PROPOSAL ON THE NASENI COMMERCIALIZATION RESEARCH GRANT PROGRAMME

Project Title: Development of an Affordable Solar Photovoltaic Powered Vehicle-Trailed System for Rice Threshing Machine for Off-Grid Farming Communities

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Team of Co-Researchers

1. Tgst Agbomabinu Emmanuel – Co-Researcher
   Focused on energy efficiency, thermodynamic simulation
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   an Engineer with expertise in modeling (CAD design, renewable energy systems, and composite material applications in sustainable engineering solutions.
3. Engr. Aju Adonis – Co-Researcher
   Skilled in structural design, fabrication, and modular engineering systems.
4. Udeh Cajethan- A seasoned fabricator and a machinist

Executive Summary

Threshing of rice is one of the pertinent post-harvest problems among smallholder rural farmers in Nigeria. The current practices of threshing are either manual or by diesel-engine threshers, which are either labor-inefficient or costly to operate considering the rising cost of fuel and unavailability of grid electricity. The study herein proposed will design, develop, and commercialize a solar photovoltaic (PV) powered, vehicle-trailed rice threshing system as a low-cost, mobile, and environment-friendly solution for off-grid farm settlements.

Studies (Kumar et al., 2018; Ahmed & Miah, 2019; FAO, 2020; IRENA, 2021) have established the viability of solar power in agricultural application. However, there have not been many that have integrated PV systems with portable threshing machines, especially those adaptable to local terrains. This project will try to fill this gap by developing a trailered, modular solar-battery system that is engineered for field mobility and ease of operation.

The innovation is aligned with Nigeria's Agricultural Promotion Policy (APP), Rice Transformation Agenda, and the National Rice Development Strategy, and aligns with SDG 2 (Zero Hunger) and SDG 7 (Affordable and Clean Energy).

The project targets advancement from Technology Readiness Level (TRL) 4–5 to TRL 7–8, leading to a commercially competitive, locally manufactured prototype.

1. Problem Statement

Rice is a staple food in Nigeria, yet threshing remains a significant bottleneck in the post-harvest value chain. Manual threshing is labor-intensive, time-consuming, and inefficient, while diesel-powered machines increase production costs and contribute to pollution.

Challenges identified include:

- **High operational cost** due to fuel dependence.
- **Inaccessibility** of electricity in off-grid farming communities.
- **Limited affordability** of imported combine harvesters.
- **Low mechanization levels** among smallholder farmers.

A **solar-powered, vehicle-trailed rice threshing system** will overcome these limitations by providing **clean, mobile, and affordable energy** for efficient post-harvest processing.

2. Aim and Objectives

Aim:

To design, develop, and commercialize a **low-cost, vehicle-trailed solar photovoltaic system** capable of powering a rice threshing machine for off-grid farming operations.

Specific Objectives:

1. To design and integrate a PV-powered system with a mobile, vehicle-drawn chassis.

2. To evaluate the energy and mechanical requirements of common rice threshing units.
3. To fabricate and test a functional prototype under laboratory and field conditions.
4. To optimize system performance through PV-battery configuration and load matching.
5. To conduct techno-economic and environmental impact assessments.
6. To establish commercialization and scalability models for Nigerian and West African markets.

3. Methodology

The project will be executed in **six (6) main phases:**

I. **Literature Review and Concept Development**
   - Review of solar-powered agricultural systems and threshing technologies.
   - Identification of design parameters and performance benchmarks.

II. **System Design and Simulation**
   - Power requirement estimation.
   - Selection of solar panels, batteries, and control electronics.
   - Design of a lightweight, vehicle-trailed chassis for field mobility.

III. **Fabrication and Assembly**
   - Procurement of local materials and system components.
   - Integration of PV-battery system with electric motor and threshing unit.

IV. **Testing and Evaluation**

- Laboratory testing for output (kg/hr), efficiency, and energy consumption.
- Field trials under real farm conditions.

V. **Techno-Economic Analysis**

- Comparative analysis with diesel-powered systems.
- Life cycle cost, payback period, and sustainability evaluation.

VI. **Commercialization and Training**

- Business model development.
- Farmer demonstration, awareness creation, and youth engagement.

4. Innovation and Novelty

The proposed system introduces several innovative features:

- **Solar-Battery Hybrid Power:** Eliminates fossil fuel dependency.
- **Vehicle-Trailed Design:** Ensures high mobility and accessibility across farmlands.
- **Local Fabrication:** Uses indigenous materials and skills for cost reduction.
- **Optimized Control Electronics:** Improved energy efficiency through smart load management.
- **User-Centric Design:** Simple operation suitable for low-literacy rural users.

5. Commercial Viability and Market Potential

- Nigeria cultivates **over 5 million hectares of rice** annually — a vast potential market.

- The system can **reduce fuel costs by 40–60%** compared to diesel alternatives.
- Adaptable for **cooperative and youth-led enterprises**, enabling shared ownership models.
- Creates **employment** in local fabrication, assembly, and servicing.
- Future potential for adaptation to **other agro-processing units** (maize shellers, millet threshers, etc.).

6. Alignment with NASENI's Mandate

This project directly supports NASENI's objectives by:

1. Promoting indigenous research commercialization in renewable energy and agri-tech.
2. Advancing local manufacturing capacity in mechanical and electrical technologies.
3. Supporting rural industrialization and national food security goals.
4. Reducing Nigeria's dependence on imported agricultural machinery.
5. Contributing to climate action through reduced carbon emissions.
6. **Technology Readiness Level (TRL)**

S/N	TRL Stage	Description	Current Status
1	TRL 4	Component and lab-scale validation	Completed
2	TRL 5	Prototype development initiated	Ongoing

3	TRL 6	Engineering-scale prototype tested	Planned (Year 1)
4	TRL 7	Field pilot demonstration	Planned (Year 2)
5	TRL 8	Commercial prototype ready for deployment	Target outcome

With NASENI's support, this project will move from TRL 5 to TRL 8, achieving market readiness.

8. Potential for Scale and Sustainability

- **Modular Design:** Scalable for small, medium, or large-scale farmers.
- **Replicability:** Adaptable across rice-producing regions in West Africa.
- **Environmental Sustainability:** Zero emissions and reduced fuel dependency.
- **Economic Sustainability:** Lower running costs, fast payback period (<3 years).
- **Social Sustainability:** Job creation, rural empowerment, and gender inclusion.
- **Policy Alignment:** Supports Renewable Energy Policy, Agricultural Mechanization Plan, and SDGs 2, 7, 8, and 9.

9. Expected Outcomes and Impact

Technical Outputs

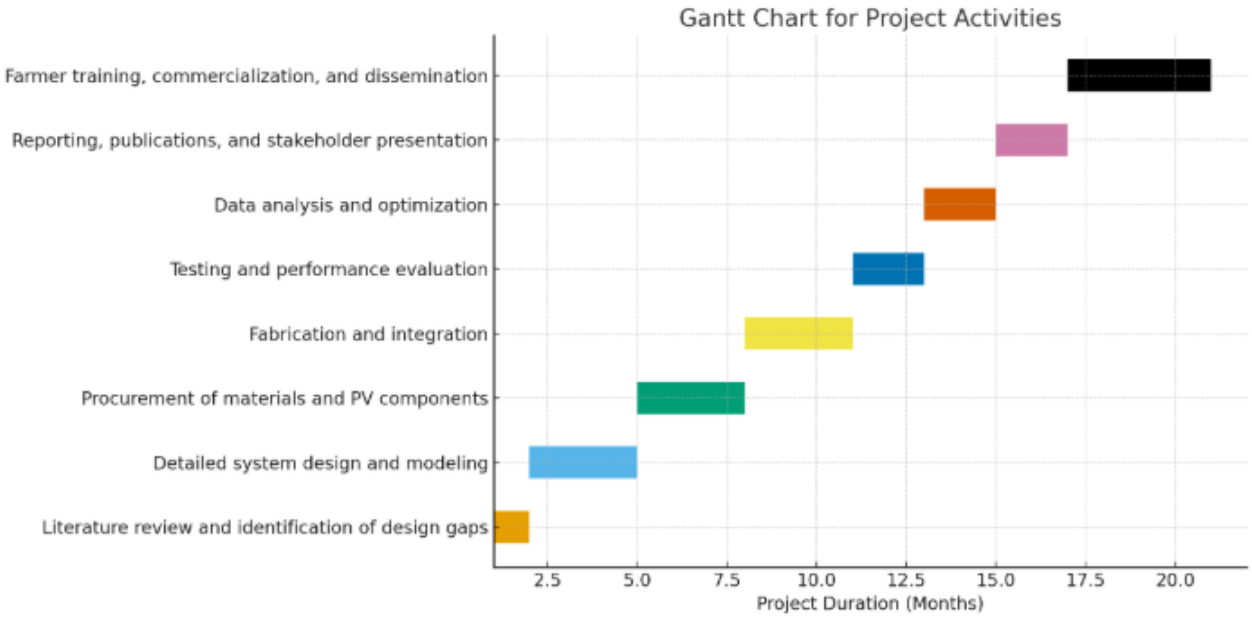
- A functional, low-cost, solar-powered mobile rice thresher.

- Published design and performance data for local manufacturers.

Socio-Economic Impacts

- Improved rice production efficiency and reduced post-harvest losses.
- Enhanced local fabrication and renewable energy adoption.
- Job creation for rural artisans, welders, and technicians.
- Strengthened food security and reduced rural poverty.

10. Activity Timeline



11. Budget Estimate and Justification

S/N	Item Description	Quantity	Unit Cost (₦)	Total (₦)
1	Solar panels (300W each)	4	500,000	2,000,000
2	Battery (12V,	4	400,000	1,600,000

	100Ah, deep cycle)			
3	MPPT Charge Controller	2	300,000	600,000
4	DC Electric Motor (1–2 HP)	1	450,000	450,000
5	Fabrication of trailer/chassis	1	3,700,000	3,700,000
6	Rice threshing unit (custom-built)	1	4,400,000	4,400,000
7	Inverter	1	1,200,000	1,200,000
8	Wiring, switches, and mounting hardware	-	500,000	500,000
9	Awareness, training, and dissemination	-	3,500,000	3,500,000
10	Contingency 10%			1,754,500
11	**Total cost**			**₦19,299,500**

12. Commercialization Strategy

1. **Prototype Demonstration:** Validate performance and gather farmer feedback.
2. **Local Fabrication Partnership:** Collaborate with NASENI engineering centers for pilot production.
3. **Business Model:** Lease-to-own and cooperative-based distribution for affordability.

4. **Stakeholder Engagement:** Partnerships with BOA, FMARD, and youth cooperatives.
5. **Scaling:** Transition from pilot to regional manufacturing within 24 months.

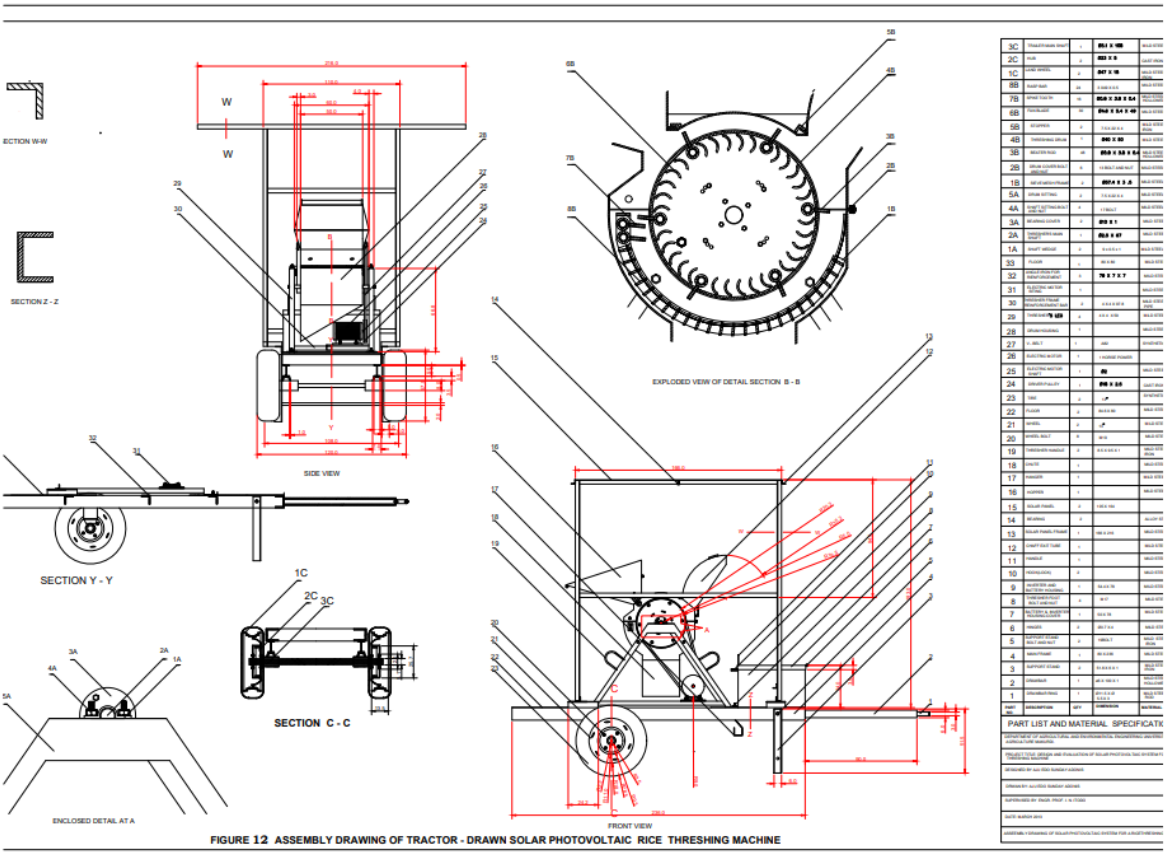


Figure 1: CAD Modeling Of the Rice Thresher

13. Conclusion

This project presents an innovative, affordable, and sustainable solution for post-harvest rice processing in Nigeria's off-grid farming communities. The Solar PV Powered Vehicle-Trailed Rice Thresher aligns with NASENI's mandate to promote indigenous technology development and commercialization.

Its implementation will enhance agricultural productivity, reduce rural poverty, foster renewable energy adoption, and contribute to Nigeria's food security and industrialization goals.

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