Semiautomated system for optimizing thermal comfort and reducing rice waste in the poultry breeding process of small producers from the interior of the Amazon region

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Abstract

In the Amazon region, the reality of the conventional laying poultry production chain consists of farms with structures that are inferior to those in other regions, with a massive presence of small poultry farmers, without a water, food and air conditioning automation system. The need for improvements in the poultry process that the small producer needs to produce can be linked to the relationship of implementing technology for monitoring equipment or systems. Therefore, the motivation of this study was the creation of a semi-automated system to optimize the thermal comfort of birds and reduce feed waste in the laying poultry production process for small producers in the interior of the Amazon region in order to reduce mortality and maximize the profit. The methodology designated for the construction of this research was based on the nature of applied research, with a view to the qualitative-quantitative approach, through technical procedures of a case study. After assembly of the semi-automated system for feeding, adding the total savings for feed consumption would be 1964.20 kg of feed, in reais it would be R$ 7,856.80. And for the ambiance system, we have savings on the energy bill of 60.94 reais a month and 731.31 reais a year. The semi-automated systems suggested for small poultry farmers in the Amazon region theoretically fulfill their objective, both for the improvement of waste and for the provision of animal welfare and increased profitability.

Keywords: Poultry, Automation, Amazon.

1. Introduction

Laying aviculture currently uses two types of system, conventional and automated (FERRAZ et al., 2017). The most common system, the conventional one, uses laying hens in suspended cages up to three levels. In this system, the egg production process requires an extensive set of, among which stand out the rations, vaccines, medicines, to genetics, the infrastructure, machinery and equipment (AMARAL, 2016).

In relation to small companies, according to the Brazilian Association of Animal Protein-ABPA, intensive poultry production system in Brazil, including in the Amazon region, is arranged in conventional cages, in open sheds upright. The preference for the use of open sheds favors the lower cost, with use of natural ventilation, with aid (or not) of artificial fans, especially during warmer periods. According to ABPA, only 40% of farms have automated processes, being a specific characteristic of large companies (ABPA, 2020). In addition to the maximum range of performance according to the potential of the birds, it is necessary that the environment provides thermal comfort conditions that vary according to the age of the birds. However, hardly the environment provides, without external intervention, the ideal thermal conditions for the animal during its production phases.

The disparities between the poultry in the production process are related to the mechanization of the production. Small winemakers produce in rudimentary sheds and, and more the aquaculture sector has grown in the last ten years in the State of Amazonas, the lack of the main input (corn) forces the import of, making productions higher, which determines the retail prices of the final product, constituting a bottleneck for development in agro-industries.

In this context, the aviaries can employ modern equities to keep the environment under control through air conditioning systems, feed weighing, among others. Many techniques are implemented in this branch to prevent diseases and even the mortality of birds. To do this, the automation of processes becomes necessary to, because it promotes specialized care and at the same time the agility of them, enabling positive economic impacts to be generated, with increased productivity, income and profit. Similarly, generates social impacts such as improving human well-being and replacing the primary workforce with more satisfactory new jobs in the aviary sector.

Thus, the need for improvements in the poultry process that the small producer needs to produce can be linked in the relationship of technology deployment by monitoring equipment or systems, ensure the reduction of waste and mortality by achieving the highest yield and productivity, with quality, at market-compatible costs.

The poultry industry stands out as one of the main in terms of technological innovations, because the improvement is constant, since producers need to meet the demand for large-scale production and the indexes of basic requirements for bird health. Given this, this study aims to develop a low cost system to optimize the conventional rearing process of laying birds of small producers of the Amazon region with emphasis on reducing high temperatures in poultry and feed waste.

2. Materials and Methods

The methodology designated for the construction of this research is based or in the nature of applied research, with a view to the quali-quantitative approach, by means of technical procedures of a case study. The approach is qualitative for doing a documental analysis, Market research and observation of the wine making company, and, because it is an experimental approach using mathematical modeling of sizing for the aviary shed, with implementation of low cost equipment for tests such as fans, nebulizers and hoods aiming to assist in the maintenance and control of the internal temperature of the aviary, in addition, semi-automating the feeding process of birds.

This hollow case study was conducted in a small company located in the municipality of Eirunepé-Amazonas, southwest of the state capital, staying about 1,160 km from Manaus. The property features a shed of 120 m2 adapted for the stages of creation and re-creation, following the guidelines of EMBRAPA's

Safety and Quality Manual for Laying Aquaculture according to ANVISA.

This aviary has the conventional containment system and the production process is carried out manually, both the power supply system and the air conditioning system. Waste is deposited below the cages, and blends with food scraps, broken eggs, feathers and other impurities. The descriptions of this property represent, in a way, the reality of small poultry producers in the Amazon.

With the vision of a small production company in the poultry industry in the Amazon, through these observations, variables have been raised that could be improved in the environment where this process of creation is carried out. In possession of these variables, which can be moved, deductive methods have been applied for a possible conclusion.

The first step in the development of the semi-automated computational system in the poultry feeding process was to survey the price of materials that were used. The second step was the survey of the structural dimensions of the shed. From this, the feeding process that would be used to replace the manual process that had been causing waste based on market research was analyzed to ensure the lowest price. And the 3rd and last step was the computational modeling in CADsoftware program for the production of 2D and 3D figures.

For the development of the prototype of the cooling system for control and maintenance of the internal temperature of the aviary, the 1st step was to carry out market research to survey the materials used. The second step was the monthly monitoring analysis of the internal temperature of the shed in order to verify the time that caused thermal discomfort for birds. And finally, the 3rd step was the structuring of the prototype on a reduced scale for testing the equipment.

3. Results and Discussion

3.1 Analysis of the structure of the laying aviary shed

The structure of the shed was planned for 1,000 birds, characterizing the small producer and is following the guidelines of EMBRAPA's Safety and Quality Manual for Laying Poultry (p. 36) according to ANVISA. The selection of the appropriate location for the implementation of the aviary aims at optimizing the construction processes, thermal and sanitary comfort, aiming at the use of the advantages of natural air circulation and, avoid air obstruction by other buildings, natural or artificial barriers. The east-west orientation in sheds for animal confinement is universally indicated, in order to make minimal the direct incidence of the sun on the animals through the sides of the installation, since, in this case, the sun travels throughout the day on the summit of the installation.

It relates the width of the aviary to the climate of the region where it will be built. In this case, the following measures are taken: width up to 10m; the right foot of the aviary established according to the width adopted, as well as the right foot of the aviary, so that the two parameters together favor natural ventilation inside the aviary with natural thermal packaging. The length of the aviary should be established to avoid problems with earthmoving, feeders and semi-automatic drinking fountains. It should not exceed 200m.

The floor is important to protect the interior of the aviary against the entry of moisture and facilitate the management. This should be washable, waterproof, non-smooth material with thickness of 6 to 8cm of concrete in dash 1:4:8 (cement, sand and gravel) or 1:10 (cement and gravel), coated with 2cm of 1:4 mortar thickness (cement and sand). The wall must have the lowest possible height, approximately 0.2 m, allowing the air to enter the level of the birds, avoiding the entry of rainwater and that the bed be thrown out of the aviary.

Between the edge of the wall and the roof should be placed a wire screen proof of birds and insects, as well as the installation of curtains to prevent penetration of sun and rain and control ventilation inside the aviary. The roof should be of material with high thermal resistance, such as ceramic tile. Unpredictably, aluminum or zinc tiles should be avoided due to the noise caused during the rainy season; as well as asbestos cement tiles with 4mm thickness, as they provide less comfort for birds. The ideal material for the roof should have high solar reflectivity and high thermal emissivity on the upper surface and low solar reflectivity and thermal emissivity on the lower surface.

3.2 Semi-automated system of feeders and egg collection

The feeding of chickens requires manpower time, if we consider its realization manually, the breeder usually provides the food by sowing it from cage to cage. This manual form arises for problems in doing so, there may be contamination of the feed, food waste, by human failure, since it is not possible to correctly administer the amount to be distributed and the need for the presence of those responsible for the supply of this ration, which makes it difficult for these individuals to perform other tasks.

In order to solve the problems described above, a semi-automatic feeder is proposed in order to semi-automate the feeding process, reducing the service time spent with feeding, taking the correct amount for the birds and enabling the breeder to comply with other obligations and minimizing feed loss.

When designing the feeder, we considered the need to store the food, administer the leftovers and the quantity to be supplied. Thus, it is suggested the vertical system of posture aviary, using the model mounted on pyramids up to 6 floors high, where the cages will be arranged in two batteries made with galvanized wire, with feeders in galvalume plate at the front of the cages (Figure 1).

Figure 1: Semi-automated system of feeders and egg collection.

In this system it is suggested that the distribution of the feed is made by bucket made of galvalume steel sheet with capacity from 240 kg that moves on profiled rails made of galvanized steel sheet, dosing nozzles with adjustment and scrapers. This distribution of the feed will be carried out with the system elevated and accurately, the feeder descends under the rails, puts the feed to the end of the battery of cages and then returns. For egg collection, it is suggested the use of a treadmill with double traction on the sides to ensure greater stability in egg transport and consequently lower crack index.

To ensure cost reduction, instead of using motors powered by electric energy or energy by petroleum fuels, the activation of the distribution of food and collection of eggs suggests the integration of equipment to a bicycle with gear system for the drive, thus using mechanical energy. And to maximize process performance, it is suggested the adoption of two bicycles, one for each battery of cages (Figure 2).

Figure 2: Bicycle coupling in semi-automated system in 1:100 scale.

3.3 Feed consumption calculations

After simulation for feeding a thousand birds, comparing the current system used by the small poultry farmer, there would be an expenditure of 7220, 36 kg in 18 weeks, this total includes 7% of feed waste that is stipulated for manual system performed by the small poultry farmer. With the semi-automated system, subtracting the 7%, reached a total of 6748 kg, thus, it reached a savings of 472.36 kg of feed until the 18th week of production, with the bag of the 50kg ration costing R $ 140.00, would be saved in Reais, a total of R $ 1,889.44.

Performing the calculations of the 18th week to the 65th week for feed consumption, adopting 4% of waste, in the conventional system would be spent 38,787, 84 kg of feed, without the waste in the semi-automated system would be spent a total of 37,296 kg, a savings of 1491, 84kg of feed (Figure 4.6). Adding the total savings up to the 18th with the total from the 18th to the 65th for feed consumption, a total of 1964.20 kg of feed would be saved, in Reais would be R$ 7,856.80.

3.4 Automated sistem for aviary refrigeration

The environmental system was executed by means of a scaled prototype in order to test the fans and sensors, according to the photos below (Figure 3).

For the climate and temperature automation system, the suggestion is to use a system of 4 ventisol fans with propeller dimensions measuring 1m in diameter weighing 13.7Kg at voltage 220v, shielded engine with 1/2HP of power, five positions in the slope regulation. The winds produced by the device reach up to 25 meters away as a wall wrench with 3-speed Minimum/Average/High.

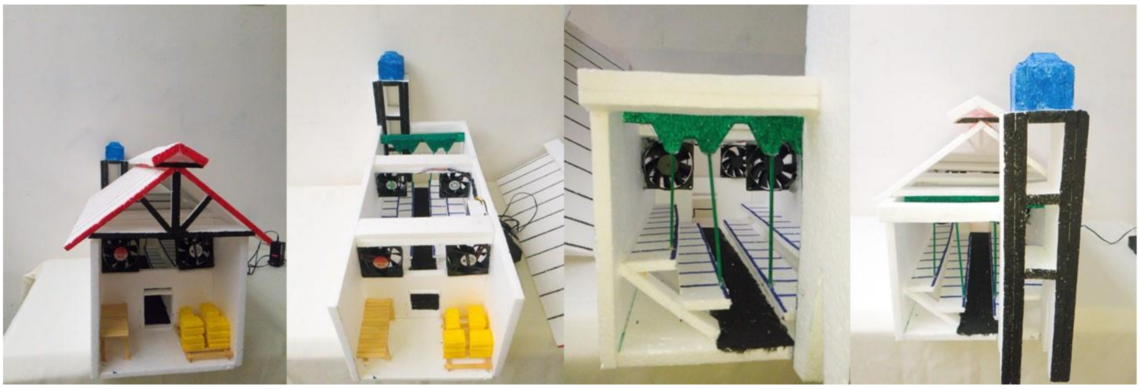

Figure 3: Front, side, top and inside the aviary scale prototype.

3.5 Energy consumption systems without temperature controller sensor

The system will be activated from 9 am to 5 pm accounting for a total of 8 hours daily which are the times of the day when temperatures are high providing wear of birds.

Each fan has a power of 1/2 HP (steamhorse) which corresponds to an energy consumption of approximately 368 Watt, making the conversion to specific unit of the energy supplier we will have 0,368 kilowatt hour (kW/h). It will be running for 8 hours a day for 30 days and so on for the period that the batch is producing.

With these data and specifications surveys as well as the tariff of the energy concessionaire chargesin the interior region of Amazonas 0.69 cents a kw / h, reached the final value of R $ 243.76 reais to be paid of the ventilation system during the month or R $ 2,925.15 per year.

3.6 Consumo energetic with temperature controller sensor

From the analyses made on the equipment to be used in the proposal to improve the system, a temperature controller sensor with a value well accessible to the small producer was chosen (Digital Thermostat 110V-220V Model: W3001) which was installed next to the ventilation system to monitor variations in temperature rates, which allows to turn on/off the fans automatically when the shed dependencies are too hot, That is, above the thermal comfort of birds in order to avoid stress too much and, consequently, low egg production and animal mortality.

With the installation of the controller sensor, the small producer will reduce their expenses by an average of 20 to 30% because the drive will be in the intervals as the equipment makes the readings of increases or reduction of heat and will not need to be more connected 8 hours daily because they will have autonomy to compensate for losses and excessive expenses. Thus, an average reduction of 25% was calculated, in addition, we will have the equipment connected about a maximum of 6 hours per day, that is, a gain of 2 hours. This applies to the months with the higher temperature rates, so on the mildest days this rate will further reduce.

Desta maneira teríamos uma economia na conta de energia de 60,94 reais ao mês e 731,31 reais ao ano, ou seja, um ventilador a menos gastando recursos que poderão ser aplicados a outros setores na granja.

Still on the environment system, the nebulizer nozzles activated to the ventilation process will reinforce in the reductions of temperatures helping birds to maintain thermal comfort. These nebulizer nozzles throw mist-shaped water droplets, which will be spread by the winds of positive pressure fans that will renew the hot air inside the shed by the colder air.

Santos et al. (2017) in a study on the reflexes of automation technology in the economic results of poultry companies integrated with a poultry company, obtained results that corroborate the results presented in this study, because they concluded that investment in technological innovation in bird life contributes to improving egg quality and, consequently, brings better economic results.

Similarly, Silva (2019) studying an intelligent system to control the air conditioning of aviaries for the production of broilers, concluded that an intelligent prototype proves to be suitable for operationalizing, automatically, the supervision of the variables of evaluation of the thermal environment and the control of equipment related to the thermal ambience of aviaries, enables the mitigation of thermal stress conditions within aviaries and, consequently, productivity losses, being an alternative for application in the agroindustry. This data is compatible with presented results, as the prototype implemented mitigates heat and reduces costs in the light bill.

The construction of the prototypes allowed to materialize ideas to solve recurrent problems in the aviculture, and the interdisciplinarity necessary for its construction making it possible to create innovative methods that facilitate on a day-to-day basis and contribute to improve production in this sector.

5. Conclusion

A low-cost semi-automatic computational model was developed for the feeder of laying birds, which avoids the waste of 1964.20 kg of feed.

A prototype was also implemented for the aviary cooling system, which provides savings in the energy bill of 60.94 reais per month and 731.31 reais per year, besides providing the reduction of heat in the egg production process.

The semi-automated systems suggested for small farmers in the Amazon Region theoretically meet their objective, both for the improvement of waste and for the provision of animal welfare and increased profitability.

For the increasing success of the poultry sector with regard to the intensified use of applied technology, it is essential to establish objectives that constitute the target of a sectoral policy for the development of the activity. For this, some points should be observed such as the updating and improvement of the production process, through mechanization, processing and training, government incentive for the acquisition of technologies at a more accessible price, dissemination of poultry products and equipment on a large scale.

6. References

Abpa. Associação Brasileira de Proteína Animal. Manual técnico de avicultura. Disponível em: < https://abpa-br.org/tecnico/>. Acesso em 16 de outubro de 2020.

Abpa. Associação Brasileira de Proteína Animal. Relatório anual 2018. Disponível em: http://abpa-br.com.br/setores/avicultura/publicacoes/relatorios-anuais >. Acesso em 18 out. 2020.

Amaral G.F. et al. Avicultura de postura: estrutura da cadeia produtiva, panorama do setor no Brasil e no mundo e o apoio do BNDES. BNDES Setorial, Rio de Janeiro, n. 43, p. [167]-207, mar. 2016.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Valor Bruto da Produção Completo. Disponível em: < http://www.agricultura.gov.br/assuntos/ política-agricola/valor-bruto-da-producao-agropecuaria >. Acesso em 18 out. 2020.

EMBRAPA Suínos e Aves. Disponível em: https://www.embrapa.br/suinos-e-aves. Acesso em: 08 jun. 2020.

Ferraz P.F.P., et al. Performance of chicks subjected to thermal challenge. Pesqui. Agropecuária Bras. 52, 113–120, 2017.

Santos T.O. Reflexos da tecnologia de automação nos resultados econômicos de aviários integrados a uma empresa do ramo avícola. XXIV Congresso Brasileiro de Custos – Florianópolis, SC, Brasil, 15 a 17 de novembro de 2017.

Silva C.T., Sistema inteligente para controle da climatização de aviários para produção de frangos de corte. Dissertação (mestrado acadêmico). Universidade Federal de Lavras -UFLA, 2019.