Asian Science and Technology
Innovation Journal

ASTIJ

Research Article

Solar Integration for Enhanced Sago Flour Production

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Citation: Nonthakarn R, Getpun S, Kerdwan S. *Solar Integration for Enhanced Sago Flour Production.* ASTIJ. 2025; **1**(1): 9-13

Received: June 7, 2025
Revised: June 9, 2025
Accepted: June 15, 2025
Published: June 26, 2025

Abstract: Sago flour production has gained immense popularity in recent times due to its promising economic prospects. Many farmers have integrated sago production as their primary occupation or supplemental income source, contributing to the thriving sector's success. This industry generates substantial profits for both individual farmers and cooperative endeavors. Traditionally, farmers have dried sago flour by sun-drying it, utilizing solar heat to remove moisture. However, this method faces challenges during periods of low sunshine and rainy seasons, disrupting the drying process and resulting in reduced or halted output, which negatively affects overall yields. To address these limitations, a novel approach has emerged. Farmers now utilize electrical energy generated by solar cells to provide additional heat during the sago flour drying process. This innovative method maintains a steady temperature throughout the 2.9-hour drying cycle, ensuring precise control over both quantity and quality. By optimizing the drying cycle, farmers can significantly increase their overall production capacity. Each cycle can be completed in a shorter duration compared to the previous one, leading to substantial productivity gains.

Keywords: Sago flour production; Economic prospects; Solar cell energy; Drying system

1. Introduction

In the modern agricultural landscape, Sago flour cultivation has become a primary source of livelihood and supplementary income for both individuals and collective ventures. This dynamic encompasses a diverse range of activities, including Sago planting and harvesting, as well as the intricate processes involved in Sago flour production [1-2]. A significant aspect of this agricultural pursuit is the multi-step process of transforming Sago roots into taro starch. Notably, the sun-drying phase is crucial, with farmers employing various methods such as rack exposure to sunlight to facilitate moisture evaporation. Some also utilize shaded structures or dedicated drying facilities to harness sunlight for the process. However, challenges arise during periods of limited sunlight and rainy seasons, which impact overall production and consequently affect income across different stages, from cultivation and harvesting to processing. In response to these challenges, there exists an opportunity for innovation and resilience in the production of Sago flour starch. Addressing the dependency on sunlight for drying processes could enhance the sustainability of income generation throughout the year, positively impacting the entire value chain [3]. This holistic approach encompasses cultivation, harvesting, processing, and ongoing efforts to transform Sago flour into valuable food products. Experiments conducted by a group of farmers revealed that the optimal percentage of humidity for Sago flour ranges from 10% to 15%. This range is considered most suitable because it allows for prolonged storage, retains the aroma, and maintains an attractive color [4-6].

Therefore, the driving force behind the design and establishment of a drying system for taro seeds that does not rely solely on sunlight but utilizes heat energy from alternative sources becomes evident. This system involves converting electrical energy into thermal energy by heating electric wires. The electrical energy powering the entire system is derived from solar cells that transform solar energy into heat energy. The key rationale for utilizing solar cell-generated electrical energy lies in its cleanliness and cost-effectiveness [8-10].

2. Materials and Methods

2.1 Study site

This study delves into the variability in solar heat availability during the Sago flour drying process, as evidenced by a month-long temperature data collection. The building, measuring 3 meters in width, 4 meters in length, and 3 meters in height, exhibits inconsistent solar heat values due to unpredictable weather conditions, such as occasional rain, intermittent sunshine, and unpredictable cloud cover. Recognizing the limitations of relying solely on sunlight, this research advocates for the implementation of a supplementary heat system to ensure consistent and controlled drying conditions. Maintaining temperatures within the optimal range of 70-80 degrees Celsius is proposed as an effective and quality-preserving approach for drying Sago flour in unpredictable weather conditions, as illustrated in Figure 1.

Figure 1. Sago flour drying house

2.2 Research Methodology

System Design:

- Study of the working area characteristics, sunlight direction, and time intervals.
- Design of solar panel arrays considering optimal positioning.
- Design of electrical transmission and quality adjustment systems. as shown in Figure 2.

Solar Panel Installation:

- Construction of foundations and installation frames according to the designed specifications.
- Installation of solar panels in alignment with sunlight direction and angle reception.

Electrical Transmission and Quality Adjustment System Installation:

- Installation of components receiving electrical currents before entering the power system.
- Implementation of electrical current reception and quality adjustment to suit the intended usage.

Establishment of a Learning Centre for Solar Cell Power Production:

- Creation of an educational centre explaining the entire process, from power production principles to factory electrical system usage.

Summary and Evaluation:

- Comprehensive review of the system, including energy output, encountered issues, expenses, cost-effectiveness, and ongoing system maintenance.

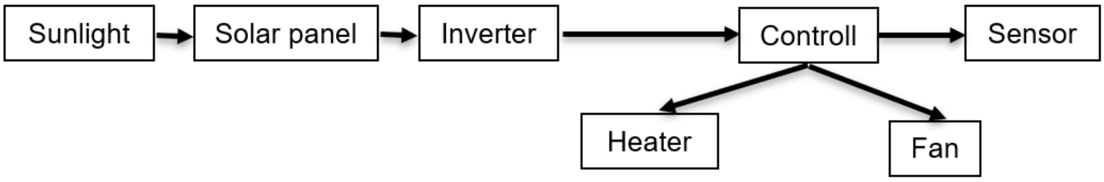

Figure 2. System structure

3. Results

From collecting data on the electrical output of the solar cell power generation system during the peak production period each day over a month, the power values ranged between 3500 to 4800 watts, with an average of 4125 watts, as shown in Figure

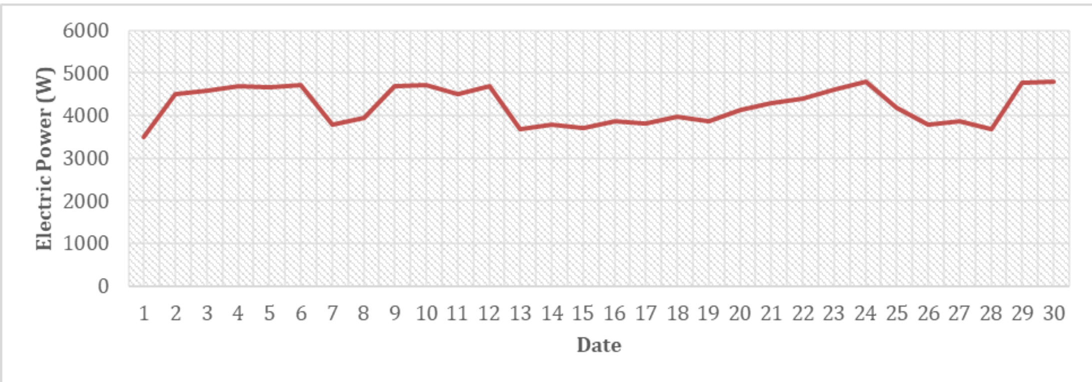

Figure 3. Electrical Power

From collecting data on the temperature of the solar cell power generation system during the peak production period each day over a month, the power values ranged between 60 to 85 degree Celsius, with an average of 72 degree Celsius, as shown in Figure 4

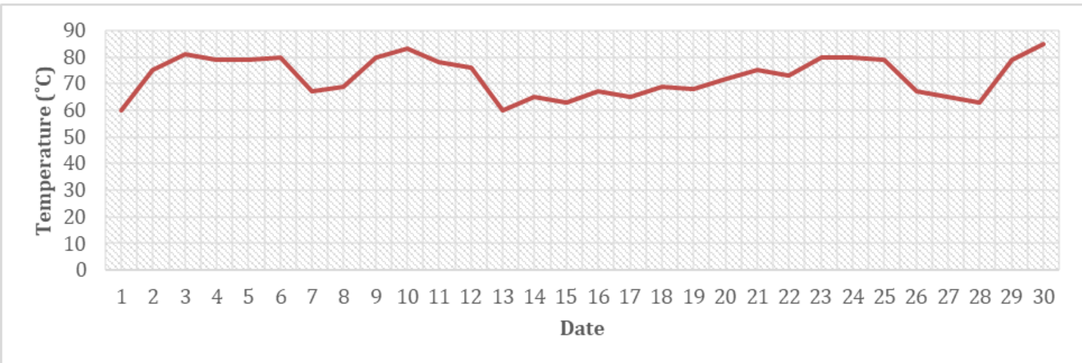

Figure 4. Temperature

From collecting data on the drying cycle during the peak production period each day over a month, the power values ranged between 2.8 to 3.0 hour, with an average of 2.9 hour, as shown in Figure 5

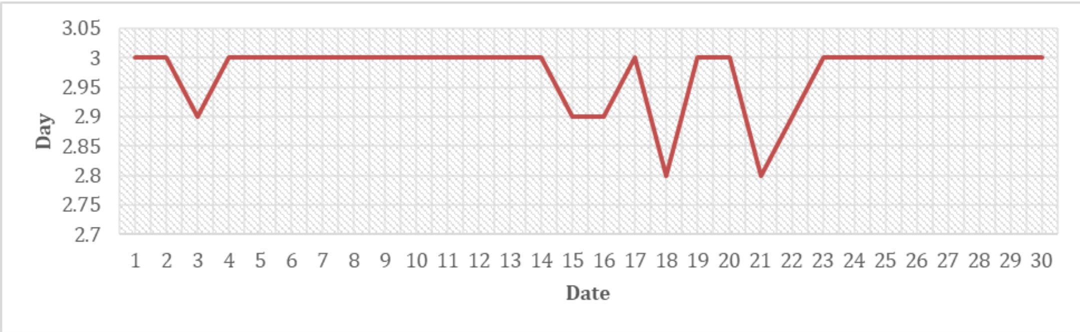

Figure 5. Drying cycle

From collecting data on quantity, the peak production period each day over a month, the power values ranged between 610 to 700 kg/day, with an average of 644, as shown in Figure 6

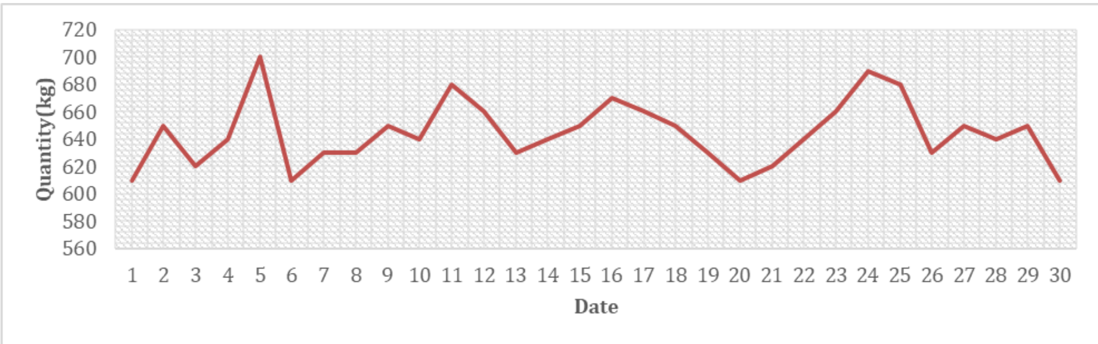

Figure 6. Quantity

From collecting data on income each day over a month, with an average of 193,300 bath, as shown in Figure 7

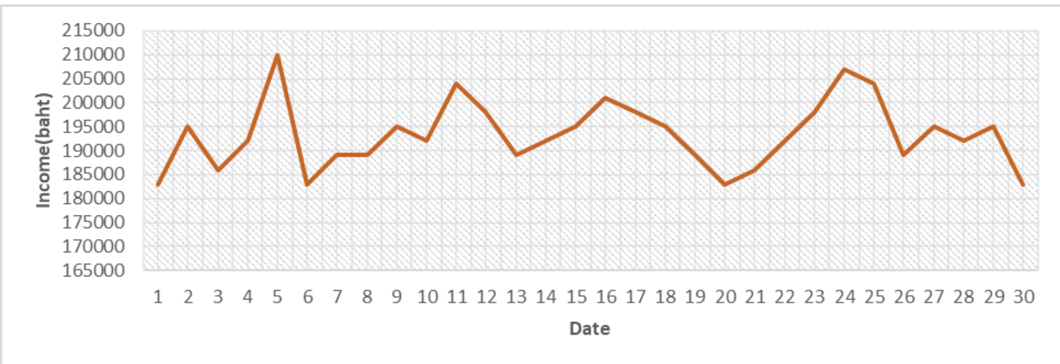

Figure 7. Income

4. Conclusions and Further Research

From experimenting with the Sago flour drying system using electrical energy from solar cells to generate supplementary heat in addition to the solar heat, it was observed that the obtained heat was sufficient for the drying requirements. The drying duration per production cycle was set at 3 hours, maintaining a consistent drying temperature throughout. This stability in drying temperature allows for precise control over both the quality and quantity of the production. Additionally, the ability to complete multiple drying cycles in a single day has increased overall production capacity due to the shorter processing time per round. The educational center on drying houses for drying Tapioca will serve as a platform aimed at disseminating two technologies simultaneously: drying houses and the utilization of solar cells for electricity generation. The objective is to enhance the quality, reduce processing time, and increase the yield of Tapioca production processes. In the investment profitability section, after evaluating the usage over a period of 3 months, it was found that breakeven would occur within six months. The remaining period would solely generate revenue, with no maintenance costs incurred for a duration of 5 years. Further research should focus on designing a sago starch drying machine to reduce drying time.

5. Patents

Author Contributions: For research articles, P.N. Conceptualized the study, The original draft was prepared by S.G. with review and editing by S.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: NA

Conflicts of Interest: The authors declare no conflicts of financial interest or personal relationships that could have appeared to influence the work reported in this paper.

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