Chapter 153

Market insertion of 4.0 technologies in poultry farming

Vivian Dos Santos Pereira
Federal University of Rio Grande do Norte, Natal, Brazil
E-mail: vivian.pereira.016@ufrn.edu.br

Yasmin Maria Santana de Melo
Federal University of Rio Grande do Norte, Natal, Brazil

Caio Christino de Oliveira Soares
Federal University of Rio Grande do Norte, Natal, Brazil

Steffany Jennyfer Santos de Araújo
Federal University of Rio Grande do Norte, Natal, Brazil

Nathalia Gabrielly Silva Souza
Federal University of Rio Grande do Norte, Natal, Brazil

Pâmella Raffaela Dantas de Freitas

Federal University of Rio Grande do Norte, Natal, Brazil

Zulmara Virginia de Carvalho
Federal University of Rio Grande do Norte, Natal, Brazil

ABSTRACT
The poultry industry has expanded with the insertion of enabling technologies. Being included in the consumer market, its economic role is of great importance. In view of the growing market and its contribution to the economy, the analysis of market technology was made, from the level of insertion in the economic techno paradigm 4.0. Through market prospection it was possible to obtain the result of the integration of industry 4.0 in the poultry sector within a culture of innovation.

Keywords: Entrepreneurial Science, Culture of Innovation, Technology Business

1 INTRODUCTION

Poultry farming has as its definition the breeding of birds with the purpose of producing food, such as meat and eggs, having among the species created the most prominent is chicken (BARBOSA, 2021). After realizing that the destination of the same animal for the production of eggs and its meat, presented the worst resultados in productivity it was necessary to divide it into areas: beef and laying bird, the opposite of that directed to one of the stages, making that there are currently selected lines for each specific area (BARBOSA, 2021).

The poultry farm would be the breeding of birds that are destined to slaughter for the commercialization of meat. Currently, in Brazil, it is one of the most produced agricultural activities, the breeding in large numbers of ready-to-eat birds was possible with the arrival of existing breeding technologies. On the other hand, laying poultry farming is the breeding of birds with the objective of marketing their eggs for consumption or reproduction, where these birds are named laying hens (ANDRADE, 2022). In Brazil, the aviculture began in the 30's with small producers of redneck chicken, but in the 70s it became a professional activity. The inclusion of technology has made this activity more efficient using genetic improvement and the creation of new bird strains has become a world reference in poultry farming and laying (ANDRADE, 2022).

Being a very current concept, industry 4.0, also called the fourth industrial revolution, cane conceptualized as everything in which technological innovations are included and that has been changing

the world of work, such as the automation of work activities (LINS,2022). According to the article published in 'The Rural Present' (2018), Paulo Roberto dos Santos - specialist in Strategic Positioning for New Trends - explains that the goal of industry 4.0 is to reach smart industry processes (smart processes), characterized by adaptability, resource efficiency and ergonomics, in addition to integrating customers and business partners in business activities and value.

According to data from the Brazilian Association of Animal Activity(ABPA, 2018), in 2017 the Brazilian production of chicken meat was 13.5 million tons, keeping the country in the position of the world's largest exporter and second largest producer of chicken meat, behind only the United States. Of the total chickens produced by the country in 2017, 66.9% were destined for domestic consumption and 33.1% for export. Per capita consumption in 2017 was 42.07 Kg/year and total export volume was 4.3 million tons exported to more than 150 countries, with a participationof almost 40% in the world market for chicken meat. The industrial poultry sector employs more than 5 million people, directly and indirectly, and accounts for almost 1.5% of the national Gross Domestic Product (GDP). This sector is represented by thousands of integrated producers, hundreds of companies and dozens of exporting companies, which underscores their importance to the country (ABPA, 2018).

In addition, data presented by the Brazilian Agency for Industrial Development (ABDI) show that 2% of the country's organizations are actually included in the concept of industry 4.0, that is, in Brazil this concept is still little known (LINS, 2022).

What differs from the fourth industrial revolution from the other is the speed of transformation and the high degree of volatility in the world of work due to the high capacity of intelligent machines. The industries are already adhering to the 4.0 revolution, which in some years will have mostly adopted artificial intelligence in data processing, the production line and its image (LINS, 2022).

Intelligent equipment capable of making decisions and executing them based on data previously collected, analyzedand cross-examined are derived from this technological revolution, their actions can be combined in several ways, from the ability to collect, analyze and store data (LINS, 2022).

Industry studies have found that, in its scope, innovation is fundamentally incremental and adaptive from technologies generated abroad to the different links of the chain. In general terms, it can be affirmed that the advances of Brazilian aviculture were resultados of the introduction of innovations in the areas of genetics, nutrition, health and new equipment in the creation system, which allowed a significant gain in feed conversion rate. These innovations occur, first, through technological import, through the adaptation process until they can be implemented, resulting in progress (SILVA et al, 2021).

The enabling technologies of the fourth industrial revolution are the main group of technologies that are part of the digitization process of companies (RIGOTTI, 2020). Advanced robotics, artificial intelligence, sophisticated sensors, internet of coisas (IoT), cloud computing and big data analysis, as they integrate with each other, are able to interact and transform the industry, being a facilitator of industry 4.0 applications (RAZALI, 2018).

This article aims to report the visible progress in the poultry production sector with the insertion of industry-enabling technologies 4.0 and a prediction of how its evolution will happen in the coming years.

2 MATERIAL AND METHODS

The study was initially based on data from the site worldwide.espacenet, through it was collected the necessary data and inserted in spreadsheets divided by categories (Big Data, Internet of Things - IoT - , Cybersecurity...) to start prospecting, analysis and treatment of data on the poultry production sector (poultry). Then, searches were made about the concept of industry 4.0 and how the productive sector is inserted in enabling technologies.

In addition, analyzing the behavior of companies, as well as the use of spreadsheets that played a fundamental role in organizing, realizing and evaluating, through graphs, the topics inserted in the article in force. Thus it was possible to notice patterns, invested area and main investors, and possible advances that, with due time, can become the form d and standardproduction in the sector focus of research and others.

Table 1 - Search terms used in Technological Prospecting on Espacenet

Objeto de Análise	Tecnologias Habilitadoras 4.0
poultry	- AND "Big Data" AND "Augmented Reality" AND ("3D Printing" OR "Additive Manufacturing") AND "Cloud Computing" AND ("Advanced Robotics" OR "Autonomous Robots" OR "Robot") AND ("Simulation" OR "Artificial Intelligence" OR "Machine Learning" OR "Cognitive Computing") AND ("Internet of Things" OR "IoT" OR "RFID" OR "Smart Sensor" OR "Machine to Machine") AND ("Cybersecurity" OR "Computer security" OR "Information Technology Security") AND "System Integration"

Source: The Authors (2022)

3 RESULTS AND DISCUSSION

From the analysis of data collection on enabling technologies present in the poultry production sector, it can be seen that among all these, three more stand out, which are: artificial intelligence, internet of things and autonomous robots.

Artificiali ligonce (intelligent machines), internet of things (connection between different devices) and autonomous robots (robots that operate alone), are 3 (three) of the 9 (nine) trends of Industry 4.0, but why are they the most developedin the viculture? These combined enabling technologies become the ideal trio for a management and monitoring system of the aviculture production system.

Among the countries that most exploit this area and have the largest number of patents are China, usa and Japan, due to large amounts of investments in the areas of science and technology, leading them to be major technological producers in the world market.

Georgia's Institute of TechnologicalResearch is already testing with a mobile autonomous robot, which could perform repetitive tasks such as monitoring farms while interacting with chickens. This

technological inclusion can help growers reduce, for example, the likelihood of disease outbreaks as well as lower labor costs and leave more important tasks with humans (BECK; PRISCILLA; 2021).

As Brazil is one of the largest exporters of chicken in the world, it did not take long tointegrate these in the vas production trends. The Stac Robot was developed in partnership between the State University of Western Paraná and the Itaipu Technological Park (PTI) and was the winner of embrapa's Inovavi Swine and Poultry challenge in 2020 (AZEVEDO, 2021).

It is astandalone robot integrated with sensors and artificial intelligence. It carries out the route throughout the aviary to help the producer to turn the bed and move the lot, favoring the agroindustry in reducing condemnations by contamination caused by problems in the management of pre-slaughter. The machine can also be controlled via mobile making use of the AveStac application (AZEVEDO 2021).

Just like the autonomous robot, additive manufacturing and 3D printing are new technologies that are being included in the aviculture and that will make an impact.

Initiatives such as block chain which is the concept in which it applies to ensure traceability of products and radio frequency identification, which would be the monitoring of transport and storage conditions are aligned with the concepts of industry 4.0, that is, are measures that have improved simple coisas that allow to reduce waste and increase profits.

Simulation is another technology, which allows virtual construction of poultry plants, data is released that allows a view before the project is executed. Another technology is the augmentedrealid ade that overlays actual images with computer data, making it possible to perform employee training in the operation of a equipment or design cutting lines that stimulate the reduction of carcass waste (BECK, 2021).

In the meantime, there was a recess that began in early 2020, leading to a growing slowdown in the processes of research and technological development of several areas, delaying possible implementations of the tools or preventing their continuity. As everyone is aware, his cause was because of the pandemic of covid-19.

According to the article published in 'The Rural Present'(2018), the competitiveness of industry and the need for renewal made humanity arrive today in the item technology and evolution in the highest degree of development. It is possible to observe this over the years from the industrial revolutions. Each of them has contributed to improving society, whether in the use of steam machines, mass production or the advent of the internet and digital platforms. Now, the fourth industrial revolution is enough for humanity to once again take a step forward. Industry 4.0 is already a reality in the world – and in agribusiness

Graph 1 - Temporal evolution (2000-2021) of the number of patents per enabling technology 4.0 in the poultry sector
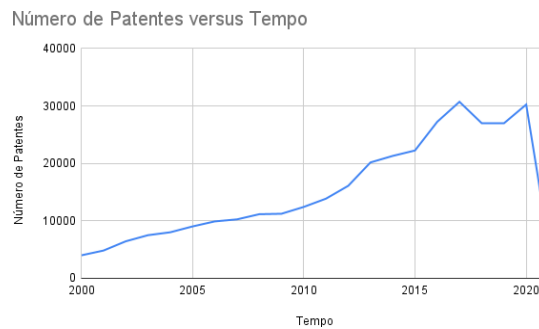
Source: Adapted from Espacenet (2022)

From the analysis of Graph 1 on temporal evolution (2000-2021) and on the events mentioned above, it is possible to conclude that the pandemic had an impact on the number of patents, which began to grow from 2015 to 2017. Moreover, it can be highlighted   that artificial intelligence, internet of things and autonomous robots are the three enabling technologies that stand out the most.

Graph 2 - Temporal evolution (2000-2021) of the number of patents of the bird setor
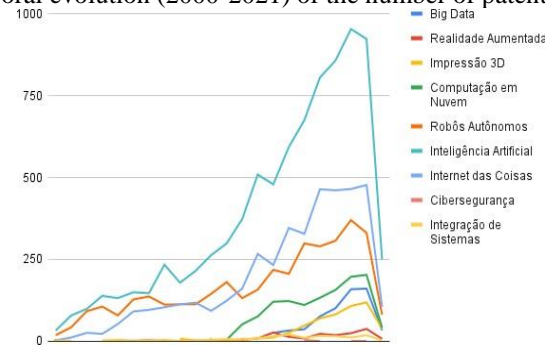
Source: Adapted from Espacenet (2022)

It is possible to infer that in the period between 2000 and 2019 patents related to artificial intelligence leveraged almost constantly, being the enabling technology   with more patents, reaching 953 in   2019, that is, 28 times higher   in 2000. technology that grew the most, starting with 3 in 2000 and peaked in 2020 with 447.

In 2020, technology and innovation projects and objectives to be made were affected by the pandemic, triggered as a result of COVID-19, and bythe consequent economic, political and social crises produced worldwide.

In the business area, most companies had to put aside their 2020 strategic plans to adapt to the crisis with emerging strategies. Governments, following very varied strategies, sought to provide answers to their population   and theirown economic problems. Currently, researchers in strategic management face the challenge of developing objective studies in the face of emerging and short-term strategies developed in these areas (BACKES et al., 2020). In the technology andinnovation sector, the main difficulties imposed by the pandemic stem from transport and logistics limitations, in addition to the shutdown of industrial activities.

China, one of the main markets for electronic goods, was the first epicenter of COVID-19, adopting social isolation measures as early as mid-February. The closure of manufacturing plants, borders, ports and airspace has impacted on the world supply chain, causing the lack of raw materials, components, production goods and goods.

Reduced production, trade restrictions and international travel have prevented thousands of fairs technological problems happen, causingan estimated loss of $1 billion. Without these trading spaces, it impacts the delay in launching new products in the sector, further aggravating the technology economic crisis (CIRNE, 2020).

Figure 3 - Main protective nations (until 2021) of poultryindustry in ventions
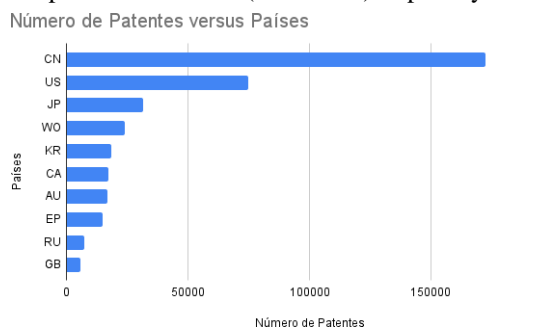
Source: Adapted from Espacenet (2022)

From the analysis of the data collection made on the main patent-protective countries (Graph 3) present in the poultry production sector, it can be seen that among all these, three maystand out, which are: China, the United States and Japan.

Graph 4 - Insertion in   enabling technologies
4.0 of the main protective nations (by 2021) of inventions in the poultry sector
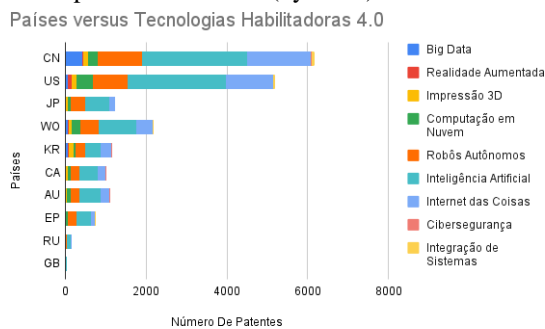
Source: Adapted from Espacenet (2022)

From the analysis of the chart above, it is determined that China, USA and Japan are the countries with the most patents, having the first with the largest number. Already an analysis made of patents within the technologies of industry 4.0 has China, USA and WO as the top three. In other words, it is concluded that even japan occupying the third place of countries with more patents, these are not mostly within enabling technologies, and that among all enabling technologies, the most standout are artificial intelligence, internet of things and autonomous robots.

New technologies applied in production systems allow producers to better control production, optimize and thus increase profitability. For example, the body weight of each bird, feed and water intake, stress level, thermal comfort and air quality parameters can be monitored in real time to ensure maximum performance and animal welfare. Agrisolus CEO Anderson Nascimento, working on developing solutions for poultry, exemplifies some of the technologies and their applicability in the poultry chain. One of them is radio frequency identification (RFID) tags, which allow recording information about food, health and location of animals. According to the speaker, it is a low cost resource that delivers effective results. (AGROLINK & ADVISORY,2021)

There is also augmented reality, which allows you to visualize the real world through a camera. In aviculture, it has enormous potential to revolutionize veterinary care, according to Nascimento. "In the future, will it take veterinarians to go to the farm or is it possible to guide producers with augmented reality glasses?" asked the expert. Another technical resource he cites is computer vision. "One of the most promising cattle ranches. Imagine a camera that can measure chickens, weigh them, analyze their behavior, and identify each animal. It is possible and is already used in the water crop." There is also Big Data, which studies how to process, analyze and organize information, the Internet of Things, which uses sensors to collect data, and artificintelligence, which automates processes.(AGROLINK & ADVISORY,2021)

Agroindustry has been increasingly competitive, which has increased the lack of technology, increasing the control and efficiency of the production process. These intelligent processesbring benefits to the various sectors of the chain, from those directly connected to production to those that promote better working conditions for operators. Having China, USA and Japan the countries that stand out the most, because they are developed, both in science and technology, they invest in artificial intelligence, internet of things and autonomous robots. Scientists from China along with the UK have begun using artificial intelligence on chicken farms to track and combat diseases and the use of antibiotics in their farms.

The potency of antibiotics is a worldwide tribulation, and unfortunately it is getting worse and worse. Some superbacteria are r-esistentes to everything, but it takes a study to know how to treat them. In farms, these superbacteria are not only transmitted in animals, but in humans and in the environment. It is necessary to understand how to stop, otherwise it will be very bad. (DOTTORINI, 2019).

Scientists, in addition to usingintelligence, used big data to search for and analyze information to determine the onset of possible outbreaks in this sector, in addition to reducing antibiotic use. As shown in graph 1 (one) the insertions with higher indices, are artificialintelligence, internet of things, autonomous robots and big data, where the countries in the spotlight invest their money and time.

This issue can be given to the economy of these countries and their focus of technological application. Japan, for example, may not have a maior development in the poultry sector because its focus is on the production of technological goods and basic industries such as electronics and spare parts (BUENO, 2021).

Graph 5 - Main inventors (until 2021) of the Parts for <<Aircraft>>
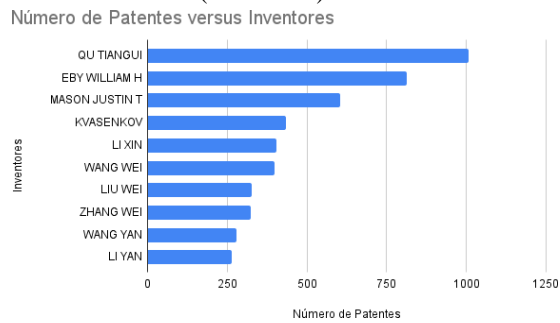
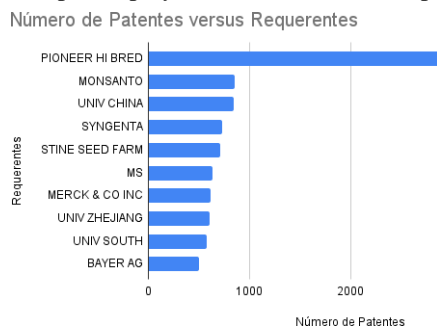Número de Patentes versus Inventores

Source: Adapted from Espacenet (2022)

From the analysis of the data collection made on the main inventors (Graph 5) present in the poultry production sector, it can be seen that among all these, three more stand out, which are: Qu tiangui, Eby william h and Mason justin t.

It is possible to point out that when comparing graphs 4 and 5, it is found that even though the three main inventors are Qu tiangui, Eby william h. and Mason justin t. none of them appropriated the technologies of industry 4.0, having only Liu Wei with patents in big data technology.

Figure 6 - Main patent players (until 2021) of the poultry sector

Número de Patentes versus Requerentes

Source: Adapted from Espacenet (2022)

From the analysis of   the data collection made on the main players (Graph 6) present in the poultry production sector, it can be seen that among all these, three more stand out, which are: Pioneer hi bred int, Monsanto Technology llc and univ china agricultural.

Graph 7   - Insertion in enabling technology 4.0 of the main patent players (by 2021) in the poultry sector

Requerentes versus Tecnologias Habilitadoras 4.0
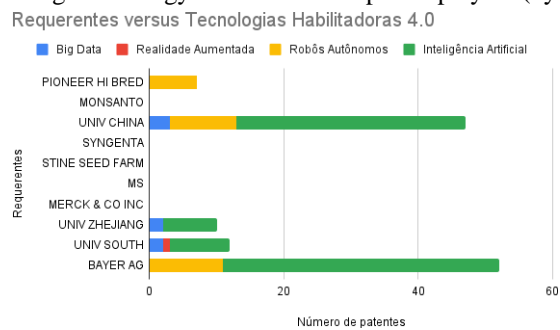
Source: Adapted from Espacenet (2022)

It can be concluded from the analysis of the graph above that the company that uses patents the most is Pioneer hi bred. However, by looking at the chart on the right, you can   see that your patents are aimed only at autonomous robots, in which, in addition to autonomous robots, they also have patents on artificial intelligence, increased r eality and big data. Even though not all companies have patents within enabling technologies, the most stand out are artificial intelligence and autonomous robots.

At first, a technological trend is something that is on the rise in the setor 4.0, so it can be reported according to the data analyzed, that the trend that stands out most is artificial intelligence in the poultry sector. It is worth mentioning that even this greater development in the area of artificial intelligence, does not leave to be desired in relation to autonomous robots and internet of things since the objective of these researches is the realization of the evolution of the productive and commercial sector of poultry cutting and laying, making the area efficient against production losses and failures, making it autonomous. In this way, the advancement of these technologies will probably make their implementation in the breeding sites necessary.

4 CONCLUSION

Based on the analysis of the data and facts presented, the Poultry sector presents a direct application in the productive area for consumption. Being an area that began with primary techniques, currently presents a great development with the use of enabling technologies that have made itsproduction massive, meeting the demand for consumption. Thus, the importance of technological implementation in the area in a world of constant innovations, it is necessary to rapidly deploy new emerging technologies to compete with the leading countries of development and, if possible, to make partnerships   in order to obtain permission for the use of patents in order to advance technologically in advance in the stages of production already considered outdated in the midst of the competitors of marketand its techniques of implementation of quality and production service.

REFERENCES

ANDRADE, Jéssica. Avicultura e sua importância no agronegócio do Brasil. Rural Centro,2022.

Disponível em:<https://www.ruralcentro.com.br/noticias/avic ultura-e-sua-importancia-no-agronegocio-d

o-brasil-87830>. Acesso em: 09/05/22 ANTONUCCI, Antonio Mataresio; ROSSATO, Monique Rusch; MATTOS, Priscila Marati de. PRINCIPAIS PARASITOS EM AVES

INDUSTRIAIS (FRANGOS, GALINHAS E PERUS) – REVISÃO DE LITERATURA. REVISTA CIENTÍFICA DE MEDICINA VETERINÁRIA - ISSN 1679-7353 Ano XVI -

Número 32 – JANEIRO de 2019 – Periódico Semestral. Disponível em:<http://faef.revista.inf.br/imagens_arquivos/ar quivos_destaque/ssv7BzkR7dcYpml_2019-

4-3-14-6-10.pdf>. Acesso em: 14/05/22 ALVES, João Marcos de Souza. ANÁLISE DE PATENTES NA INDÚSTRIAAVÍCOLA

INTERNACIONAL.Disponívelem:<https://lume. ufrgs.br/bitstream/handle/10183/4851/0005 05489.pdf>. Acesso em: 11/05/22

BACKERS, Danieli Artuzi Pes et al. Os efeitos da pandemia de Covid-19 sobre as organizações: um olhar para o futuro.Revista ibero-americana de Estratégia, 2020. Disponível em:

<https://periodicos.uninove.br/riae/article/view/18 987/0> , Acessado em: 12/05/2022.

BUENO, Sinara. Importações do Japão Fazcomex. Disponível em:

<https://www.fazcomex.com.br/blog/importacoes- do-japao/>. Acesso em: 19/05/2020.

CIRNE, Stefanie. Impactos da COVID-19 no Setor de Tecnologia e Inovação. Cadastra, 2020. Disponível em:

<https://cadastra.com/pt/insights/impactos-da-co vid-19-no-setor-de-tecnologia-e-inovacao/>.

Acesso em: 12/05/2022

DUARTE, Daniel Azevedo. FAEMG, 2021. Disponível em:

<http://www.faemg.org.br/inaes/noticias/robos-aj udam-no-manejo-das-granjas>. Acesso em: 15/05/2022

GENERA, Rigotti. Conheça as tecnologias habilitadoras da indústria 4.0 e algumas aplicações. ABii , 2020.Disponível em:

<https://abii.com.br/com-abii-single-post-conheca- as-tecnologias-habilitadoras-da-industria-4

-0-e-algumas-aplicacoes/>. Acesso em: 10/05/2022

IMMERMAN, Graham. INDÚSTRIA 4.0

HISTÓRIA ATÉ AGORA. machinematrics, 2017. Disponível em:

<https://www.google.com/url?q=https://www.m achinemetrics.com/blog/industry-4-0-his

tory-up-to-now&sa=D&source=docs&ust=1652 833484362037&usg=AOvVaw33HWkoN 7UANS6eAILBsepF>. Acesso em: 12/05/22 LINS, Maria Fernanda. O surgimento da indústria

4.0. Migalhas,2021. Disponível em:<https://www.migalhas.com.br/depeso/338895/o-surgimento-da-industria-4-0>. Acesso em:09/05/22

O Presente Rural, 2018.4.0 também na avicultura. Disponível em:

<https://opresenterural.com.br/4-0-tambem-na- avicultura/>. Acesso em: 12/05/22 SILVA,Christian Luiz da; SCHMIDT, Nádia Solange. Pesquisa e Desenvolvimento na Cadeia Produtiva de Frangos de Corte no Brasil. Avicultura, 2021. Disponível em:

<https://pt.engormix.com/avicultura/artigos/pes quisa-desenvolvimento-cadeia-produtiva-t479 00.htm>. Acesso em:11/05/22)