I-Light: An Improved Lighting System For Poultry Farms

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***Abstract*— Poultry farming is one of the most progressive enterprises where millions of broilers are produced every year. Improvement on poultry farms includes systems where the basic needs of broilers are addressed. I-Light is an improved lighting system that incorporates three (3) major factors in the growth of broilers – color, photoperiod, and light intensity. This system compared the existing traditional lighting system (TL) and LED lighting system (LL) between the improved system in terms of broiler growth and at the same time determined the mortality rate and power usage. Arduino Mega Microcontroller and an LED sensor were used to control the light intensity. The performance was assessed by comparing the average weight and mortality of the chickens as well as the power usage within the conduct of the experiment. The results determined that the i-Light system performed better than both TL and LL systems. In terms of growth, the i-Light system demonstrates its ability to outperform TL and LL as seen by the fact that the i-Light system's weight gain on the final week of experimentation is 55.45% heavier than TL and 36.36% heavier than LL. It was also shown that the system logs the lowest mortality rate compared to the TL and LL system which records a 30% mortality rate which is more ideal than the 50% shown on TL and 40% for LL. The power usage results show the savings from the electricity consumption of the three systems. It shows that the i-Light used the least electricity. The i-Light system is 75.44% more efficient than the TL which saves up to 95.914 PHP monthly. On the other hand, i-Light is 63.12% more efficient than LL which saves up to 53.42 PHP per month. This study proved the system to be advantageous in terms of growing broiler chickens and power saving. Based on the results of the tests, it has been determined that using the i-Light Lighting system instead of the TL system and LL system is a viable option for poultry farmers.**

***Keywords*— poultry, led, intensity, broiler, lighting system**

I. Introduction

Poultry farming, most commonly referring to chickens, is the practice of keeping and breeding animals to obtain meat or eggs. It is currently one of the most forward-thinking animal enterprises. The Philippines has achieved poultry self-sufficiency and is a prolific poultry product producer. Millions of broilers are produced each year, and the country's supply keeps up with demand. The Philippines produced 431.77 million metric tons of chicken in the third quarter of 2020 [1]. However, in September 2021 it was reported that total chicken production was at 425.89 thousand metric tons, which was -1.4 percent lower than the previous year's same-period output [2]. Inefficient poultry management and a slew of devastating poultry diseases are provoking significant concern. In the past, chicken farms used only incandescent, fluorescent, or high-pressure sodium lamps for artificial lighting. Because these lamps have a fixed intensity and hue, the only variable that can be changed once they're placed is the length of daily light exposure [3], chickens get very little vision from an incandescent bulb. Using fluorescent light tubes is unsuitable for poultry farms because they are designed for humans, and chickens perceive them as light and dark stripes.

In previous studies, Light-emitting diodes (LED) are gradually becoming a substitute for conventional incandescent and fluorescent lights for lighting in poultry houses. chickens raised using poultry LED lighting systems have been found to produce a higher quantity and quality of eggs, develop into maturity at a faster rate, and enjoy an improved standard of health as compared to chickens raised under traditional light sources [4]. Various light colors have different effects on behavior and growth performance. They concluded that the blue light color may improve the birds' welfare [5]. In addition, studies about hens, quail, turkeys, geese, and ducks have looked at the effects of short (blue and green) and long (orange and red) wavelengths on animal welfare, body weight increase, and egg production. Blue or green illuminations are helpful to body weight in chickens and quail, and red or white illuminations are advantageous to egg production in chickens and quail. When compared to red light, blue and green lights promote increased antibody synthesis and immunological activity [6]. Due to variations in spectral sensitivity, broilers sense light intensity differently than humans. Greater knowledge of broiler behavioral reactions to perceived illumination might assist farmers in enhancing animal comfort and production [7].

The previous study has been using LED light as an alternative lighting source for the poultry farm and indicated the fixed intensity, photoperiod, and color they use. The Blue light was discovered to have the highest eating frequency, as well as the calmest birds, as shown by more intensive sleeping, sitting, and idling behaviors. Red light reduced hostility when compared to white light. Red light has been shown to hasten the sexual development of laying chickens [8]. In this work, the researchers improve the system and address the use of blue and red LED light as an alternative lighting source on poultry farms.

Furthermore, the researchers developed an automated poultry farming lighting system that uses an energy-efficient light-emitting diode (LED) source that combines the four different features. In the system, three characteristics of a lighting system will be considered: the color of light, photoperiod, and light intensity. For the photoperiod of the system, the researchers will be using intermittent lighting, which has a ratio of 2 hours of light and 2 hours of darkness. For the intensity of light, the researchers used 30 lux and blue light. Another feature was added to the system in which you can switch the color of the light to either red or blue LED light depending on the result you want to achieve. Moreover, the researchers integrated a light intensity sensor into the system to optimize the standard intensity required for a poultry farm.

II. Related Works

Environmental monitoring in a poultry farm using an instrument developed with the Internet of Things concept. This gadget and its companion application allow the poultry farmer to record and analyze temperature, relative humidity, airborne ammonia concentration, and luminosity in real-time, allowing for quick data analysis and decision-making. The LDR (light-dependent resistor) sensor, which is a light-controlled variable resistor, was used to monitor luminance. In the dark, the photoresistor has a high resistance, whereas, in the light, it has a low resistance [9].

Implementation of the energy-saving lighting mode in the poultry-farming house due to the automated control system. The findings of research utilizing programmable logic controllers (PLC) to construct software for autonomous control and maintenance of illumination conditions in bird-keeping facilities, based on the cross, keeping technologies, and bird age, are reported. Dimming systems minimize lighting energy consumption and improve electrical energy efficiency [10].

An IoT Monitoring Assistant for Chicken Layer Farms. The goal of this research is to create a gadget that can be connected to an app and used as monitoring assistance for chicken layer farms. The device regulates the lighting of an enclosed vent-type coop and shows humidity and temperature. Artificial light management regulates and manages the quantity of light and duration that artificial lights emit at a certain power level [11].

Field trials were conducted in commercial broiler houses to test the effects of various light sources (incandescent and fluorescent) and light intensity on BW, feed conversion, mortality, condemnations, field defects, electrical usage, and electrical costs. Light sources included: 15- and 40-W incandescent lamps; 5 and 9-W compact, fluorescent lamps; and 40-W, 1.2-m fluorescent tube lamps. Both incandescent and fluorescent light sources will adequately support broiler performance and processing quality. Fluorescent light sources will provide adequate illuminance at a lower electrical cost, thereby allowing economic savings without a loss in production [12][13].

III. Methods

A. *Project Design and Specification*

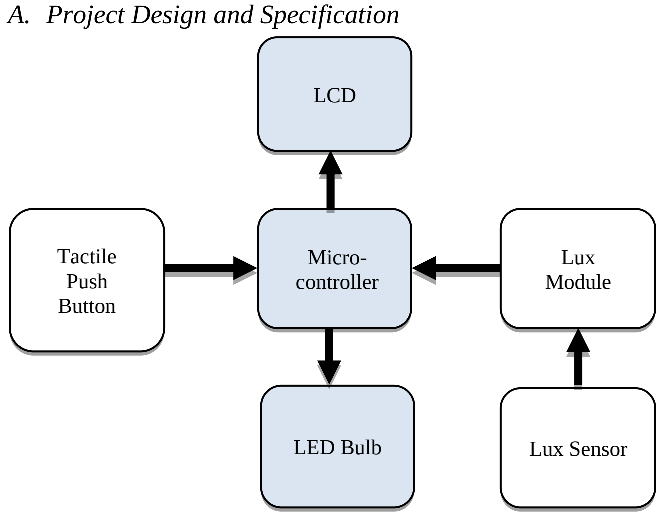

Fig. 1. Block Diagram of the System.

The block diagram of the system is shown in Fig. 1. The push button allows the user to select a certain light color. The lux sensor measures the amount of light present in the environment. The measured lux will then be recorded by the lux module for it to compute the desired intensity. The collected data will then be sent to the microcontroller.

Furthermore, based on the data collected by the sensor, the Arduino will command the LED Bulb to increase or decrease the intensity of the light while keeping the optimum light intensity required for poultry farms while displaying the timer on the LCD.

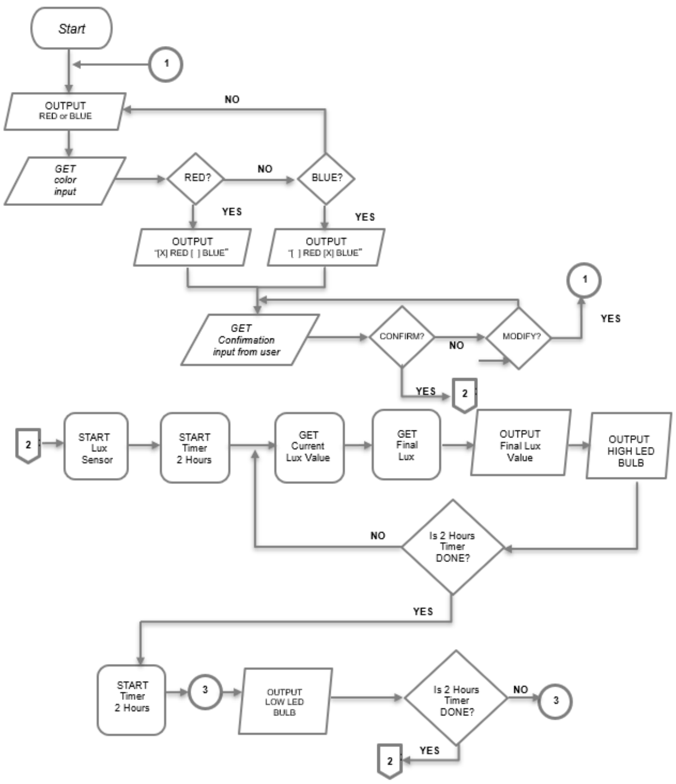

Fig. 2. Flowchart of the System.

The flow chart in Fig. 2 explains how the system works. The color of the LED light will be manually set by the operator at first, whether blue or red. Following that, it will go on to confirm the input choice of the user. The system is designed in the 2L:2D ratio. It means that it will alternately change the state of the LED from on to off mode every 2 hours. When the LED color is chosen, the lux sensor will detect the available light intensity present in the environment. It can be seen that if the sensor detects light in the surroundings, whether it is high or low, the lux module with the help of the programmed Arduino will set the optimum light intensity required for poultry farms.

B. *Parameters Integrated into i-Light*

The different parameters used to develop the i-Light are shown in Table I. A photoperiod of 2L:2D shows a significant effect on the body weight of chickens [14]. Moreover, light intensity equivalent to 30 lux is the standard light intensity for growing chicks [12]. In terms of color, chicks that are under blue light manifest a good condition for chick and have a positive effect on body weight. An LED light was also integrated because it is more energy efficient compared to other types of bulbs [8].

TABLE I. PARAMETERS INTEGRATED IN I-LIGHT

Parameters	Values
Photoperiod	2L:2D
Light intensity	30 lux
Color	blue
Type of Lighting	LED

The light wavelength, strength of light, and duration with the distribution of photoperiods are the elements that were found to be critical management techniques in broiler production [14]. Photoperiod and nutritional management tactics are important variables in a bird's health. Commercial poultry reviews marked the importance of photoperiod in controlling both behavioral and physiological processes affecting bird reproduction, health, and performance in broiler chickens [15]. A previous study conducted shows that bodyweight in intermittent light (2L:2D) was significantly better than the control group with other treatment groups ($P<0.05$). In addition, the dressing percentage of birds reared in the (2L:2D) treatment group is greater than the measurements observed in the control or other lighting programs.

The standard recommendation for growing pullets is to brood at 30–50 lux [12]. Light intensity manipulation is a major management tool that affects broiler production and well-being [16]. According to a past study, light intensity was the major factor affecting the behavior and health of broilers [17]. Low contrast light intensity dampened the behavior of broilers has possible effects.

Various light colors have different effects on behavior and growth performance. The Blue light was discovered to have the highest eating frequency, as well as the calmest birds, as shown by more intensive sleeping, sitting, and idling behaviors. They concluded that the blue light color may improve the birds' welfare [5]. In addition, another study shows that blue illuminations have a positive effect on body weight [18].

Light Emitting Diode (LED) is favored over other conventional light sources in poultry housing. Broiler immunity and meat quality responses have been found to improve when LEDs producing blue, green, and yellow wavelengths are used. Moreover, an artificial lighting system for laying hens using light-emitting diodes is beneficial in reducing production costs [19], [20]. Thus, compared to incandescent and fluorescent lamps, LEDs have high luminous efficiency, lower power consumption, and longer service life when used in broiler production [4].

IV. RESULTS AND DISCUSSION

The actual project is shown in Fig. 3. To prevent corrosion on the device, the output project was made of an aluminum composite panel which served as the casing. The sensor was put on top of the device to ensure that it could detect the amount of available light in the surroundings. The device has three pushbuttons for selection and an LCD for display on the front. The bulb was placed at the bottom of the device. For pest protection, the Arduino mega and wires were installed inside the device.

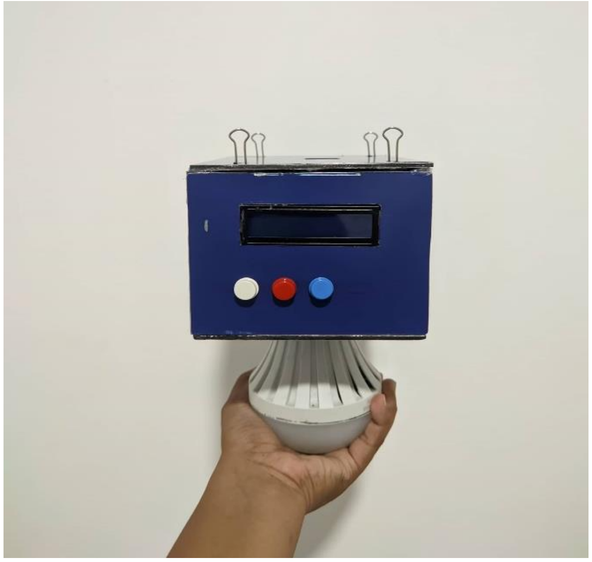

Fig. 3. The AUDI System.

During the experiment, the chicks were given the same amount of food and water under traditional lighting (TL), LED lighting system (LL), and the i-Light system. Based on Table II, the i-Light system's gain during week one is 48.68% heavier than the TL at the same time it is 17.65% heavier than the LL. Based on the data collected during Week 2, the effectiveness of the i-Light system was once again demonstrated. During that week, the growth was 37.97 grams, compared to only 19.91 grams with TL and 12.89g with LL. This implies a 47.56% difference with TL and a 66.05% difference with LL.

Further, during week 3, the i-Light still shows its effectiveness because it is 36.63% heavier than TL and 26.89% heavier than LL. Finally, like in previous weeks, the i-Light system demonstrates its ability to outperform TL and LL as seen by the fact that the i-Light system's weight gain is 55.45% heavier than TL and 36.36% heavier than LL. Furthermore, literature reviews show that the average weight gain for chicks with an average feed consumption of 20g is 24g, these show the effectiveness of the i-Light system since it surpasses the standard weight gain for chicks [21].

TABLE II. AVERAGE WEEKLY WEIGHT GAIN

Setup	Average Weight Gain per Week (g)				
	Week 0 (Initial)	Week 1	Week 2	Week 3	Week 4
Traditional Lighting	0	7.79	19.91	24.6	21
LED lighting	0	12.5	12.89	28.38	30
i-Light System	0	15.18	37.97	38.82	47.14

The mortality rate is an indication of whether a system is effective or not. The higher the mortality rate the less effective the system and vice versa. The mortality rate throughout the 4 weeks experimentation process is shown in Table III. The results reveal that the i-Light system logs the lowest mortality rate compared to the TL and LL systems. The acceptable range of mortality for 10 chicks is 0-30% [22].

TABLE III. MORTALITY RATE

Setup	Power Usage per Week (KWh)				Total	Cost (@14/KWh)
	Week 1	Week 2	Week 3	Week 4		
Traditional Lighting	2.122	1.902	1.856	2.086	7.966	Php.111.52
LED lighting	1.213	1.165	1.328	1.225	4.931	Php.69.034
i-Light System	0.324	0.276	0.307	0.208	1.115	Php.15.61

A portable kilowatt-hour meter was used to measure the electricity consumption of the three systems. The power utilization from week one to week four is shown in the table, demonstrating that i-Light outperforms the TL system and LL systems. The table shows that the i-Light used the least electricity. The i-Light system is 75.44% more efficient than the TL. The researchers found out that we can save money up to php.95.914 per month when we use the i-Light system rather than TL. On the other hand, i-Light is 63.12% more efficient than LL. Using i-Light can save up to PHP. 53.42 per month. Therefore, it is more cost-effective to use the i-Light system compared to the two other systems.

TABLE IV. POWER CONSUMPTION

Setup	Dead Chicks					Mortality Rate
	Week 0	Week 1	Week 2	Week 3	Week 4	
Traditional Lighting	0	3	2	0	0	50%
LED Lighting	0	0	3	1	0	40%
i-Light System	0	1	1	1	0	30%

V. CONCLUSION

Based on the results of the tests, it has been determined that using the i-Light lighting system instead of the traditional lighting system and LED lighting system is a viable option for poultry farmers. Aside from maintaining the optimal light intensity which improved the chicken's growth, including a sensor in our system and an LED bulb saves more energy and money. Moreover, i-Light is seen to have a lower mortality rate compared to traditional lighting and LED lighting.

Based on the results of the study conducted, the researchers recommend further study of the i-Light system on an actual poultry farm. In addition, to further enrich the study, future researchers may test the effectiveness of red light for egg production.

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