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# Reduce Fuel Consumption in Poultry Houses by Leveraging Day-Night Temperature Variations in the MENA Region.

*By*

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## Abstract

This paper presents the development of an algorithm aimed at reducing fuel consumption in poultry houses, specifically designed to leverage the significant differences in day and night temperatures in the MENA region during winter. This algorithm is a key component of a comprehensive Poultry House Management System (PHMS). The proposed algorithm adjusts heating and ventilation parameters based on real-time environmental data and bird activity levels. By exploiting natural temperature fluctuations, dynamically allowing more fresh air into the house during warm time of the day and reducing it to a minimum during cold time during the night, the algorithm demonstrated a substantial reduction in fuel usage—up to 30%—without compromising the health and productivity of the poultry, contributing to the overall efficiency of the PHMS. Additionally, increased fresh air intake helps dry litter pads and remove moisture, further enhancing the poultry house environment.

## Introduction

Energy costs (fuel and electricity) consume approximately 25% of the annual gross farm income at the Applied Broiler Energy Unit [2]. Maintaining the appropriate temperature and ventilation is essential for poultry health and productivity. Traditional methods often result in energy inefficiency, particularly in regions like the MENA (Middle

East and North Africa) where there are significant temperature variations between day and night during winter [7]. Figure-1 shows night and day temperature is maximum during December, January and February.

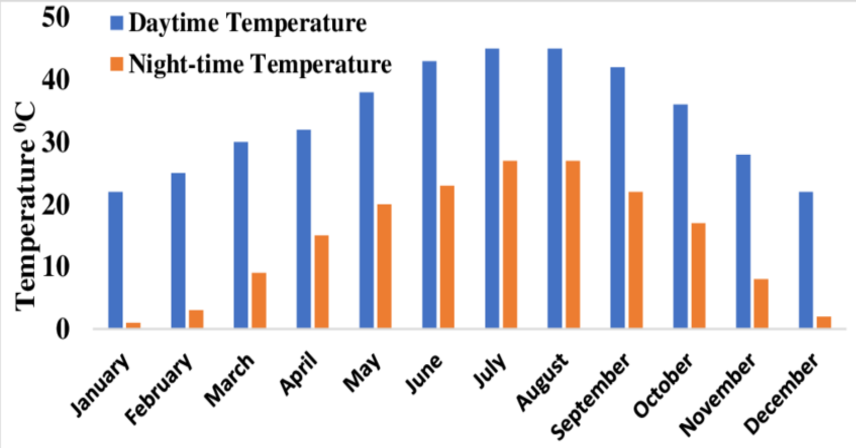

Figure-1 Daytime and Nighttime differences at MENA region

This study is part of a larger project to develop a Poultry House Management System (PHMS), which integrates various aspects of poultry house management to enhance operational efficiency. The specific focus of this paper is the development and implementation of an algorithm within the PHMS that optimizes fuel usage by adjusting environmental controls based on real-time data and leveraging natural temperature fluctuations.

**PHMS Overview**

The PHMS is a comprehensive system designed to manage all aspects of poultry house operations, including environmental monitoring, feed management, health tracking, and energy optimization [4]. The system integrates various modules that work together to provide a holistic approach to poultry house management. The algorithm discussed in this paper is a critical component of the environmental monitoring and control module of the PHMS.

**Minimal ventilation**

Minimal ventilation in poultry houses is essential for maintaining optimal air quality and environmental conditions[1]. It ensures fresh air, controls moisture and harmful gases, and supports bird health without excessive energy use. Key factors include ventilation rates based on house size and bird numbers, seasonal adjustments for temperature balance, and sensor-driven adjustments for consistent air quality [6]. In a Poultry House Management System (PHMS), the algorithm dynamically adjusts ventilation based on real-time data, optimizing conditions and enhancing efficiency.

**PHMS Integration**

In a Poultry House Management System (PHMS), the algorithm controls minimal ventilation by:

- **Dynamic Control:** Adjusting rates based on real-time data.
- **Predictive Modeling:** Using machine learning to optimize future settings.
- **User Interface:** Allowing easy monitoring and manual adjustments.

Figure-2 shows actual PHMS developed for this project

The algorithm dynamically increases the ventilation rate when it detects warmer temperatures outside relative to inside the poultry house. This adjustment takes advantage of natural temperature differentials to enhance air circulation and maintain optimal conditions inside, contributing to improved environmental control and energy efficiency.

**Algorithm Design**

The algorithm was designed to adjust heating and ventilation settings dynamically. It uses a combination of table-lookup and proportional control to figure out optimal air-in settings, taking into account the significant day-night temperature variations.

The core concept involves allowing more fresh air into the poultry house during warm days to take advantage of natural warming and reduce heating requirements. This increased fresh air intake also helps dry litter pads and remove moisture, creating a healthier environment.

Equation (Eq.1) that relates the temperature difference ($D$) and the air flow volume (V) is used to regulate this additional air flow into a poultry house.

$$V = v_1 + v_1 \left( \frac{2^{(-aD)}}{1} \right)$$

1. V is the total air flow volume.
2. D is the temperature difference between the inside and the outside of the poultry house.
3. v1 represents the baseline air flow volume when the temperature difference is zero.
4. k is a constant that determines how quickly the air flow volume decreases as the temperature difference increases.

As figure-x illustrate this working range of this equations

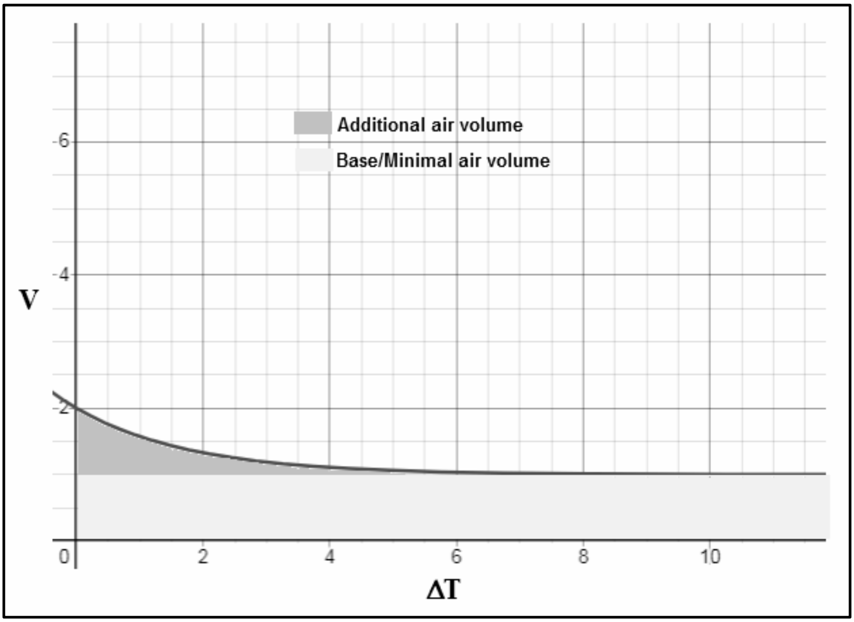


Figure -x Base and additional air volume

The base airflow (v1) is set using the Poultry House Management System (PHMS), which depends on the age of the birds. Using the house's real-time clock, the current base airflow is calculated using a table lookup. The total air flow volume is then adjusted based on the difference between the set temperature (D) and the outside temperature

## Implementation

The algorithm was implemented as a function block using a Programmable Logic Controller (PLC) connected to the field devices of the poultry house. The PLC is connected to a Human Machine Interface (HMI) to facilitate user-friendly access to PHMS, which is accessible via web and mobile applications.

## Testing and Validation

The algorithm and PHMS were tested over a period of six months in a commercial poultry house in Tarhuna city 80 Km south of Tripoli-Libya. Fuel consumption was recorded and compared to a control period with traditional environmental control methods. The PHMS logged data showed stable temperature during all 35 working days, confirming the system's effectiveness in maintaining optimal environmental conditions.

## Results

The implementation of the algorithm resulted in a reduction of up to 60% in fuel consumption compared to the control period. The temperature and ventilation levels remained within the optimal range for poultry health Figure-3. The PHMS facilitated easy monitoring and control of the environmental conditions, contributing to overall operational efficiency. The logged data demonstrated stable temperatures throughout the 35-day period, indicating the reliability of the system. Additionally, the increased fresh air intake helped dry litter pads and remove moisture, further enhancing the poultry house environment.

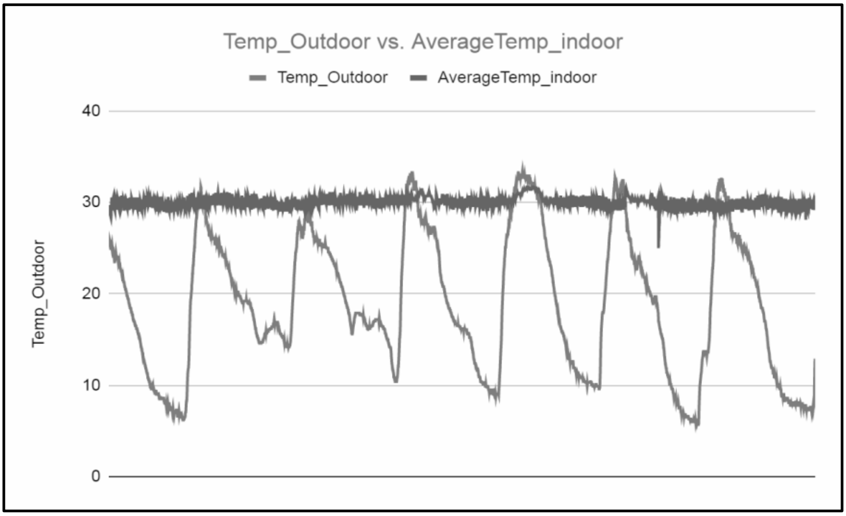


Figure-3 data logged for 6 days (28th Feb to 5th Mar)

## Discussion

The results indicate that the algorithm effectively reduces fuel consumption by leveraging the natural temperature fluctuations between day and night in the MENA region during winter. By dynamically adjusting ventilation rates to allow more fresh air during warm days and minimizing it during cold nights, the algorithm optimizes energy use. The increased fresh air intake not only reduces heating requirements but also helps dry litter pads and remove moisture, contributing to a healthier environment for the poultry. The integration into the PHMS allows for seamless management of various aspects of poultry house operations, providing a comprehensive solution for enhancing efficiency.

## Future Work

Future work will focus on introducing advanced Artificial Intelligence(AI) techniques to further enhance the algorithm's predictive capabilities and adaptive control mechanisms. AI integration will enable more precise environmental control, taking into account a broader range of variables and potential scenarios. This will improve the system's ability to respond to changing conditions and enhance overall efficiency. Further development of the PHMS will include additional features and improved user experience, expanding its applicability and effectiveness in poultry house management.

## Conclusion

This study demonstrates the feasibility and benefits of using an algorithm to reduce fuel consumption in poultry houses by exploiting day-night temperature variations as part of a PHMS. Future work, including the introduction of AI, will focus on refining the algorithm and testing it in different poultry house configurations. The PHMS will continue to evolve to incorporate more features and improve user experience.

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