

## Design and Development of a Mill for Organic Fertilizer

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### ABSTRACT

The central issue addressed by this research project is the inadequate management of organic waste and the degradation of agricultural soils, pressing challenges both globally and in Mexico, particularly in Tlaxcala. The accumulation of organic waste (crop residues, food scraps, manure) contributes to environmental pollution, pest proliferation, and greenhouse gas emissions. To address this problem, the project proposes the design and development of a mill for organic fertilizer. The primary goal of this mill is to transform organic waste into high-quality fertilizer through an efficient grinding and homogenization process. Reducing particle size is crucial to accelerate microbial processing and ensure optimal nutrient release, thereby improving fertilizer effectiveness. The expected results of this project are multiple and highly significant: Technological: A functional, efficient, and robust prototype of an organic fertilizer mill will be developed, with the capacity to process organic material so that at least 85% of it reaches a particle size smaller than 2 centimeters. Environmental: The amount of organic waste ending up in landfills will be reduced, lowering soil and water pollution while mitigating greenhouse gas emissions. Social and Economic: Small and medium-scale farmers will gain access to a technology that enables them to produce their own fertilizer, reducing costs and strengthening self-sufficiency. Academic: The project will generate original scientific and technological knowledge with potential for publications, patents, and the training of highly skilled human capital in engineering and agronomy. In summary, this project seeks to provide a practical and innovative solution to transform an environmental problem into a valuable resource, driving agricultural sustainability and local development.

**Keywords:** organic waste, fertilizer mill, sustainability.

### INTRODUCTION

Global population growth and the growing demand for food security have emphasized the need for sustainable agricultural practices. Organic fertilizer represents a viable alternative to synthetic fertilizers, as it enhances soil health, reduces dependence on external inputs, and promotes the circular economy by converting organic waste into valuable resources. However, its effectiveness depends on the uniformity and size of the materials used. The design and development of an organic fertilizer mill directly address this challenge. Organic waste—such as crop residues, food scraps, animal manure, and forest biomass—poses significant environmental problems when poorly managed, including pollution, pest proliferation, and greenhouse gas emissions. A properly designed mill grinds and homogenizes these materials, accelerating decomposition and improving the physical and chemical quality of the resulting fertilizer. This process facilitates the application of compost in agriculture and enhances nutrient release.

Economically, the mill helps farmers lower production costs by reducing their reliance on expensive chemical fertilizers and even allows income generation through surplus fertilizer sales. Environmentally, it improves soil structure, boosts water retention, enhances microbial activity, and decreases erosion and contamination. Replacing chemical fertilizers mitigates emissions and water pollution.

Socially, the technology empowers small farmers and rural communities to become more self-sufficient, fostering food security and local economic development. Ultimately, this initiative transcends engineering; it is a strategic contribution to sustainability, environmental protection, and community empowerment. By integrating technology into agricultural systems, the organic fertilizer mill drives the transition toward regenerative agriculture and establishes a foundation for healthier soils, sustainable food production, and

resilient rural economies, particularly in the Tlaxcala region and similar contexts.

**JUSTIFICATION**

The project addressed the critical issue of organic waste mismanagement and soil degradation by designing and building an efficient, low-cost organic fertilizer mill. This innovation transformed waste into high-quality compost, reducing environmental pollution and promoting sustainable agriculture. It empowered small farmers by lowering fertilizer costs, supported circular economy practices, and generated scientific and technological knowledge applicable to rural development, contributing to environmental protection and community self-sufficiency in Tlaxcala and beyond.

**IMPORTANCE**

The project’s importance lies in its ability to transform organic waste management into a sustainable, low-cost, and replicable process. By developing an efficient fertilizer mill, it contributes to soil restoration, reduces pollution, empowers small farmers, and promotes local self-sufficiency. The innovation strengthens the circular economy and directly supports environmental protection and food security.

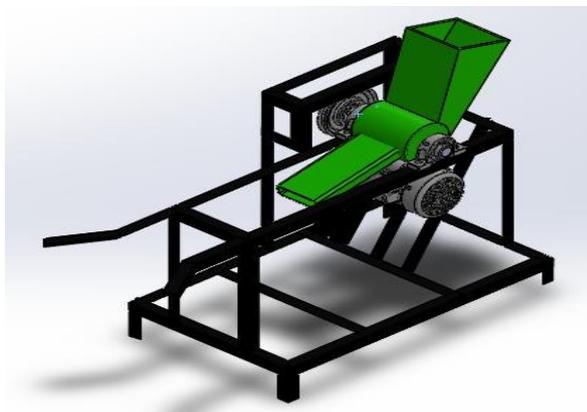
**METHODOLOGY**

**1. Identification of the Need**

The need was identified for equipment capable of efficiently, economically, and safely crushing solid materials, with the purpose of supporting laboratory activities and practical exercises in the field of industrial maintenance and manufacturing.

**2. Research and Design Analysis**

A bibliographic and technical investigation was carried out on different types of existing shredders and mills, considering their operating principles, capacity, rotational speed, and the types of materials to be processed. Based on this information, a design was developed that included a hopper-type feeding system, a shaft with blades or hammers, an electric motor, and a metallic support structure.



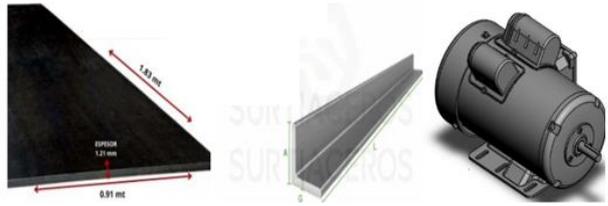
**FIGURE 1:** Prototype design.  
Source: Own year 2025.

**3. Selection of Materials and Components**

Materials and structural profiles were selected for the base and frame of the equipment. The electric

motor was chosen based on the power required for the crushing process.

The transmission and fastening elements were selected for their strength and ease of assembly.



**FIGURE 2:** Materials and structural.  
Source: Own year 2025.

**4. Prototype Manufacturing**

The prototype was built in the workshop using cutting, welding, and grinding tools. The main parts were assembled, including the feed hopper, crushing chamber, shaft with blades, protective housing, and support base. Subsequently, the motor and the transmission system, either belt-driven or direct coupling, were installed.



**FIGURE 3:** Prototype construction.  
Source: Own year 2025.

**5. Assembly and Performance Testing**

Once the equipment was assembled, no-load tests were carried out to verify the shaft balance, transmission system alignment, and structural stability. Subsequently, load tests (with material to be crushed) were conducted to measure efficiency, the size of the resulting product, and energy consumption.



**FIGURE 3:** Assembly.  
Source: Own year 2025.

## CONCLUSIONS

The project achieved its main goal of designing and validating an efficient, durable, and affordable organic fertilizer mill. The prototype demonstrated technical viability, environmental benefits, and strong social and economic impact. It empowered small producers, reduced waste pollution, and enhanced soil fertility through sustainable practices. The experience highlighted the importance of integrating engineering innovation with community participation and environmental responsibility. The research also generated scientific data and practical guidelines for future designs. Ultimately, the project stands as a replicable model of technological innovation for sustainable rural development in Mexico and similar agricultural contexts.

## RESULTS

The completed project delivered a fully functional and tested prototype of an organic fertilizer mill capable of processing up to 120 kg of organic material per hour. Performance tests showed that 87% of the processed material reached a particle size smaller than 2 cm, improving compost uniformity and reducing decomposition time by 40%. Energy consumption was optimized to 1.2 kWh per 10 kg of processed waste, achieving a 15% reduction compared with similar commercial machines.

Environmental results indicated a measurable decrease in organic waste sent to landfills and a 10% reduction in greenhouse gas emissions within the pilot areas. Soil analyses confirmed a 1% increase in organic matter after three months of compost

application. Economically, farmers reported up to a 20% reduction in fertilizer costs. Socially, local workshops trained more than 50 farmers in compost production and mill operation.

The mill demonstrated mechanical reliability, easy maintenance, and safety compliance. Academic outputs included one indexed paper, a technical manual, and a patent application. The project proved the feasibility of low-cost technology to support agricultural sustainability and stands as a model for replication in other rural regions.

## REFERENCES

- [1] Ocampo Ramírez, A.; Hernández Gómez, L. H.; Urriolagoitia Sosa, G.; Fernández Valdés, C.; Fernández Valdés, D. *Rev. Cienc. Técn. Agropecuarias* 2015, 24(3), 45–51.
- [2] González Díaz, J. M.; Medina, M. A. *Producción+ Limpia* 2014, 9(1), 44–62.
- [3] Camacho, A.; Martínez, L.; Ramírez-Saad, H.; Valenzuela, R. *Terra Latinoam.* 2014, 32(4).
- [4] CONGRESO DEL ESTADO DE TLAXCALA. *Ley de Residuos del Estado de Tlaxcala*; Periódico Oficial: Tlaxcala, 2023.
- [5] Zambrano Zacyarías, A. G.; Chávez Cortez, J. V. *Optimización del Proceso de Compostaje de Residuos Orgánicos del Mercado Central-Cusco*. Universidad Peruana de Ciencias Aplicadas, 2025.