Uganda Martyrs University

Faculty of Agriculture

Master of Science in Agroecology

RESEARCH PROPOSAL

Title: Estimation of Energy Potential from Biomass Residue in Mali Cotton Belt: implication to clean energy access and environmental sustainability

Case of Crops residue and livestock waste in Zoumana-diassa and Nafegue

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HCE Solution Project

Kampala, 2025

Plan

- Introduction
- Problem STATMENT
- Objectives
- Research question/hypothesis
- Materials and Methods
- Expected results
- Bibliography

Introduction(1/5)

Unquestionably, human activities contribute sequentially to climate change, and one of the biggest causes is the use of fossil fuels to provide energy. It was concluded that 75% of the world's energy is provided by fossil (1), whereas the combustion of fossil fuels leads to augment amount of carbon dioxide(co_2) and other greenhouse in the atmosphere, which in turn is seriously linked to increase global temperature (IPCC,2023).

Introduction(2/5)

Besides the climate change concern, fossil fuels are increasingly expensive, because of being a limited resource regarding growing demand. However, energy access is crucial factor in any nation socio-economic development and has presented significant global challenges, impacting all aspect of human existence.

Once this had been identified as an international concern

Introduction(3/5)

The United Nations Framework Convention on Climate Change (UNFCCC), through its various agreements and treaties, has obligated signatories to reduce greenhouse gas emissions. Each member state is invited to propose specific measures aimed at achieving this goal (UN, 1997; COP19). Consequently, researchers have increasingly focused on evaluating and comparing alternative energy sources.

Introduction(4/5)

In the face of this situation , bioenergy is one possible form of renewable energy that can be address to supply part of the country portfolio. The use of livestock waste and crop residue as renewable energy source for the generation of heat and electricity has been investigated in various countries and has highlights the effectiveness of biogas derived from livestock waste and crop residue as a mean of generating energy.

Introduction(5/5)

However, in Mali, the assessment of the renewable energy potential of agricultural waste remains limited. While a recent study has estimated at 116,219 TJ/Y the potential of bioenergy(R. Bhandari,2024). Furthermore, the study didn't evaluate the environmental aspect for the adoption of this energy, nor the suitable amount and primary data. It is to some of these fields of research, not yet elucidated or partially studied, that this work attempts to provide answers.

Problem Statement(1/2)

Despite the growing attention to biomass especially (crop residue and livestock waste) as a renewable energy source, Mali still relies heavily on wood fuel for energy production especially for cooking energy (DGEF,2024);whereas the country produces a huge quantity of biomass residue estimated at **5516kt**(R. Bhandari,2024).

Further study reveals that the management of these residues constitutes a critical bottleneck for these communities(CMDT,2024).

Problem Statement(2/2)

Up to now, the only alternative to handle these residues remains traditional, such as open burning and burial both of which are harmful for the environment(IPCC,2023).

Given the growing energy demand and climate concerns, it is crucial to study the energy potential of these residues. Such an assessment will not only highlight their contribution to clean energy access but also inform strategies for reducing GHG emissions and environmental degradation.

Objectives

Aim/ specifics

- **to evaluate the sustainable amount of biomass residue that can be generated for modern energy, and the life cycle environmental impact of using it. standard procedures are applied, considering global and regional bioenergy sources and local variation.**

To identify the type and quantities of underutilised biomass residues available.

To estimate the energy potential from these available biomass residues.

to determine the environmental implications of the biomass energy system through LCA

Research question

How can underutilised biomass residues from ROI be sustainably converted into clean energy sources while reduce environmental degradation?

Hypothesis

- **Biomass residues generated in the ROI have significant energy potential that is currently untapped.**

Hypotheses

- **H1: Biomass residues in the cotton belt contain a significant untapped source of clean energy.**
- **H2: The conversion of crop residue and livestock to bioenergy in the cotton belt has some environmental impact.**

MATERIALS AND METHODS

- **Research design**

This study will be conducted through a cross-sectional research design applying a quantitative method integrating elaborate structural equation models.

MATERIALS AND METHODS

- **Target population**

The target population comprises farmers and animal husbandry practitioners who reside in the study area for at least six months.

They will be selected purposely, looking at the above statement.

MATERIALS AND METHODS

- **Source of Data**

The data requirement for this research work will be both primary and secondary. Farmers will be selected purposively for each subarea based on their production system. The entire target population will be considered for both subareas.

In other words, the procedure will be census.

MATERIALS AND METHODS

- **Source of Data**

Primary data: data will be collected regarding agricultural practices and livestock situations. The study will focus on key parameters such as:

- **Crop yield**
- **Cultivated area**
- **Livestock type and population**
- **Crop and manure management.**

MATERIALS AND METHODS

- **Secondary Data**

Secondary data will be collected from published studies, government reports, agricultural databases(Gavi), and scientific literature. This process will help us address gaps where primary data might be unavailable.

Data collection strategy: Questionnaire

Data collection approach: Interview

Data collection tools: KoboToolbox, papers

MATERIALS AND METHODS

- **DATA ANALYSIS METHODS/CROP RESIDUE**

❖ **Residues demand for animal feeding**

- **The DMC of sheep and goats as shown**

Uresk's, the DMC of matured cattle of an average weight, ranging from 363 to 636 kg, can Using the equation:

$$DMC = 6.34 + 0.014 \times \text{cow weight}$$

$$DMC = 2.95 + 0.02 \times \text{calf weight}$$

- **The DMC of sheep and goats as shown**

$$DMC = 0.04 + BW_{actual} \left(1.7 - \frac{BW_{actual}}{BW_{matured}}\right)$$

MATERIALS AND METHODS

- **DATA ANALYSIS METHODS/CROP RESIDUE**

❖ **Residues demand for mulching**

The standard quantity of residues needed for Mulching of cropland is in the range of 2.5-3.75 t/hm Since tubers require more nutrients, a higher value of 3.5 t/hm was assigned to tubers, while 3.0 t/hm and 2.5 t/hm were allocated to Cereals and legumes, respectively.

MATERIALS AND METHODS

- **Surplus crop Residue energy potential in Biogas.**
- **$E_{biogas,cr}(j) = \sum SRCP(i,j) \times DM(i) \times YC_{H4}(i) \times UC_{H4}$**
- **where $E_{biogas,cr}(j)$ is the biogas energy potential at the jth region (TJ/y); SCRP(i,j) is the sustainable residue crop potential for the ith crop at the jth region (t/y); DM(i) is the dry matter content of the ith crop (-); YC_{H4} is the methane yield of the ith crop (m CH_4 /t DM); and UC_{H4} is the energy density of methane in (TJ/m).**

MATERIALS AND METHODS

- **DATA ANALYSIS METHODS/LIVESTOCK**

Livestock waste refers to the dung produced by farm animals.

$$SLW\ P(j) = \sum NA(i, j) \times YM(i) \times AF(i) \times Dy$$

where SLWP(j) is the sustainable livestock waste production at the jth region (t/y); NA (i,j) is the number of heads of the ith animal at the jth region; YM (i) is the daily manure yield of the ith animal in [t/(day·animal)]; AF(i) is the availability factor for the ith animal (-); and Dy is a conversion factor representing the number of days in a year (d/y), i.e.,

MATERIALS AND METHODS

- **DATA ANALYSIS METHODS/LCA**

Life Cycle Assessment (LCA) is systematic method for evaluating the environmental impacts of a product throughout its entire life cycle, encompassing four key stages:

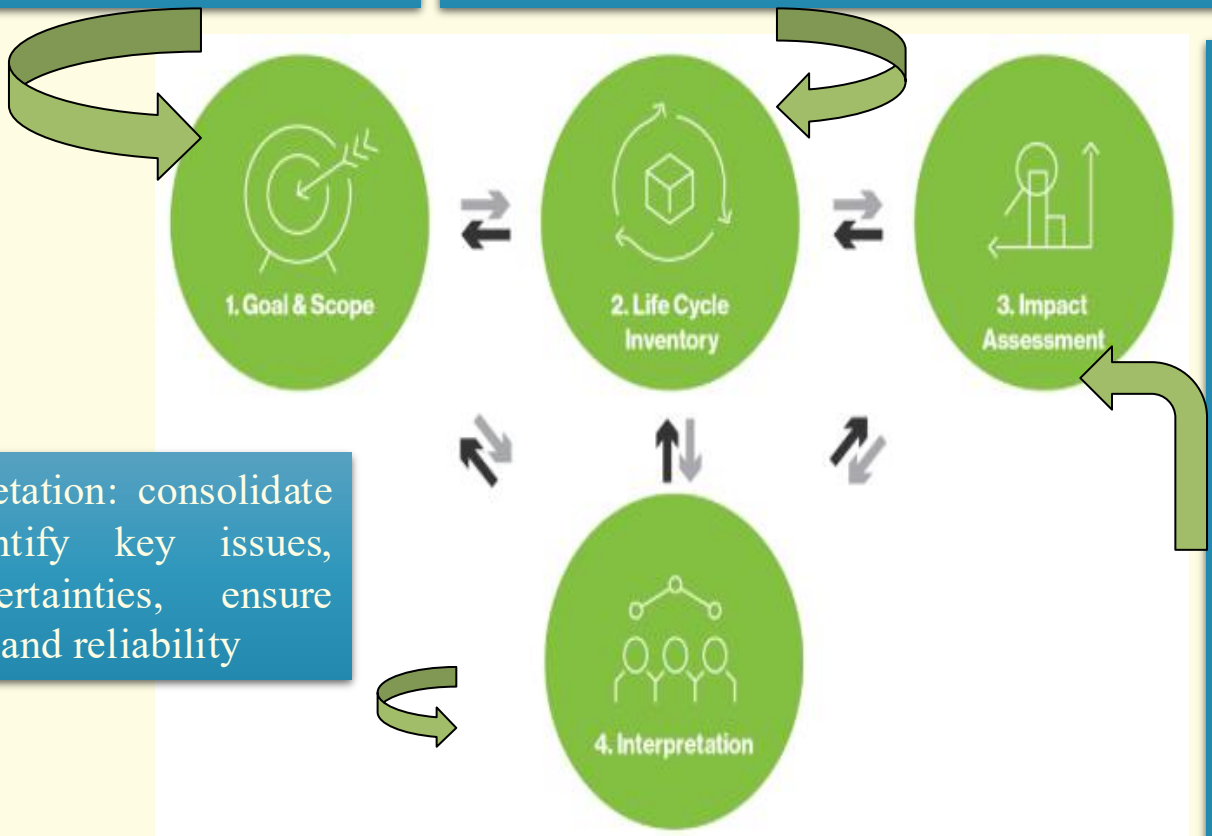
- **goal and scope definition;**
- **inventory analysis;**
- **impact assessment;**
- **and interpretation.**

MATERIALS AND METHODS

- **DATA ANALYSIS METHODS/LCA**

define purpose, scope, system boundaries, functional unit, and impacts.

LCA Inventory: collect inputs/outputs data, build energy–material balances, use standard databases."



"LCIA: translate inventory into impact categories (e.g., climate, toxicity, resource use) using models, to guide decisions.

LCA Interpretation: consolidate results, identify key issues, assess uncertainties, ensure transparency and reliability

Research novel(Significance)

- for the first time, a comprehensive life cycle assessment will be addressed in Mali bioenergy sector, especially crop residue and livestock waste;
- estimates for the total amount of biomass available or potentially available for use in energy sector;

Expected results

At the end of the research, we should be able to identify clearly:

- **The type and quantity of biomass available for bioenergy ;**
- **Assess the environmental impact of each expected bioenergy production;**
- **The biomass residue management should be solved.**

BIOENERGY

CLEAN ENERGY FROM BIOMASS

Renewable Solutions for a Sustainable Future

Crops Residue

Livestock Waste

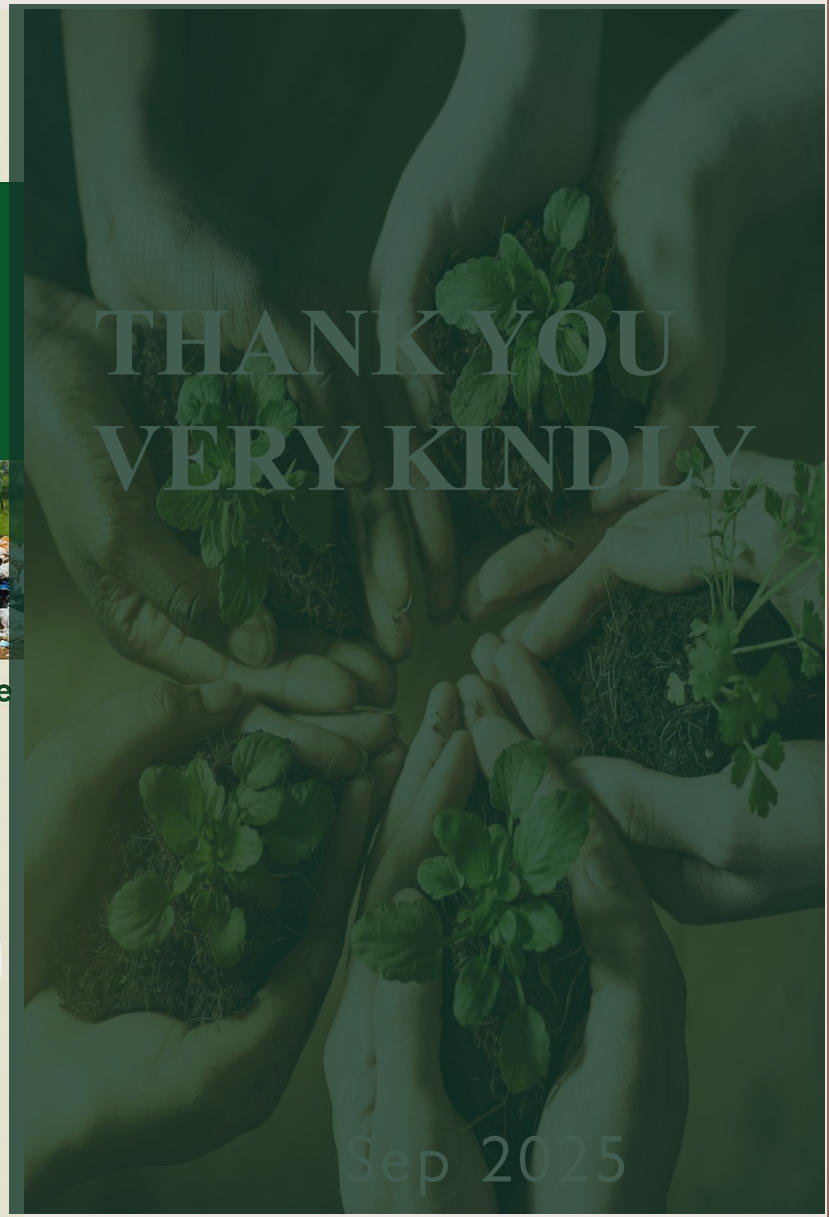
Municipal Waste

Harness Nature's Power, Preserve Our Planet

Biogas
Briquette

Biogas

Briquete



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