Comprehensive Waste Management Plan for Rice Milling Industry in Odisha

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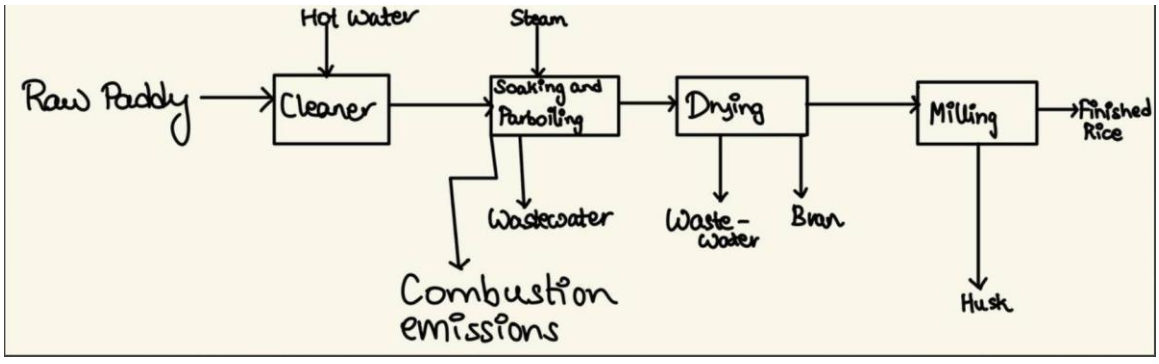
1. Industry Selection: Rice Milling in Odisha

Odisha is a major rice-producing state with numerous rice mills, especially in districts like Bargarh, Sambalpur, and Kalahandi. I live in Odisha and I have seen all this up close. Thus I chose this. These mills produce large amounts of waste, primarily:
- Solid waste: Rice husk, bran
- Liquid waste: Parboiling wastewater

[Parboiling, also known as converting or partially cooking, is a hydrothermal treatment applied to paddy rice before milling. It involves soaking, steaming, and drying the paddy, resulting in a product called parboiled rice. This process aims to improve the nutritional value, cooking quality, and reduce breakage during milling.]
- Gaseous emissions: From steam generation using husk

2. Process Flow Diagram and Material/Energy Balances

Simplified Process Flow Diagram:



Byproducts: Husk, Bran, Wastewater, Combustion Emissions (released due to parboiling)

Material Balance (for 1,000 kg of paddy):

Input	Quantity
Raw Paddy	1,000 kg
Water (Parboiling)	12,000 L
Energy (Steam from Husk)	150 kWh

Output	Quantity
Milled Rice	650 kg
Husk	200 kg
Bran	80 kg
Broken Rice/Dust	70 kg
Wastewater	12,000 L

3. Waste Streams and Current Handling

Solid Waste:
- Rice Husk: Partially burned, rest dumped or sold
- Bran: Sold for oil or cattle feed

Liquid Waste(wastewater):
- Effluent from parboiling: High BOD(biological oxygen demand), usually untreated

Gaseous Emissions:
- Particulate matter, CO, SO_2, NOx from husk combustion(during parboiling)

4. Optimization Strategies

Proposed Interventions:
- Install anaerobic digester and constructed wetlands for wastewater
- Use husk gasifier for cleaner combustion
- Extract oil from bran on-site
- Replace steam dryers with solar-assisted dryers

Before vs After Comparison:

Metric	Baseline	After Optimization
Husk Utilization	~60% burned, rest dumped	90% gasified
Wastewater Discharge	Untreated	Treated + reused
Bran Utilization	Sold raw	Value-added (oil)
Energy Consumption	150 kWh/ton	110 kWh/ton(lower)

5. Life Cycle Assessment (LCA) and Product Carbon Footprint (PCF)

Baseline Scenario:
- High emissions from husk burning
- Water pollution from untreated wastewater
- No carbon capture or offset mechanism

Optimized Scenario:
- Husk gasification reduces PM and GHGs
- Wastewater treatment and reuse
- On-site oil extraction reduces supply chain emissions

Qualitative Impact Summary:

Impact Category	Baseline	Optimized
Global Warming	High	Medium

Water Pollution	Severe	Controlled
Resource Efficiency	Low	High

6. Cost-Benefit Analysis (in ₹)

Estimated Costs (for 10 Tons per day mill)[Taken from references]:

Item	Cost (₹ Lakhs)
Husk Gasifier	8.0
Effluent Treatment Plant	5.0
Solar-Assisted Dryer	6.0
Bran Oil Unit	4.5
Total CAPEX(Capital Cost)	23.5

Annual Savings/Revenues:

Source	Savings/Revenue (₹ Lakhs/year)
Fuel Cost Savings	4.5
Water Reuse Savings	1.5
Bran Oil Revenue	3.0
Avoided Fines	1.0
Total Annual Benefit	10.0

Payback Period: ~2.4 years(lesser than before)

All this data is taken from the resources.

7. Final Recommendations

1. Adopt husk gasification for cleaner and more efficient energy use.
2. Install ETP systems and reuse wastewater in parboiling and cleaning.

3. Implement value addition for bran through oil extraction.
4. Deploy solar-assisted dryers to reduce energy consumption.

Environmental Gains:
- Reduced GHG emissions
- Lower water pollution
- Better resource utilization

Economic Benefits:
- Short payback period
- Reduced recurring costs
- New revenue sources

8. References

1. Odisha Rice Millers Association Reports
2. CPCB Guidelines for Rice Mills
3. IPCC Emission Factors (2021)
4. MNRE – Renewable Energy for Agro Industries
5. Academic Journals on LCA of Rice Milling (ScienceDirect, Springer)