Proceedings of the 10th World Congress on Mechanical, Chemical, and Material Engineering (MCM'24)
Barcelona, Spain - August 22-24, 2024
Paper No. ICMIE 160
DOI: 10.11159/icmie24.160

Production of Cobb 500 Chickens under Controlled Environments At "Granja De Valle Colorado"

Isabela Milagros Limaylla Leon[1], Kelly Lizbeth Curi-Pianto[1], Mariel Milena Machuca-Balbin[1], Rodolfo Antonio Chávez-Castillo[1]
[1]Department Of Industrial/Universidad Continental
Address, Huancayo, Peru
First. 75173865@continental.edu.pe; Second. 75492003@continental.edu.pe; Third. 72246385@continental.edu.pe;
Fourth. rchavezc@continental.edu.pe

Abstract **-** The Ministry of Agrarian Development and Irrigation (MIDRAGRI) states that the poultry sector is the main source of protein for the Peruvian population. Therefore, it is essential to provide quality meats with an adequate weight, according to the Cobb-Vantress recommendations. Research, has shown that the growing environment plays a crucial role in the health and development of poultry. In the present study, the production of Cobb 500 chickens under controlled environments on the 'Granja De Valle Colorado' is addressed. The production activities have been analysed, focusing on house preparation, chick reception, rearing and eviction. Critical factors to ensure the quality of the chickens include feed, weight and mortality rate. After assessing the company's processes and parameters, analysis tools such as the Ishikawa Diagram to identify the causes of problems and Value Stream Mapping to detect delays in activities were implemented. This made it possible to define the parameters necessary to control the breeding processes in the controlled environments. Finally, a system was developed to manage the feeding, supply and control process at altitude as the chickens grow. This system also controls the water supply through drinking troughs. In addition, heaters and curtains were installed around the animal spaces to maintain a suitable temperature during growth. Regarding the management of the manure generated, a methane sensor was implemented to trigger the extraction of gases and fans to ensure adequate ventilation. The implementation of the system reduces the mortality rate from 2.5% to 0%, generating an annual income from the sale of poultry of s/ 11 047.09 nuevos soles.

Keywords**:** Cobb 500 chickens, Value Stream Mapping, Mortality rate, Weight standards, Adequate feeding.

1. Introduction

The Directorate of Statistics and Agrarian Information (DEIA) of the Ministry of Agrarian Development and Irrigation (MIDAGRI) reported in April 2023 that the poultry sector accounted for 23.1% of the gross value of agricultural production, consolidating its position as the main source of protein at national level and one of the most demanded foods by the Peruvian population [1]. This research analyses the production of Cobb 500 broiler chickens. The analysis focuses on their performance, which varies from country to country, with growth rate as a key objective. This performance is closely related to the cost-benefit of the producing companies. Farmers are not only looking for efficient growth of the birds, but also for viability and animal welfare, which is reflected in weight gain and meat quality. Newborn chicks are particularly vulnerable to environmental conditions, including climate, cleanliness, feed and disease. It is therefore essential to implement management practices that ensure optimal growth and minimisation of mortality [2].

In the United States, the Department of Poultry Science analyses poultry meat production, considering its importance in the agricultural sector and its relevance to human nutrition. High meat quality is an essential requirement, which depends to a large extent on the proper rearing of chickens on farms. To improve efficiency and reduce costs, the development of modern biotechnologies and molecular biology in poultry production has been encouraged [3]. In France, broiler production is predominantly carried out in controlled and suitable indoor growing systems. However, outdoor systems also exist, which can negatively affect meat quality due to problems such as deep breast disease, exposure to contaminants and environmental pathologies caused by viruses and bacteria [4],[5].

In Australia, the Poultry Centre focuses on maximising profits rather than minimising costs, using complex models of poultry growth and breeding genetics. Environmental variables and feed are slow to respond, so the production function is analysed as a function of inputs such as feed quality, bird genetics, housing and environment. Poultry companies employ various techniques to control optimal conditions for bird growth, such as maintaining controlled temperatures and adequate feed supply, with a focus on digestible amino acid requirements. These practices reduce overall costs and maximise process gains [6], [7]. In addition, there are specific programmes to improve meat weight and yield in short periods: in 30 days, birds can reach a body weight of 1.5 kg, and in 42 days, 2.5 kg. Most of these birds are reared in climate-controlled environments on litter-based flooring [8], [9].

In Bangladesh, the Faculty of Animal Husbandry and Poultry Science focuses on the analysis of broiler feed. In their research on feed additives based on chitosan oligosaccharides (COS), it was shown that after 35 days of consumption, the body weight of broilers increased significantly. In addition, improvements in intestinal morphology and general health of the birds were observed. The use of low doses of this additive also contributed to an increase in intestinal villi and a reduction in cholesterol in broilers. However, its large-scale implementation in the agricultural industry is still under development [10], [11]. In China, researchers from the School of Food Science emphasise that the incorporation of probiotics, phytoextracts and prebiotics in chicken feed not only promotes growth, but also improves meat quality. These additives provide significant nutritional benefits, such as increased vitamin and mineral content, which is highly beneficial for consumers [12], [13].

After evaluating the available research, we have observed that all of them focus on the importance of controlled environments and proper feeding to ensure high quality meats. However, these factors are analysed independently in most studies. For this reason, in our research, we addressed the production of Cobb 500 chickens under controlled environments in the company 'Granja de Valle Colorado'. In this study, we simulate the process of feed and supply control, including controlled height for the feeders and water supply in the drinkers. The internal temperature is also monitored and regulated by heaters. In addition, to manage the methane generated by animal manure, exhaust fans and ventilators are used, ensuring a healthy environment for poultry growth.

2. Materials and Methods

This study analyses the activities in the production of Cobb 500 chickens at the company 'Granja de Valle Colorado'. Initially, activities from microclimate preparation to the eviction process for sale are examined. Critical processes include feeding, weight control and mortality rate, essential factors to ensure adequate profitability.

Each of these factors was analysed using Ishikawa diagram indicators and subsequently assessed using Value Stream Mapping (VSM). This approach allowed the researchers to identify and propose effective solutions to improve the Cobb 500 broiler rearing process.

2.1. Activities for Cobb 500 chicken production

The production of Cobb 500 chickens in the company 'Granja de Valle Colorado' starts with the preparation of the sheds, where all rearing activities are carried out. This process involves several stages: preparation of the house microclimate, reception, rearing and eviction.

Preparation of sheds: The sheds must be adequately equipped to house the chickens. This activity lasts between 3 and 4 days, with a working schedule of 8 hours a day. It is organised in two shifts: the first employee handles 5,000 birds from Monday to Friday, while the second employee handles 5,000 birds on Saturdays and Sundays.

Reception of cobb 500 chickens: This activity lasts 1 hour, during which the chickens are placed in the previously prepared sheds.

Breeding of cobb 500 chickens: The rearing of the chicks lasts 42 days from the time they are received. During this stage, several critical factors are monitored to ensure optimal growth.

Chicken cobb 500 eviction: The sale and removal of the chickens takes 2 days. The process of loading 5000 chickens onto the truck requires 2 hours and the participation of 4 employees.

These activities are analysed using Ishikawa diagram indicators and Value Stream Mapping (VSM) to identify areas for improvement and optimise the rearing process, thus ensuring efficient and profitable production.

Figure 1 shows the processes of the 'Granja De Valle Colorado' for growing Cobb 500 chickens. The items visualised in the figure are described below:

Item A: Shed where the entire process of rearing Cobb 500 chickens is carried out.

Item B: Installation of the microclimate, using blankets to maintain the required temperature for the birds.

Item C: Complete set-up of the microclimate, including the provision of the necessary feeding and watering systems for the chickens.

Item D: Hard yellow maize supply area.

Item E: Unloading of chicks.

Item F: Installation of the chickens in the pre-prepared microclimate.

Item G: Night-time supervision of chicks to avoid crowding, which can cause death by crushing, and strict temperature control during the first week.

Item H: Vaccination of chicks.

Item I: Maintenance of temperature control process with blankets.

Item J: Preparation of cages for storage of chickens prior to sale.

These processes are essential to ensure optimal growth and high quality production of Cobb 500 chickens. Each stage is carefully monitored to maintain ideal conditions and minimise mortality, ensuring efficient and profitable production.

Fig. 1: Processes for Cobb 500 chickens

2.2. Analysis of critical processes in parenting

Feeding in Cobb 500 chickens: The company 'Granja De Valle Colorado' provides a recommended poultry feed, supplied by Molinos Agropecuarios Saravia. These balanced feeds are specifically formulated for broilers, ensuring optimal nutrition for the growth and development of Cobb 500 chickens, as shown in figure 2.

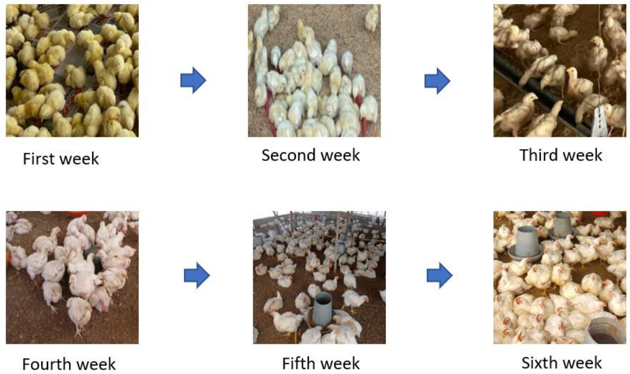


Fig. 2: Feeding processes of Cobb 500 broilers

Cobb 500 chicken weight standards: The weight standards of the Cobb 500 chickens at ‘Granja De Valle Colorado’ are presented in Table 1, based on an analysis of 5000 units of females and males respectively. However, when comparing these weights with the Cobb 500 performance and nutrition information supplement [2], it is observed that the weights are below the expected weights. This indicates an opportunity to improve feeding and broiler management in order to achieve higher profitability and production quality.

Figure captions and table headings should be sufficient to explain the figure or table without needing to refer to the text. Figures and tables not cited in the text should not be presented. Refer to the tale below for a sample.

Table 1: Weight of the birds of ‘Granja De Valle Colorado’.

Weeks	Females (kg)	Male (kg)
1	150	165
2	300	483
3	500	728
4	1300	1740
5	2100	2300
6	2700	3200

Mortality rate chicken cobb 500 : The mortality rate is a critical factor in the company ‘Granja De Valle Colorado’, as it directly influences profitability. This rate determines the deaths per flock, and is considered ideal when it is around 2.5%, with an acceptable maximum of 5%. This parameter is assessed from placement in microclimates to sale, and factors involved include housing, cleanliness, water quality, disinfection, feed, vaccine quality and heating.

The mortality rate (Tm) is calculated using equation 1, which takes into account the number of dead birds in a given population. In our case, with a population of 5000 females and 5000 males, 44 females and 56 males died, as shown in Table 2. Applying these values in equation 1, we obtain a Tm of 0.88% for females and 1.12% for males, which is below the threshold of 2.5%. This indicates that Granja De Valle Colorado maintains an adequate mortality rate in its chickens throughout their growth cycle.

$$T_M = \frac{N° \; dead\_birds}{Poultry\_population} \% \tag{1}$$

Table 2: Number of dead cobb 500 chickens at the ‘Granja De Valle Colorado ‘per flock of 5000 units

Weeks	Females (kg)	Male (kg)
1	3	5
2	5	9
3	10	12
4	15	17
5	6	5
6	5	8
Total	44	56

2.3. Evaluating indicators using the Ishikawa Diagram

A detailed analysis of each item sectorised into environment, method, machinery, measurement, man and material was carried out using the indicators of the Ishikawa Diagram. Figure 3 summarises the factors affecting poultry production at Granja De Valle Colorado. Based on this analysis, subsequent decisions were made to adequately address each factor and cause identified.

This approach allowed the identification of the underlying causes of the problems and challenges in poultry production, which in turn facilitated the implementation of specific and effective solutions. The application of the Ishikawa Diagram was instrumental in improving efficiency and quality in the company, ensuring a more optimised and profitable poultry production process.

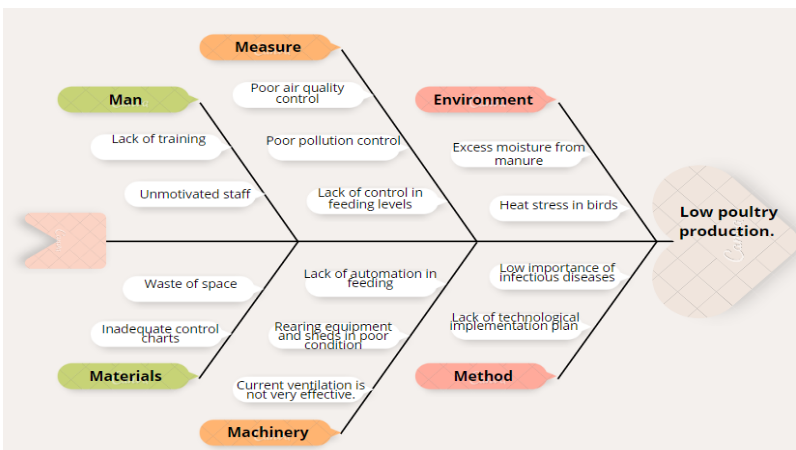


Fig. 3: Ishikawa Diagram of the company ‘Granja De Valle Colorado’

2.4. Value Stream Mapping (VSM) analysis of the ‘Granja De Valle Colorado’

Value Stream Mapping (VSM) is a tool that allows examining the production process of a product, which facilitates the identification of problems that can damage or delay the activity. Based on this, a lean production model is developed in manufacturing companies, restructuring the process by eliminating or modifying activities that do not add value to the manufacturing process [14], [15].

In the context of Cobb 500 chicken farming, a sequence of activities was established to visually identify problems. Figure 4 shows the symbology used in the VSM, where both the customer and raw material suppliers, such as maize and other inputs, are represented. In addition, elements such as the process box, batch inventory, production control, transport and manual transfer of information between processes are visualised. These elements are identified as areas requiring improvement to optimise broiler rearing.

The VSM analysis provides an understanding of all processes involved in broiler rearing, which facilitates the identification of areas for improvement and the implementation of corrective actions to optimise efficiency and quality poultry production.

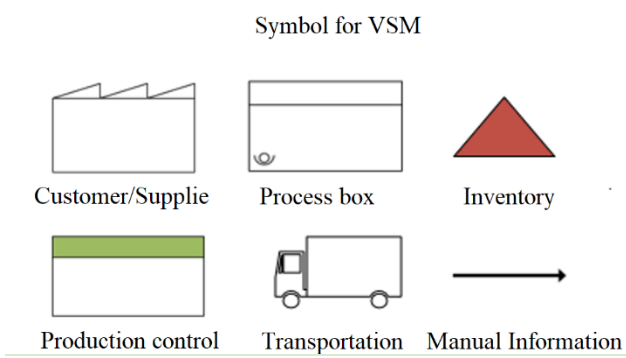


Fig. 4: VSM Symbols

This is followed by the reception and housing of the baby chickens, for which it is crucial that the houses have automated feeders for efficient feeding. Thirdly, the rearing process takes place, in which a methane meter generated by the manure is installed to monitor and control the levels of gases in the environment.

Finally, the process concludes with the removal of the chickens, which are grouped and selected in cages for transfer. This detailed analysis can be seen in Figure 5, through the VSM it is possible to identify areas for improvement in the poultry production process, which facilitates the implementation of corrective actions to optimise efficiency and quality in the rearing of chickens.

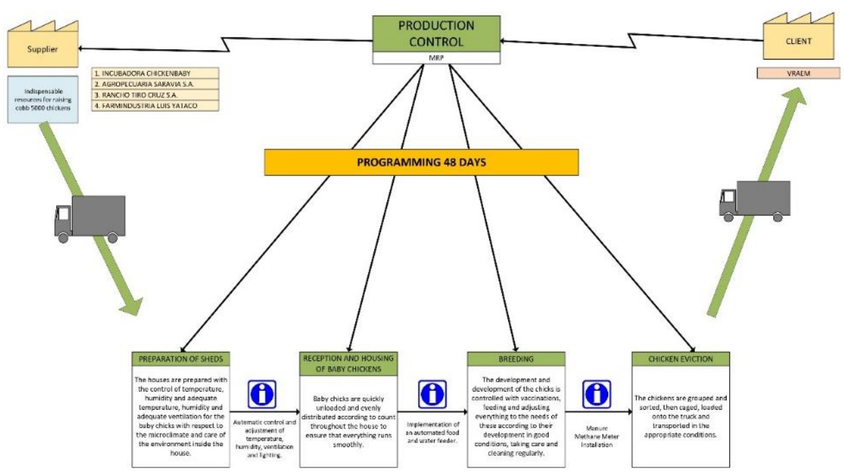


Fig.5: VSM diagram of the company ‘Granja De Valle Colorado’.

3. Results

The results obtained are based on the requirements evaluated in the Value Stream Mapping (VSM), which proposes improvements using Lean Manufacturing. In addition, the environments required in the company ‘Granja De Valle Colorado’ are simulated.

3.1. Lean Manufacturing Improvement Plan

The Lean Manufacturing improvement plan originates from Toyota's industrial automotive manufacturing systems, focused on improving communication and teamwork management to ensure product or service quality. This involves a comprehensive value stream analysis to identify areas for improvement, carried out through value stream mapping

(VSM). The aim is to minimise wasted time and resources in the creation process to add value to the final product [16], [17].

The diagnosis, operationalisation and follow-up to improve the breeding process in the company 'Granja De Valle Colorado' is presented in Figure 6: Adaptation of automatic netting systems, Implementation of air conditioners, Installation Installation of a manure generated methane meter, Improvements in lighting, heating and cooling, Piped feed control. These These improvements are designed to optimise the broiler rearing process, ensuring an optimal environment for growth and development.

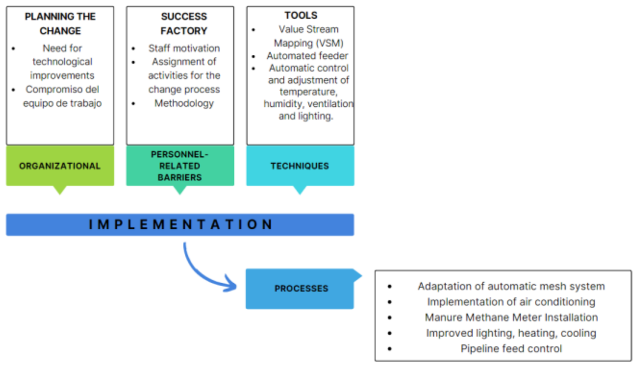


Fig. 6: Views of the operation of the proposed machine

Table 3 details the processes that are being improved in the company 'Granja De Valle Colorado' after a thorough evaluation of the VSM and the critical analysis of the Ishikawa Diagram.

These improvements aim to optimise efficiency and quality in poultry production, ensuring a more effective and profitable process in chicken rearing.

Table 3: Improvement process at the "Granja De Valle Colorado"

Proceso	Descripcion
Alimentación	The feeding system shall consist of a grain storage and dosing hopper. By means of a worm screw driven by a geared motor, the feed will be transported to each dosing unit. Each dosing unit will be equipped with two inductive sensors to detect if the container is empty and to fill it automatically. A motor-driven winch system shall be used to control the height of the feeder. This system shall allow the height of the feeder to be adjusted according to the size and height of the chickens.
Drinker	The drinking system will consist of a line of nipple drinkers with a mini-regulator. To maintain a constant pressure in the system, a PID control system with a pressure sensor and an electric pump controlled by a VDF frequency inverter will be used, ensuring a continuous supply of water.
Heating	During the winter season, automatic and manual control of temperature and humidity will be carried out by means of an HMI (Human Machine Interface), controlled by a PID control system.
Release of gases	The system will display the percentage of gas accumulation, allowing the user to program the optimum percentage for opening the exhaust fan, ensuring adequate ventilation.
Cobijo	The shelter system will consist of a servomotor controlled by a PLC (Programmable Logic Controller), linked to a Servodriver interface. This will allow a laminated curtain with UV protection to be raised and lowered according to the user's needs.
Illumination	This auxiliary system will activate the lighting for a defined time, according to the specific requirements of the user, ensuring adequate lighting conditions in the poultry environment.

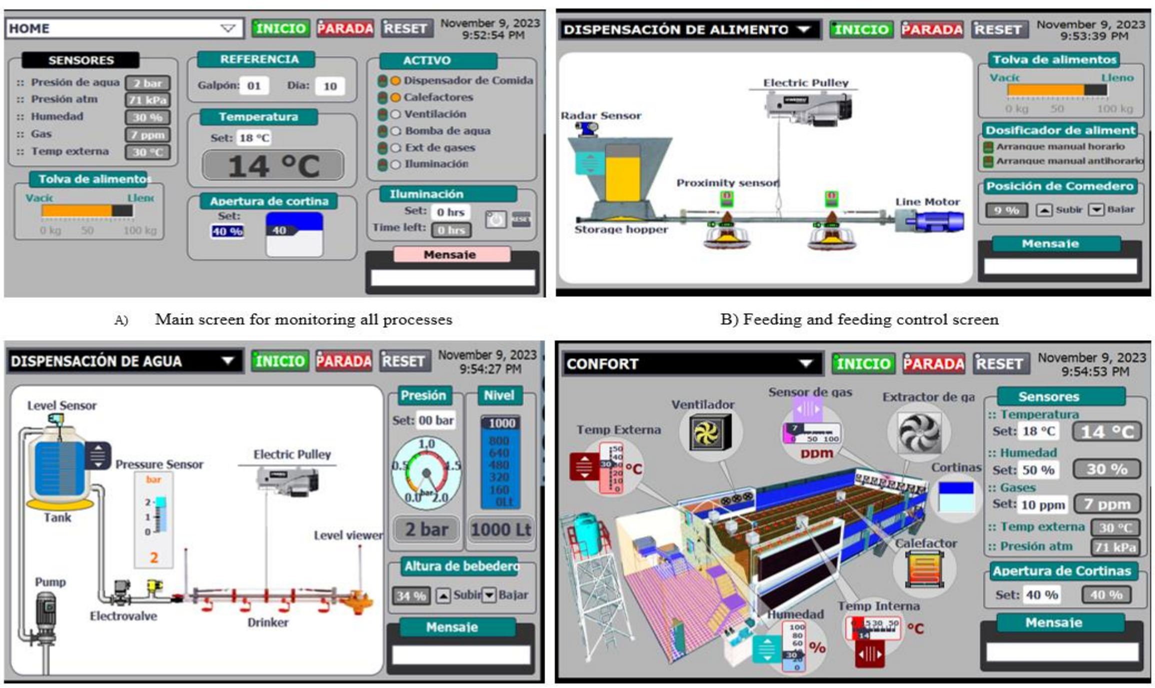
3.2. Graphical simulation of VSM requirements

Within the HMI user interface, the design and simulation of all required processes is presented. For this purpose, four different screens have been designed. Figure 7, section A shows the main panel where all sensors and actuators of the process can be monitored. In addition, the warning or error messages of the proposed system are displayed here.

Seccion B, shows the second screen where the feeding process is represented. From this interface, one has the ability visualise the amount of feed remaining in storage and to manipulate the linear feed supply motor. In addition, parameters such as the height of the feeder can be adjusted, allowing accurate and efficient management of the feed supply to the chickens.

Seccion C, shows the third screen, where the water supply system or drinking fountain is displayed. Here you can see the water level in reserve, activate the hydraulic pump and the solenoid valve controlled by a pressure sensor. This sensor keeps the system at a constant pressure and, in case of loss of pressure due to leakage, activates the emergency solenoid valve to prevent flooding. The height of the sprue can also be manipulated according to the user's needs.

Seccion D, shows the fourth screen, which displays the various sensors and actuators responsible for ensuring comfort in the farm. These devices are programmed according to the user's requirements, and among them are temperature control, humidity and gas detection, as well as the opening of curtains. This proposal aims to improve the weight of the animals and ensure their proper care. In addition, this automated system would reduce the need for personnel in the process, requiring only one operator to handle these screens within the 'Granja De Valle Colorado'.



A) Main screen for monitoring all processes

B) Feeding and feeding control screen

C) Water drinking fountain supply screen

D) Comfort screen of the company 'Granja De Valle Colorado' to observe the different sensors and actuators.

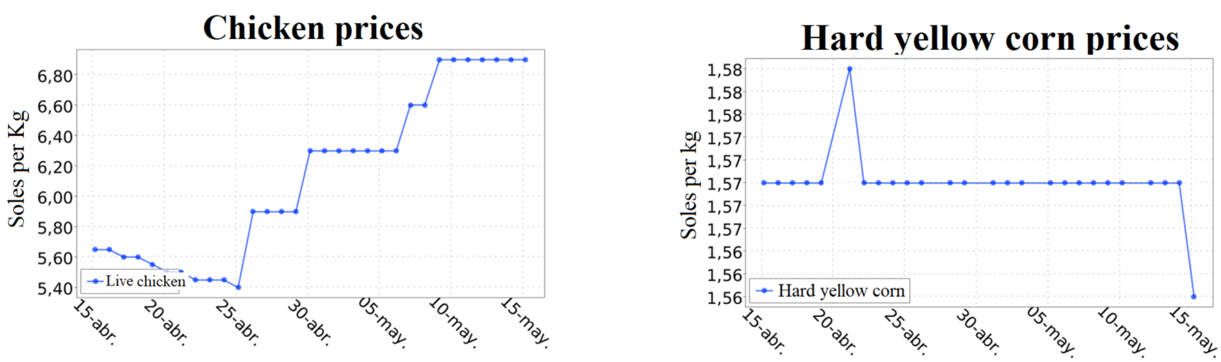
Fig. 7: Screen of the company 'Granja De Valle Colorado' to observe the different sensors and actuators.

3.3. Cost analysis

After the implementation of the system, a significant reduction in the mortality rate is expected, decreasing from the current 2.5% to 0%. This is because the precise control of temperature conditions will prevent cases of death by crushing. In addition, a detailed cost analysis was carried out, presented in Table 4. The selling price of chicken per kilogramme and the cost of the main input, hard yellow maize, were evaluated, as shown refer to Figure 7, sections A and B. During the month of May, the price of chicken reached S/6.90 nuevos soles per kilogram, while the cost of maize was S/1.56 nuevos soles.

According to the Cobb 500 Vantress chicken catalogue, it is estimated that females will reach a weight of 3,052 kg at at 42 days, with an accumulated maize consumption of 4,843 kg to date. On the other hand, males are expected to reach a a weight of 3,503 kg, with a feed consumption of 5,352 kg [2].

Table 4 provides a detailed breakdown of the costs associated with the chickens that died and could have been marketed if the proposed system had been implemented. The costs of inputs, chicken procurement and labour were considered. Since only one operator would be required to control the entire proposed system, a minimum wage of S/1025 was estimated, considering the care of 500 birds. This would result in a net income of S/2.05 per bird cared for, with a periodicity of every 42 days. For deceased males, this translates into an annual income of S/6684.79 nuevos soles, while for females it would be S/4362.30 nuevos soles, for a total annual income of S/11047.09 nuevos soles. It should be noted that in this analysis additional expenses such as water, electricity and space used were omitted, as the focus was on primary inputs.



A) Price of chicken

B) Price of hard yellow corn

Fig. 8: Price of inputs for Cobb 500 chickens [18].

Table 4: Cost analysis after implementation of the controlled environment system

Item	Weight (kg)	Intake (kg)	Units	Unit cost of feed (kg)	Unit cost of poultry sales (kg)	Poultry acquisition cost/unit	Screen Operator Worksheet	Income from sale of chickens	Exit food	Net income	Number of times per year	Net annual income
Male	3.503	5.352	56	S/ 1.56	S/ 6.90	S/ 2.00	S/ 114.80	S/ 1,353.56	S/ 467.55	S/ 769.21	8.69	S/ 6,684.79
Female	3.052	4.843	44	S/ 1.56	S/ 6.90	S/ 2.00	S/ 90.20	S/ 926.59	S/ 332.42	S/ 501.96	8.69	S/ 4,362.30

4. Discussions

After reviewing the literature related to controlled environments for broiler rearing, it was considered important to compare the work carried out by E. Baéza, L. Guillier and M. Petracci [4]. These authors emphasise that meat quality develops from the rearing stage of the animal until it reaches the final consumer. They recommend rearing chickens under intensive conditions in controlled indoor conditions to guarantee the quality of the final product. This analysis is in line with our observations at the company ‘Granja De Valle Colorado’, where we have observed the significant influence of environment, feed, water supply and growing conditions on the development of the chickens. In order to meet the weight standards set by Cobb Vantress [2], it is imperative to control all these aspects of the animals' environment, which will not only guarantee the quality of the meat for the consumer, but also improve the quality within the company. The proposed system will monitor and control all these aspects of the environment to ensure optimal growth.

Secondly, this research proposes a specific focus on the control of poultry feeding. In contrast to other studies, such as those conducted by L. D. Butler et al. and F. R. Dunshea et al. [19][20], which focus on increasing the weight of the animals through the use of antibiotic growth promoters (APG) and adjustments in the amino acid density of the diet. While these approaches have shown positive results on meat yield and animal growth, we believe it is crucial not to neglect the precise control of feeding at the right times for the animals. In addition, the growth environment plays a critical role in the development of the chickens. Therefore, we believe that future research looking at both factors, quality feed and controlled environment, could represent a beneficial challenge to improve both the quality and weight of the resulting meat.

5. Conclusions

In conclusion, after evaluating the crucial aspects in the company 'Granja De Valle Colorado', it is clear that tools such as the Ishikawa diagram and Value Stream Mapping are essential to understand the causes and observe the production processes, allowing to identify the problems that hinder the activity and to establish the necessary improvement requirements from one process to another.

The implementation of a controlled environment system represents a significant step forward in improving poultry production. In addition to drastically reducing the mortality rate of chickens from the current 2.5% to 0%, this work demonstrates its positive impact in economic terms. A detailed cost analysis reveals that the decrease in mortality translates into a substantial increase in revenue generated from poultry sales. For example, it is estimated that the annual net income from the sale of deceased male chicks would increase to S/6,684.79, while for females it would be S/4362.30. This clearly underlines the significant economic value of implementing control systems in poultry production. This approach not only improves operational efficiency and reduces economic losses associated with broiler mortality, but also has a positive impact on the company's financial results. It is an outstanding example of how the application of innovative technologies can not only benefit animal health and welfare, but also strengthen the economic viability of poultry production.

Thirdly, the proposed system consists of a simulated virtual environment to control aspects of feeding, water supply and sensors necessary for the proper growth of Cobb 500 chickens in the company 'Granja De Valle Colorado'. Although it addresses the problems identified, it recognises limitations in its operation and performance within the real facilities of the company, as well as the need for an initial investment to get it up and running.

It is important to note some limitations and future challenges. On the one hand, the proposed system, although promising, faces limitations in terms of its performance and operation in the real company environment. In addition, the need for investment to implement the proposed system is identified. Finally, it is suggested that future research should address aspects such as the automation of animal excreta removal and the optimisation of the chicken sales process, which could offer further improvements in the efficiency and profitability of poultry production. Overall, this work lays the foundation for continued research and development in the field of poultry production, with the potential to further improve the quality and economic viability of this industry.

References

[1] C. L. H. Oyola, C. B. Helen, and B. Z. Elva, "Production and Commercialisation of Poultry Products", Accessed: Jan. 05, 2024. [Online]. Available: https://siea.midagri.gob.pe/portal/phocadownload/datos_estadisticas/mensual/Avicola/2023/avicola_04_2023.pdf

[2] Cobb Vantress, "Cobb 500 Broiler Chicken Performance and Nutrition Information Supplement", Accessed: Jan. 06, 2024. [Online]. Available: www.cobb-vantress.com

[3] A. Golkar-Narenji and P. E. Mozdziak, "Biotechnology approaches in poultry meat production," Encyclopedia of Meat Sciences, pp. 72–79, Jan. 2024, doi: 10.1016/B978-0-323-85125-1.00180-0.

[4] E. Baéza, L. Guillier, and M. Petracci, "Review: Production factors affecting poultry carcass and meat quality attributes," Animal, vol. 16, p. 100331, Feb. 2022, doi: 10.1016/J.ANIMAL.2021.100331.

[5] S. Husseini de Araújo, “Assembling halal meat and poultry production in Brazil: Agents, practices, power and sites,” Geoforum, vol. 100, pp. 220–228, Mar. 2019, doi: 10.1016/J.GEOFORUM.2019.01.014.
[6] G. M. Pesti and M. Choct, “The future of feed formulation for poultry: Toward more sustainable production of meat and eggs,” Animal Nutrition, vol. 15, pp. 71–87, Dec. 2023, doi: 10.1016/J.ANINU.2023.02.013.
[7] C. Hammemi, A. Askri, M. P. Létourneau-Montminy, and N. Alnahhas, “Current state of breast meat quality in standard-yielding broiler strains,” Journal of Applied Poultry Research, vol. 33, no. 1, p. 100383, Mar. 2024, doi: 10.1016/J.JAPR.2023.100383.
[8] P. Glatz and M. Moore, “MEAT, ANIMAL, POULTRY AND FISH PRODUCTION AND MANAGEMENT | Poultry,” Encyclopedia of Meat Sciences, pp. 204–210, Jan. 2014, doi: 10.1016/B978-0-12-384731-7.00028-3.
[9] J. E. Hermansen, K. Horsted, and A. G. Kongsted, “MEAT, ANIMAL, POULTRY AND FISH PRODUCTION AND MANAGEMENT | Meat Production in Organic Farming,” Encyclopedia of Meat Sciences, pp. 199–203, Jan. 2014, doi: 10.1016/B978-0-12-384731-7.00021-0.
[10] Ayman, U., Akter, L., Islam, R., Bhakta, S., Rahman, M. A., Islam, M. R., Sultana, N., Sharif, A., Jahan, M. R., Rahman, M. S., & Haque, Z., “Dietary chitosan oligosaccharides improves health status in broilers for safe poultry meat production,” Annals of Agricultural Sciences, vol. 67, no. 1, pp. 90–98, Jun. 2022, doi: 10.1016/J.AOAS.2022.05.003.
[11] D. H. Beermann, “MEAT, ANIMAL, POULTRY AND FISH PRODUCTION AND MANAGEMENT | Beta-Agonists,” Encyclopedia of Meat Sciences, pp. 177–180, Jan. 2014, doi: 10.1016/B978-0-12-384731-7.00017-9.
[12] Dong, S., Li, L., Hao, F., Fang, Z., Zhong, R., Wu, J., & Fang, X, “Improving quality of poultry and its meat products with probiotics, prebiotics, and phytoextracts,” Poult Sci, vol. 103, no. 2, p. 103287, Feb. 2024, doi: 10.1016/J.PSJ.2023.103287.
[13] C. Castellini and A. Dal Bosco, “Animal Welfare and Poultry Meat in Alternative Production Systems (and Ethics of Poultry Meat Production),” Poultry Quality Evaluation: Quality Attributes and Consumer Values, pp. 335–357, Jan. 2017, doi: 10.1016/B978-0-08-100763-1.00014-3.
[14] Y. El Kihel, A. Amrani, Y. Ducq, and D. Amegouz, “Implementation of Lean through VSM modeling on the distribution chain: Automotive case,” International Colloquium on Logistics and Supply Chain Management, LOGISTIQUA 2019, Jun. 2019, doi: 10.1109/LOGISTIQUA.2019.8907282.
[15] F. Chouiraf and A. Chafi, “Adaptation of the Value Stream Mapping (VSM) for the Moroccan Artisanal Enterprise,” Colloquium in Information Science and Technology, CIST, vol. 2018-October, pp. 124–129, Dec. 2018, doi: 10.1109/CIST.2018.8596624.
[16] Q. Liu and H. Yang, “Incorporating Variability in Lean Manufacturing: A Fuzzy Value Stream Mapping Approach,” Math Probl Eng, vol. 2020, 2020, doi: 10.1155/2020/1347054.
[17] Y. Zhang, Z. Jia, and Y. Dai, “Real-time performance analysis of industrial serial production systems with flexible manufacturing,” Proceedings - 2018 Joint 10th International Conference on Soft Computing and Intelligent Systems and 19th International Symposium on Advanced Intelligent Systems, SCIS-ISIS 2018, pp. 360–365, Jul. 2018, doi: 10.1109/SCIS-ISIS.2018.00069.
[18] “AgroChatea.” Accessed: May 15, 2024. [Online]. Available: https://siea.midagri.gob.pe/portal/agrochatea/
[19] Butler, L. D., Scanes, C. G., Rochell, S. J., Mauromoustakos, A., Caldas, J. V., Keen, C. A., Owens, C. M., & Kidd, M. T., “Cobb MV × Cobb 700 broiler responses to eight varying levels of amino acid density with emphasis on digestible lysine,” Journal of Applied Poultry Research, vol. 29, no. 1, pp. 34–47, Mar. 2020, doi: 10.1016/J.JAPR.2019.12.002.
[20] F. R. Dunshea, D. N. D’Souza, B. B. Jensen, and R. M. Engberg, “MEAT, ANIMAL, POULTRY AND FISH PRODUCTION AND MANAGEMENT | Antibiotic Growth Promotants,” Encyclopedia of Meat Sciences, pp. 172–176, Jan. 2014, doi: 10.1016/B978-0-12-384731-7.00018-0.