FABRICATION AND DEVELOPMENT OF A PROTOTYPE AUTOMATED SOLAR POWERED COCOA SEEDS DRYER

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Cocoa production is a significant agricultural activity in many tropical countries, contributing to economic development and global chocolate production. Cocoa is one of the world's most valuable agricultural commodities, predominantly grown in tropical regions of Africa, Asia, and Latin America. The crop serves as a significant source of income for millions of smallholder farmers, especially in countries like Ghana, Côte d'Ivoire, and Nigeria, which account for over 60% of global cocoa production (ICCO, 2021). To preserve cocoa beans and ensure market competitiveness, effective post-harvest processing, particularly drying, is essential.

Proper drying is critical in maintaining cocoa bean quality, as inadequate drying can lead to spoilage, mold growth, and loss of market value. Drying reduces the moisture content of cocoa beans from about 60% to the desired level of 6-7%, inhibiting microbial growth, preventing spoilage, and enhancing flavor development during fermentation (Afoakwa, 2010).Traditional sun-drying methods are widely used but are labor-intensive, weather-dependent, and inconsistent in results (Koya et al., 2014). Solar-powered dryers provide a sustainable, efficient alternative by leveraging renewable energy to ensure consistent drying conditions, enhancing bean quality, and reducing post-harvest losses.

Solar drying systems, including intermittent and continuous types, have been developed over the years to address challenges in cocoa drying. These systems utilize solar energy as a heat source, reducing dependency on conventional fossil fuels and minimizing environmental impact (Afoakwa et al., 2011). Solar-powered dryers have emerged as a viable alternative to traditional methods, offering a more controlled and efficient drying process. By harnessing renewable solar energy, these systems reduce reliance on fossil fuels, lower operational costs, and mitigate environmental pollution (Koya et al., 2014). Modern solar dryers are designed to optimize drying performance through features such as thermal storage, airflow control, and intermittent drying cycles. These advancements enhance drying efficiency and preserve the biochemical properties of cocoa beans, contributing to improved quality and market value (Olunloyo et al., 2016).

Technological advancements have facilitated the design of prototype dryers, incorporating features like thermal storage and controlled airflow for optimal drying performance.

1.2 Problem Statement

Despite advancements in cocoa drying technologies, smallholder farmers in many developing regions still rely on traditional methods. These methods expose cocoa beans to unpredictable

weather conditions, pests, and contamination, leading to quality degradation and economic losses. Additionally, the lack of affordable, user-friendly drying technologies limits the adoption of improved systems among resource-constrained farmers (Zahouli et al., 2010).

The development of a prototype cocoa solar-powered dryer addresses these challenges by offering an efficient, cost-effective solution tailored to the needs of small-scale producers.

1.3.0 Aim of the Study

The aim of the project is to fabricate and develop a prototype automated solar-powered cocoa seed dryer that ensures efficient, sustainable, and uniform drying of cocoa seeds, utilizing solar energy and automation to enhance drying performance while maintaining the quality of the seeds.

1.3.1 Objectives of the Study

The objectives of this study are:

1. To design a prototype cocoa seed dryer that optimally utilizes solar energy for sustainable drying operations.

2. To develop an automation system that monitors and regulates drying conditions (temperature and humidity) for consistent drying.

3. To fabricate the dryer using locally available and durable materials to ensure cost-effectiveness and accessibility for smallholder farmers.

4. To test and evaluate the prototype's performance in terms of drying time, moisture reduction, and energy efficiency.

5. To compare the prototype's performance with traditional drying methods, highlighting improvements in productivity and quality.

6. To identify potential challenges and suggest design modifications for scalability and enhanced functionality.

1.4 Justification of the Study

This study contributes to sustainable agricultural practices by promoting the use of renewable energy for cocoa drying. The prototype dryer offers practical benefits such as improved bean quality, reduced drying time, and minimized environmental impact. By addressing the limitations of traditional drying methods, this innovation supports smallholder farmers, enhances economic outcomes, and aligns with global sustainability goals (FAO, 2020).

1.5 Scope of the Study

The scope of this study includes the fabrication and development of a small-scale solar-powered dryer prototype for cocoa beans. The study evaluates the prototype's performance in terms of drying rate, energy efficiency, and impact on bean quality. While focusing on cocoa drying, the principles and design approach can be adapted for other agricultural products requiring solar drying.