

LEVERAGING ARTIFICIAL INTELLIGENCE AND AUTOMATION FOR BUSINESS-LED GREEN TRANSFORMATION IN RICE MILLS IN MADURAI

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Abstract—This study investigates how artificial intelligence (AI) and automation might help rice mills in Madurai achieve green transformation. It emphasizes the use of smart technologies to improve energy efficiency, reduce waste, optimize manufacturing processes, and track resource consumption. AI-based solutions can assist rice mills in forecasting maintenance requirements, optimizing machinery performance, and reducing wasteful energy consumption. Automation can also increase operational efficiency and product quality while reducing resource waste. The study emphasizes the potential for technology-driven techniques to improve cost efficiency, environmental sustainability, and productivity in rice milling operations.

Keywords: Artificial Intelligence, Automation, Productivity, Rice Manufacturers, Land Preparation.

Introduction

Rice has been the staple subsistence crop for many cultivations over thousands of years. Through trial and error, subsistence farmers developed various cultural practices to deal with “pest problems”. India, the world’s second-largest rice producer and consumer, produces and consumes almost 45 million hectares of rice. Over 100 million people’s livelihoods depend on this crop. Although rice plays a major role in India’s food and nutrition security, threats like climate change, groundwater depletion, yield gaps, labour shortages, and post-harvest losses may undermine the country’s capacity to meet current needs. Productivity in rainfed and stress-prone ecological zones, which dominate much of east and northeast India, averages less than 2.2 tons per hectare. Furthermore, post-harvest losses of almost 15% of total production are also a concern. The mechanization and modernization of the rice industry led to the development of high-yield, machine-intensive methods of production.

Rice manufacturers in India are not just manufacturers; they are a tapestry of tradition, technology, and transformation. This staple food is at the heart of Indian culture and economy. For millions of people, rice is more than just a grain; it's a way of life. In this blog, we'll journey through the rice fields and mills, discovering how this beloved crop is cultivated and processed. From time-honoured practices to modern innovations, we'll explore the entire spectrum of rice manufacturing in India.

Traditional rice cultivation relies on manual labour, animal power, and natural water sources. Shift from peasant subsistence farming to mechanized commercial production. Mechanization of farm operations. Land preparation is done by introduction of iron plows, power tillers, and tractors. Planting and weeding mechanization are done through seed drills and rotary weeders. And by use of reapers, threshers harvesting is done.

Revolution in milling

1. Transition from hand-pounding to steam-powered and rubber-roll mills,
2. Increased efficiency and reduced broken grains in rice production.
3. Water management, which includes Construction of canals, deep tube wells, and electric pumps, Ensured water supply for multiple crops per year.

Traditional Rice manufacturing:

The traditional method of rice manufacturing is done by hand, using sun to dry the rice, and using wooden mortars and pestles or stone hullers to separate the edible rice grain from the husk and bran layers. **Traditional Rice Processing Steps**
Harvesting and Drying: Traditionally farmers harvest paddy by hand using sickles and then dry the bundles of harvested rice in the sun on some racks or the open ground. **Pounding (Dehusking):** Pounded mixture is tossed in the wind using shallow bamboo trays (soop) which results in the light chaff and leftover husks to drift away and leaving the heavier grains. **Hand Pounding (Whitening):** To remove the nutrient-rich bran layer and turn brown rice to white rice requires an additional gentle pounding or rubbing against abrasive stones. **Cleaning and Sorting:** Women or local artisans remove the remaining stones, dirt, and broken rice kernels by hand before storage or cooking.

Artificial intelligence Manufacturing:

This method enables rice manufacturing through the use of computer vision, machine learning, and IoT sensors to automate sorting, milling quality control, and grading with a high degree of accuracy

.How AI Empowers Rice Processing and Manufacturing.

Automatic Quality Control and Inspection: AI-powered optical systems and computer vision platforms (such as Qualitas Technologies Grain Analyzer and CGrain AI) measure individual grain length, width, chalkiness, and whiteness in seconds as opposed to hours.

- **Defect Detection and Sorting:** Machine learning algorithms identify broken kernels, discoloration, immature grains, and foreign impurities during the milling and polishing stages to reduce waste.
- **Optimization of Process:** Smart manufacturing lines modify whitening pressure, glossiness, and length-sorting in a dynamic manner based on real-time feedback from digital sensors.
- **Traceability and Packaging:** Automated grading and digital tagging assign unique identification codes to batches for strict quality compliance and uniform consumer packaging.

The green revolution and the input of capital in the production process (1960s-1980s)

High-yield varieties: Semi-dwarf, disease-resistant varieties of rice, such as IR8. •

Chemical Inputs: Stimulated by capital and the use of chemical fertilizers (N/P/K) and pesticides. •

Production boom: Allowed for doubling the yield of rice in Asia, guaranteeing food supply. Socio-economic and ecological impact •

Economic benefits: Lower prices for food due to mechanization., Increased employment due to commercialization and machinery.

Ecological challenges: Groundwater depletion, pollution of the soil, and a reduction in biodiversity.

Objectives of the study:

1. To study about the evolution of Industrial revolution with reference to Rice Industry.
2. To study the transition of traditional manufacturing into fully converted, automated self-optimising role of smart technology in manufacturing.
3. To analyse the impact of effective use of technology with reference to Rice Industry in Madurai.

Methodology:

Case Study Method was adopted for this study.

Area of Study:

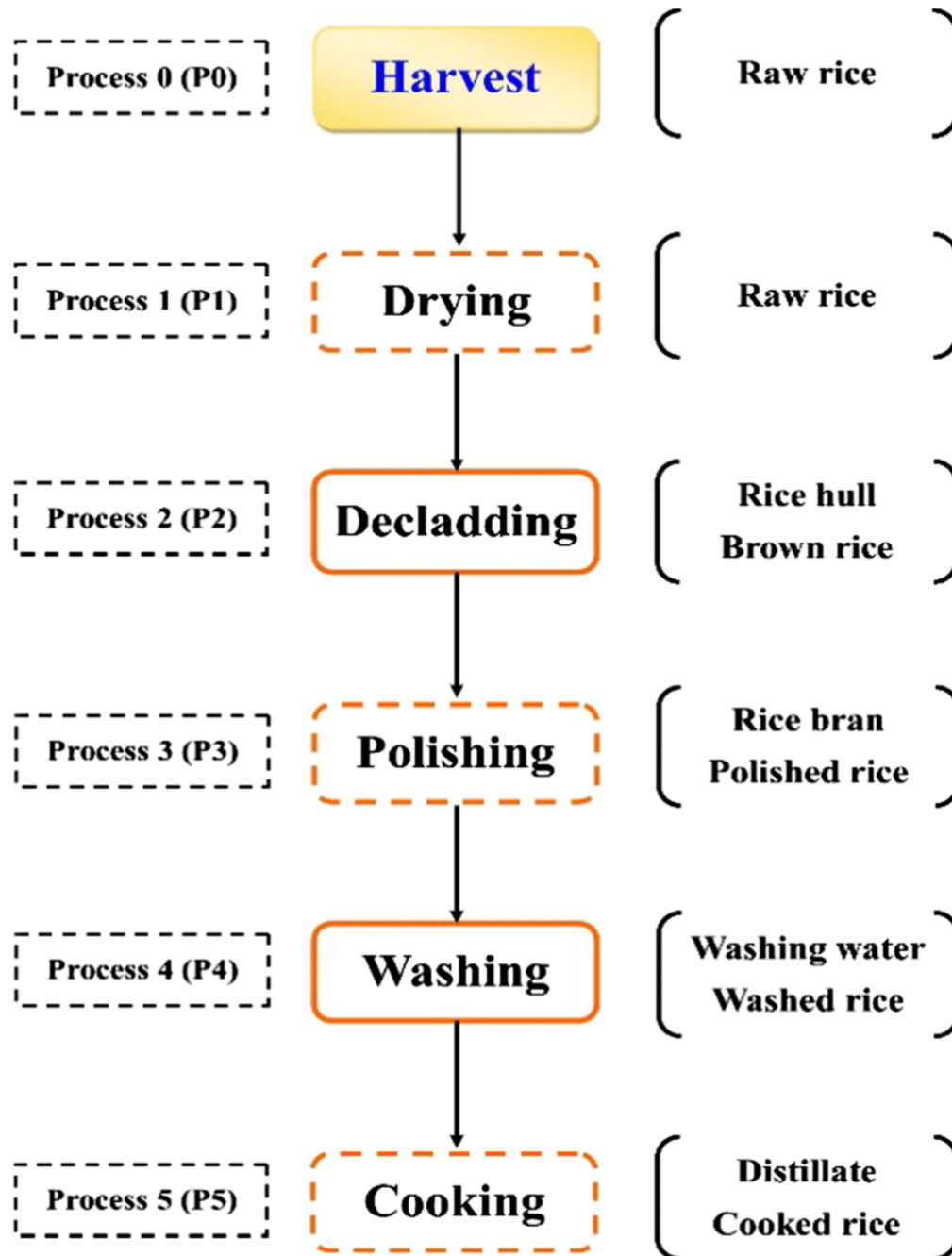
The study was conducted in Madurai.

Key Findings:

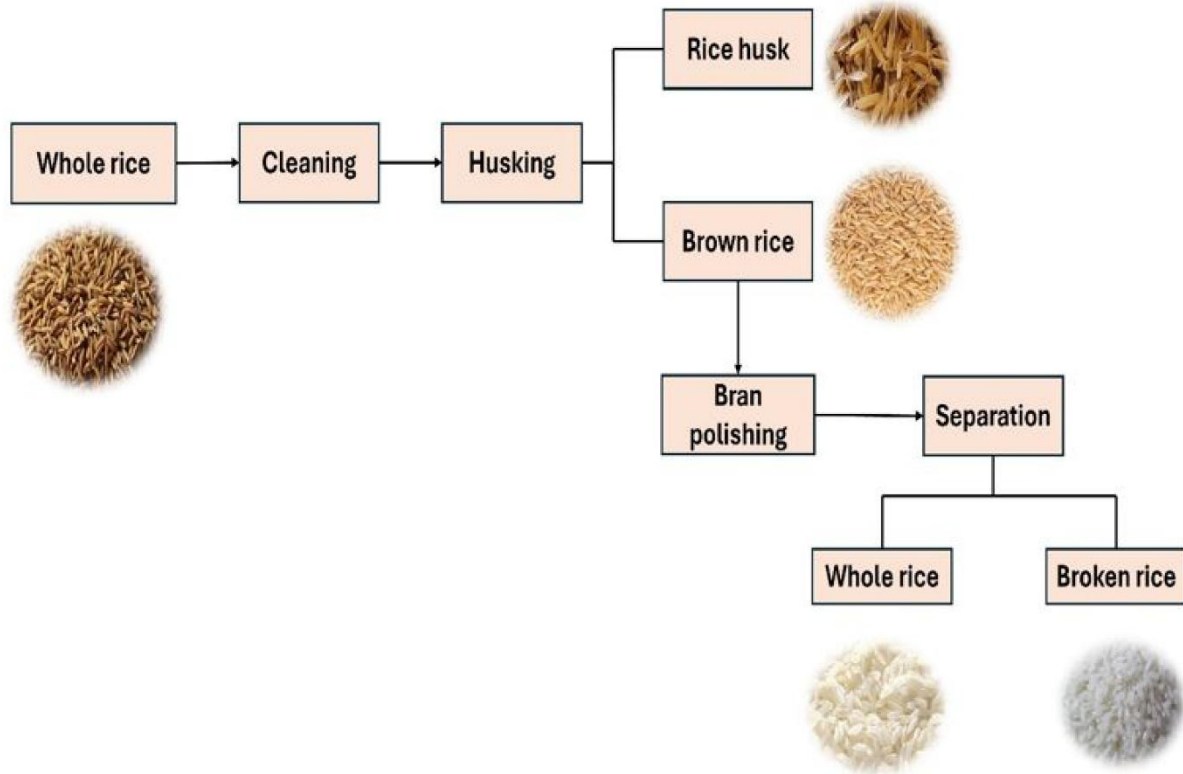
From the case study researchers came to know that , AI-powered predictive analytics, machine learning, computer vision, IoT-based monitoring, intelligent automation, and decision-making software can improve energy efficiency, reduce

material waste, increase machinery performance, optimize water and resource use, and enhance value recovery of rice by-products in rice mills.

Traditional processing procedure:



AI processing processing



Tradition harvesting



AI in Rice cultivation process



Rice Milling plant in Madurai



Implications of the Findings:

The rice milling industry is a crucial component of the agricultural and food-processing economy but faces energy consumption, resource use, production efficiency, waste generation, and environmental sustainability challenges. The rise of Automation Artificial Intelligence (AI) offers rice mills an opportunity to transform traditional production processes into intelligent, resource-efficient, and environmentally responsible business processes. This article aimed to demonstrate the potential of AI as a business-led mechanism for green transformation in rice mills. The article discussed how AI can be leveraged in procurement, milling operations, quality control, energy management, maintenance, waste management, logistics, and decision-making. The article highlighted the business benefits of AI adoption, including operational efficiency, cost reduction, improved product quality, resource optimization, waste minimization, and long-term sustainability. At the same time, it identified challenges such as investment requirements, digital infrastructure, data availability, employee skills, cybersecurity, and technological change resistance. The article proposed an AI-powered green transformation framework for rice mills that balanced economic performance and environmental responsibility. It concluded that AI could become an important strategic enabler for rice mills that sought to achieve sustainable growth while enhancing competitiveness and operational resilience.

Conclusion:

Artificial intelligence is not a matter of the future for the rice manufacturing industry. It is rather a necessity of the present. Advanced milling technologies, enhanced by artificial intelligence, combined with automated sorting and predictive maintenance, ensure the reduction of wastes and expenses, as well as the stable production of high-quality products. Such benefits help the manufacturers to maintain competitiveness on the global market.

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