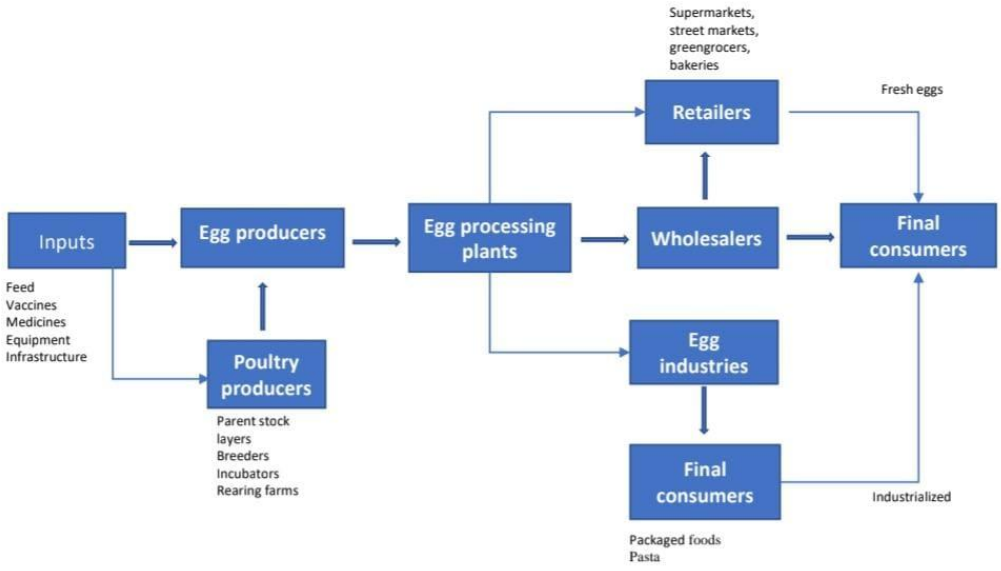
consumption, combined with the high yields achieved by Brazilian farms, has enhanced consumer demand for high-quality eggs. Therefore, quality-affecting aspects of the production chain need to be thoroughly investigated (ALCÂNTARA, 2012).

Pereira *et al.* (2021), in a study assessing egg quality throughout production and sales, noted that some factors have a great influence on egg integrity and safety, such as natural defense mechanisms, inadequate bird handling, lack of hygiene during egg collection and processing, and failure to comply with regulatory requirements on storage and sales conditions. The dissertation of Mizumoto (2004) discusses important transactions and operations of the egg production chain, including relationships between feed plants and egg producers, egg producers and processing plants, and food industries and their respective distribution channels. Figure 1 illustrates the main connections between egg production systems, poultry breeders, and other links in the egg production chain.

Figure 1 – Egg production chain



Source: Mizumoto (2004)

The Brazilian egg production chain is composed of several fundamental links that play distinct and interconnected roles to ensure egg production, grading, packing, transport, distribution, and sales (KAKIMOTO, 2011). The major links are described below.

(A) Input production: considered by many authors as the first link of the chain. It is responsible for the production of vital inputs for the breeding of laying birds. The main products are feed, feed supplements, vaccines, and medicines.

(B) Egg production: it is the central link of the production chain. Laying birds are reared under diverse systems to produce eggs, including conventional, enriched, free-range, and organic systems.

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(C) Egg grading and packing: collected eggs are graded according to specific criteria, such as weight and shell integrity. Subsequently, eggs are packed in suitable boxes or trays and prepared for transportation and distribution.

(D) Transportation and distribution: packaged eggs need to be properly transported to preserve quality and integrity. Distribution networks collect eggs from producers and transport them to points of sale, such as supermarkets, fairs, and restaurants.

(E) Sales: in this final link of the production chain, eggs are made available to final consumers. For diversification, eggs can be sold in different formats, such as fresh eggs, processed eggs, or eggs intended for the food industry (KAKIMOTO, 2011).

It should be noted that each link of the egg production chain plays an important role in ensuring the quality, safety, and availability of this food. Integration and proper functioning of all agents and/or processes are fundamental to the efficiency and sustainability of the egg production sector. Furthermore, the use of appropriate technologies and adoption of good production practices are crucial to ensuring the quality and safety of eggs throughout the production chain (PIANTKOSKI; BERTOLLO, 2020). New technologies such as Poultry Farming 4.0, artificial intelligence, and precision farming can contribute to improving production efficiency, reducing costs, and increasing egg quality.

3.2 Diversification of the egg production chain

Diversification in egg production refers to the practice of rearing different breeds of laying hens and/or adopting different production systems to afford more than one type of egg. Diversification of activities, also expressed as diversification of production or integration, is one of the most distinctive characteristics of a company in the industrial and commercial sectors (PENROSE, 1979). Such diversification seems to be associated with company growth and plays a key role in operations (RAHMAN; LAMBKIN, 2015; CASONATO; COSTA, 2019).

According to Martins *et al.* (2000), in recent years, there has been a considerable diversification of the egg market, along with attempts to establish brands and product differentiations. In supermarkets, a variety of options are available, such as low-cholesterol eggs, free-range eggs, and transparent packaging containing 6, 12, or 18 units. The industrialized products sector, particularly the food industry, has increasingly sought innovations to meet the demands of the consumer market, as evidenced by the launch of egg powder for consumer consumption. Egg powder is sold in packages containing the equivalent of four units; the product was developed with the aim of conquering a new market (MARTINS *et al.*, 2000).

Overall, diversification of the egg production chain involves the expansion of activities and products related to egg production and marketing. Diversification can be seen as a strategy not only to increase the supply of eggs but also to take advantage of new market opportunities, reducing risks and promoting sustainability.

4 RESULTS AND DISCUSSION

There are several ways to market eggs (LINS JÚNIOR, 2019). However, one of the most common forms is their sale in supermarkets and grocery stores, where eggs are sold in packs labeled with the expiration date, weight, and origin. As stated by Cunha *et al.* (2017), eggs can

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also be sold at street markets or directly to consumers, resulting in a more affordable price and greater proximity between producer and consumer. Pereira *et al.* (2023) observed that street markets play a primary role as marketing channels, contributing to the cultural and socioeconomic integration of communities.

The diversification process can be categorized into three niches related to (i) the market, (ii) business, and (iii) production. Table 1 describes some examples of diversification in the egg production chain.

Table 1 - Examples of egg production diversification strategies

Example	Description	Niche
Product variation	It is possible to diversify production by including other types of eggs, such as organic, free-range, cage-free, and even traditional. Such product diversification can cater to the diverse demands and preferences of consumers.	Market and production
Product processing	In addition to selling fresh eggs, companies could diversify their product line by offering processed egg products, such as liquid eggs, pasteurized egg whites, and pre-prepared omelets. These value-added products can provide consumers with a wider range of options.	Business
Alternative production system	Diversification can also involve adopting alternative production systems, such as free-range chicken farming and organic egg production. These systems align with the growing demand for sustainable products and can add value to eggs.	Production
Segmented markets	This involves targeting production toward specific niches, such as premium eggs, omega-3 enriched eggs, and eggs certified by quality seals.	Market
Vertical integration	Diversification can also take place through vertical integration, which involves expanding activities across different stages of the production chain. For instance, an egg-producing company can invest in animal feed production or the breeding of laying birds, thereby gaining control over the entire production process.	Business

Source: the authors (2023)

It is evident that diversifying the egg production chain can provide producers with opportunities to expand their business, explore new market possibilities, and mitigate the risks associated with relying solely on one method of selling the product. However, it is necessary to carry out feasibility studies to better understand market demands and invest in adequate training and infrastructure to achieve success.

Ribeiro (2019) reported that free-range, organic, cage-free, and traditional eggs can be found in the market. The authors aimed to compare the quality of red eggs sold in street markets with that of different types of eggs sold in supermarkets. It was concluded that eggs from street markets did not have inferior quality to those purchased in supermarkets, differing significantly only in weight. Saccomani *et al.* (2019) evaluated the physicochemical quality indicators of eggs from semi-heavy laying eggs reared under three different production systems: cage batteries, cage-free, or cage-free with access to a paddock for grazing (i.e., free-range). The authors determined the weight loss percentage, specific gravity, Haugh unit, yolk index, yolk and albumen percentages, lipid oxidation, yolk and albumen pH, and proximal composition of eggs.

Eggs from hens raised in cage-free and free-range systems showed improved yolk and albumen percentages. Cage-free eggs had a better Haugh index at the beginning of storage, whereas conventional eggs had a better yolk pH. The authors also found that egg quality is influenced by temperature and storage period: refrigerated storage resulted in better egg parameters.

Lima (2021) investigated the technologies, innovations, and sanitary and quality control aspects associated with egg processing. Shelled eggs are still the most common and most consumed products. However, chilled liquid egg, frozen egg, and egg powder, among others, deserve attention. The author reported that both egg and shell contents are rich sources of antibacterial substances, ingredients with anticancer properties, and compounds with immunostimulant effects. These properties could arouse great interest not only of traditional areas but also of biomedical and nutraceutical sectors. In light of the above, further studies on the diversification of egg processing are crucial.

Santos *et al*. (2018) argued that technological innovations play a key role in enhancing agility, standardization, and quality in poultry production. A case study conducted by Neves *et al*. (2020) showed that the Mantiqueira group is innovating and revolutionizing the egg market. In Mantiqueira plants, all stages of production are mechanized, including feed production (specific feeds for each developmental stage), shed management (feed, manure, and egg management), and egg grading and packing (separated by size, quality, and type). This innovative model ensures the production of higher quality eggs compared with the conventional eggs available on the market. Another example is the use of automation, which ensures that the final consumer is the first human to come into contact with purchased eggs (NEVES *et al.*, 2020).

Alternative egg production systems may be a viable strategy to meet specific market demands and ensure production sustainability (DEMATÊ FILHO; MARQUES, 2011). Organic egg production, for instance, values sustainability, animal health, and environmental sustainability, catering to consumers who seek healthier and more natural foods (DIAS, 2022). Azevedo *et al.* (2015) explained that the laying poultry sector is increasingly confronted with concerns regarding animal welfare. This is particularly evident in conventional systems, where birds are confined to cages throughout the production cycle. Although the space in cages is considered adequate for birds to move, it does not allow them to express some natural behaviors, such as sand bathing, perching, and exploring a wider environment. These behaviors are expressed in organic, free-range, or semi-confined systems (AZEVEDO *et al.*, 2015).

Egg consumers have become increasingly aware about animal welfare issues, demanding transparency, ethics, and responsibility in this regard. In the Brazilian market, consumers may encounter various labels and claims promoting differentiated products, such as happy eggs, happy chickens, from the farm, *caipira*, natural, and free-range chickens, among others (ALVES *et al.*, 2021). However, consumers are not necessarily provided with information about how eggs are produced and cannot verify whether the available information is true, unless products are certified by competent bodies.

Enriched eggs represent another strategy to add value to eggs by promoting additional health benefits through the addition of omega-3 and vitamin D, for instance. According to Costa *et al*. (2006), the enriched egg market is on the rise because of the potential health benefits to consumers. Omega-3 polyunsaturated fatty acids are widely recognized for their importance in the prevention of cardiovascular disease. These functional ingredients have a reduced content

of saturated fats, making them a healthy option. Of note, alternative egg production must be carried out in a planned and sustainable way, taking into account aspects such as economic viability, food safety, and environmental preservation. It is essential to ensure egg quality and safety throughout the production chain, from production to sales, with the use of good production practices and regular quality controls (MAZZUCO, 2008).

Another example of diversification in the egg production chain is vertical integration. Mizumoto and Zylbersztajn (2008) argued that vertical integration in feed manufacturing and egg processing by North American poultry farmers is stimulated by the uncertainties associated with breeding, such as disease susceptibility, difficulties in adjusting supply and demand, long cycles of activity, and geographical and temporal specificity (egg perishability). Vertical integration may also serve to avoid opportunism by the processing industry, as egg grading is a crucial stage of the value chain. Therefore, it can be said that integration of egg processing is an interesting strategy to ensure continuous egg supply (MIZUMOTO; ZYLBERSZTAJN, 2008).

Mastronardi, Cavallo, and Romagnoli (2022) evaluated the impact of diversification on the response of Italian poultry farms to the COVID-19 pandemic. The authors investigated whether changes brought by the pandemic could generate opportunities for egg production systems. It was found that the food supply chain faced serious challenges, although its countercyclical nature provided great resilience compared with other economic sectors. In the cited study, the importance of diversification in the post-pandemic period was made evident. Some of the factors deemed relevant by the study were policy implications regarding the promotion of farm competitiveness, improvements in sustainable logistics, e-commerce, and the exchange of knowledge and innovations between farmers. These measures may guide future agricultural, rural, and food policies at both national and local levels.

Other diversification strategies can be applied to the egg production chain. It is worth emphasizing, however, that business patterns are usually dependent on the path of structural development associated with the interaction of specific configurations of market structures, market dynamics, and strategic motives for mergers and acquisitions (KLIMEK; HANSEN, 2017).

5 CONCLUSION

The growth of laying poultry systems in Brazil can be attributed to the fact that it provides one of the most significant sources of animal protein: the egg. Eggs are a nutritious food accessible to all social classes because of their low cost. Possibilities for diversifying the egg production chain were investigated in the current study. The main strategies include product variation, alternative production systems, segmented markets, and vertical integration. Such diversification can provide the benefits listed below.

Economic advantages: egg production diversification promotes relevant economic benefits, increasing the income of small farmers and creating employment opportunities. By diversifying egg production and offering a variety of products (e.g., organic, free-range, and specialty eggs), it is possible to achieve higher prices than that of conventional eggs. Furthermore, by investing in innovative technologies and production methods, the egg industry can improve its efficiency and competitiveness in the global market.

Environmental benefits: although the egg industry could exert a substantial negative impact on the environment, especially with regard to chicken manure management, diversification could promote important environmental benefits. Farmers may adopt sustainable practices, such as composting and biogas production, to handle manure and reduce their environmental footprint. Moreover, by utilizing renewable energy sources such as solar and wind power, the egg industry can reduce its carbon emissions and contribute to more ambitious climate goals.

Social benefits: diversification of the egg production chain can produce positive effects on social development, especially in rural areas, such as northeastern Brazil, where many small farmers depend on egg production as an income source. By providing training and technical assistance, the egg industry can help farmers improve production practices and increase productivity. Furthermore, gender equality and woman empowerment can be stimulated, given the important role of women in the egg industry. With this, the sector can contribute to the achievement of the SDGs related to gender equality.

Overall, diversification of the egg production chain in Brazil can contribute to economic, environmental, and social development, with the added benefit of being aligned with the SDGs of the 2030 Agenda. However, the theme requires further research for the sharing of knowledge and implementation of sustainable practices in egg production, aiming at a more promising, profitable, and sustainable future for this industry.

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