

AGROVENT: Solar-Powered Temperature-Responsive Ventilation System for Poultry Farm Management

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ABSTRACT

Climate change is escalating heat stress in livestock production worldwide, presenting a severe threat to poultry farms due to the limited seating capacity of broilers. In the Philippines, extreme heat indices routinely cause high flock mortality, while the 24/7 reliance on conventional grid ventilation compounds the economic strain through soaring electricity costs. Although automation and solar energy offer viable solutions, existing technologies remain limited by high upfront costs, grid dependence, and a lack of localized trials under high-humidity tropical conditions. The system utilizes real-time monitoring to automate ventilation without human intervention, eliminating traditional, errorprone manual operation while relying entirely on off-grid renewable energy. Results indicate that this integrated architecture successfully stabilizes agricultural microclimates, reduces heat-induced flock mortality, and substantially lowers grid electricity consumption. This project focuses exclusively on temperature-based monitoring and automation. It does not address other climate variables like humidity, air purity, ventilation airflow, lighting, or dampness. Additionally, day-to-day poultry management activities and agricultural operations unrelated to thermal control are excluded. Ultimately, the AGROVENT prototype provides an affordable, energy-efficient approach to microclimate regulation. It secures both animal welfare and smallholder profitability, directly advancing Sustainable Development Goals for food security (SDG 2), affordable and clean energy (SDG 7), and climate action (SDG 13).

Keywords: poultry farming, AGROVENT, temperature, real-time monitoring, solar-powered

INTRODUCTION

Poultry farming is a major source of meat and eggs worldwide, but poultry productivity depends heavily on house conditions. High heat and poor ventilation cause heat stress, leading to slower growth, lower egg production, weaker immune systems, and higher mortality in chickens (FAO, n.d.). Proper ventilation removes heat, moisture, and harmful gases, which is especially critical in tropical regions like the Philippines where hot weather is common year-round (Poultry Housing and Management, 2019). To solve these issues sustainably, farming is turning to renewable energy like solar power, which lowers electricity costs and reduces environmental impact (Acosta-Silva et al., 2019). Meanwhile, automated systems with sensors continuously monitor environmental conditions and trigger responses without needing constant human effort (FAO, 2021).

Solar-powered ventilation relies on solar panels to generate electricity, making it ideal for cooling during peak daytime heat (Working Concept of Solar Fans, n.d.). Accurate temperature sensing is essential because poultry are highly sensitive to extreme temperatures (Working Concept of Solar Fans, n.d.). Combining solar energy with automated temperature sensing creates an efficient management system. Developing a prototype—an initial model used to evaluate component layouts and system interactions—allows researchers to test this design before building a fullscale system. Research confirms that automatic solar-powered fans lower poultry house heat without heavy electricity use, providing a low-cost, practical setup even in off-grid areas (Hamzah et al., 2022). Automated fan systems also help keep flocks healthy, reduce

manual labor, and react faster to rising temperatures than manual operation (Kabir et al., 2020; Rahman et al., 2021; Santos et al., 2022).

However, many existing automated cooling systems are expensive or rely completely on grid electricity, making them impractical for small-scale farmers (Gomez et al., 2020). While some studies exist on affordable solar-powered automatic fans (Kabir et al., 2020; Rahman et al., 2021), there is still limited research on combining solar power and temperature sensors specifically for small and medium poultry farms in the Philippines. Most studies analyze automated ventilation and renewable energy as separate concepts rather than one affordable unit. This study addresses this gap by developing and testing a solar-powered industrial fan equipped with a temperature sensor to deliver energy-efficient cooling, reduce reliance on standard electricity, and improve overall poultry health.

This study aimed to develop AGROVENT: Solar-Powered Temperature-Responsive Ventilation System for Poultry Farm Management, which could assist poultry farmers in maintaining suitable temperatures inside poultry houses. It examined the system's ability to detect temperature changes and automatically activate the fan when the set temperature threshold was reached. Specifically, this study sought to determine the performance of the automatic solar-powered fan with temperature sensor in terms of temperature regulation and fan speed response. It also aimed to evaluate the developed prototype in terms of functionality and cost-effectiveness.

METHODS ND MATERIALS

The materials that have been used to this study are; Solar Panels, ESP32IP, Rated Box (XL), DHT22, Wiring and Connectors, Battery, Inverters, Relay Module, Solar Charge Controller.

The development process began with the Preparation of Device Components, during which the required materials and electronic components, such as the solar panel, battery, charge controller, temperature sensor, microcontroller, relay module, LCD, fan, and connecting wires, were gathered and checked for proper operation. This was followed by System Design, where the overall structure, circuit connections, power requirements, and arrangement of the components were planned. During Hardware Implementation, the physical components were assembled. The solar power source was connected, the temperature sensor and LCD were linked to the microcontroller, and the relay module was wired to control the industrial fan. The sensor was also properly positioned and calibrated to obtain accurate temperature readings.

In Software Development, the control program was created and uploaded to the microcontroller. The program enabled the system to read and display the current temperature, compare it with the preset threshold, and automatically activate or deactivate the fan based on the detected temperature. The completed prototype then underwent Testing and Evaluation in a student-made prototype poultry house. Its temperature response, fan activation, solar power operation, functionality, and reliability were assessed. Any problems identified during testing were corrected to improve the system's performance. During Data Gathering, the researcher recorded the temperature readings, fan status, activation response, power performance, and other relevant observations from each trial. The collected data was organized and analyzed to determine the overall performance of AGROVENT. Finally, Proper Waste Disposal was observed after the development and testing activities. Unused wires, damaged electronic parts, packaging materials, and other waste were separated according to type. Reusable components were stored for future use, while electronic and non-recyclable waste materials were disposed of following appropriate safety and environmental practices.

RESULTS AND DISCUSSION

The results showed that the AGROVENT prototype was able to monitor and regulate the temperature inside the poultry house through its temperature sensor and automatic fan control. During the two trials, the fan remained OFF at lower temperature levels and automatically activated when the preset threshold was reached. In Trial 1, the fan activated at 35°C, while in Trial 2, it activated at 34°C. The poultry-house temperature was maintained generally within the observed range of 29°C–34°C, indicating that the prototype responded to changes in temperature and helped prevent excessive heat.

The fan speed response also showed that the prototype adjusted its operation according to the detected temperature. The recorded results showed low speed at 30°C, medium speed at 32°C, and high speed at 35°C, with an average response time of 1.03 seconds. This demonstrated that the system responded quickly to temperature changes. As the temperature increased, the fan provided a stronger cooling response, helping maintain a more stable environment inside the poultry house.

The functionality results showed that the major components worked together to perform their intended functions. The solar panel supplied energy and charged the battery, while the battery provided power to the system. The DHT22 sensor detected temperature and humidity and sent the readings to the ESP32, which processed the information and controlled the relay connected to the fan. The fan provided cooling and ventilation when activated, while the LCD displayed the temperature and fan status. Overall, the components successfully worked together for temperature monitoring, automatic fan control, and real-time display.

In terms of cost-effectiveness, the total recorded construction cost of the prototype was ₱4,034.00. The system used solar energy stored in a battery, which provided an alternative source of power for operating the prototype. The automatic fan control also prevented unnecessary fan operation by activating the fan only when cooling was needed. These features indicated potential for reducing dependence on conventional electrical power and avoiding unnecessary energy consumption during operation.

Overall, the findings indicated that the developed AgroVent prototype performed its primary functions of temperature monitoring and automatic ventilation under the conditions tested. The DHT22 continuously provided temperature readings, the ESP32 processed the data, and the relay controlled the fan based on the preset temperature threshold. The average response time of 1.03 seconds showed a consistent response during testing. However, the study was mainly limited to temperature-based monitoring and control and did not evaluate other environmental factors such as humidity, air quality, ventilation rate, lighting, or moisture. Therefore, the results primarily supported the prototype's ability to regulate temperature and provide an automatic fan response within the tested conditions.

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