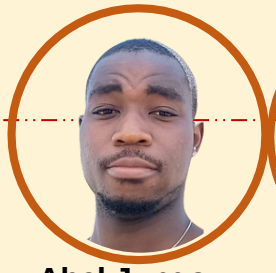
Green Poultry Farm



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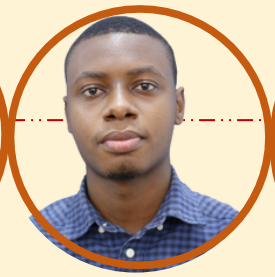

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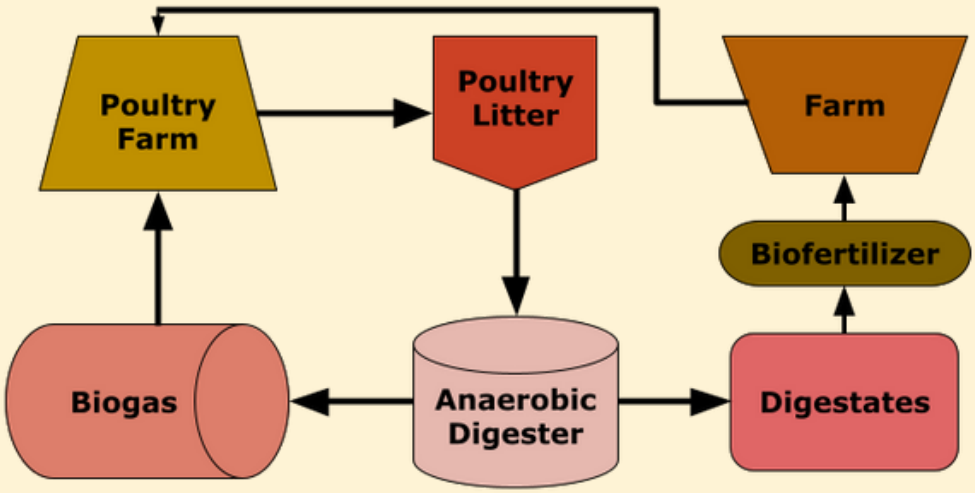
PART ONE - SOLUTION SUMMARY

The Mozambican Ministry of Agriculture and Rural Development estimates that over 200,000 tons of poultry waste is produced annually in Mozambique, including hatchery waste, manure, litter, and mortalities. This waste is often disposed of in landfills and water bodies, leading to environmental pollution. Our team addresses the wicked problem of environmental pollution associated with poultry farming, with an innovative biodigester system that converts poultry litter into biogas and biofertilizers, through anaerobic digestion. The biogas is converted into electricity and heat to meet energy needs within poultry production and the biofertilizer is used to grow feed for the poultry, promoting maximum use of resources and contributing to the circular economy by keeping materials in the loop.



Solution summary

PART TWO – CONTEXT

HISTORY

The history behind the environmental pollution associated with poultry farming can be traced back to the rapid expansion of the poultry industry worldwide. Poultry meat production has increased significantly since 1961, now representing almost 40% of global meat production (FAO, 2020). Poultry farming's expansion cause environmental pollution due to GHG emissions, nutrient loss, biodiversity loss, and human health issues. Poultry farming contributes to 8% of global GHG emissions, or 606 billion kg of CO2e, and 11% of manure-related emissions (Bah, 2020). Improper poultry waste disposal worsens the problem, especially in developing countries like Mozambique, where uncontrolled dumpsites produce 776,546 tons of CO2e emissions. By 2030, these emissions are expected to double to 1,369,721 tons of CO2e (Tas & Belon, 2014).

SCOPE

In many developing countries, particularly in rural areas, poultry farming is a prevalent practice, with around 80% of rural households raising poultry (Constantini, 2021). In Mozambique, poultry production is decentralized and widely accessible to farmers. However, with the increase in livestock production, there is a pressing need to manage poultry waste properly to avoid excessive pollution in the form of GHGs, eutrophication, and disease spread. We propose anaerobic digestion of poultry litter for biogas and biofertilizers production as the most suitable solution for reducing environmental pollution related to poultry waste management.

LOCATION

We adopt a global mindset while implementing our pilot activities at the local level. To be specific, we are currently focusing on Matola, a municipality located in the southern part of Mozambique, representing about 48% of annual poultry meat production with 12% annual growth (Bah, 2019). With around 500 farms, Matola has the largest number of poultry farmers in the province, making it the most affected by poultry waste pollution.

Poultry litter pollution on the side of a highway in Matola

STAKEHOLDERS

Mozambican Poultry Industry Association (AMIA)

National Union of Farmers (UNAC)

Subsistence farmers

Eduardo Mondlane University (UEM)

Innovation Centre at UEM

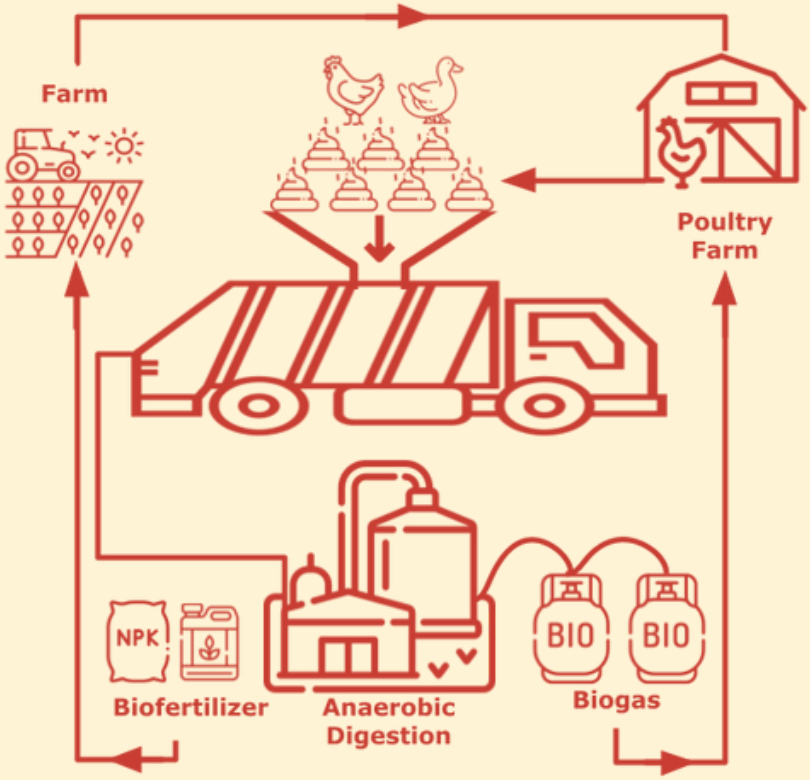
Ministry of Agriculture and Rural Development (MADER)

Matola City Council

PART THREE - SOLUTION OVERVIEW

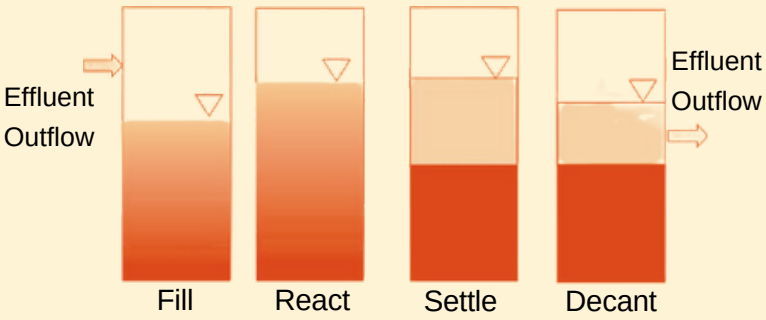
DETAILED SUMMARY

Biogas recovery is key to unlocking the environmental and financial benefits of managing waste from poultry farming. Our solution involves producing biogas by anaerobically (without oxygen) decomposing poultry litter in a biodigester. This process reduces greenhouse gas emissions, limits odor from manure storage and application, and allows for methane capture and use, while effectively separating solid and liquid portions of the digestate into valuable by-products such as biofertilizer, bedding, and soil amendment. By selling the biogas and by-products to poultry farmers and farmers we turn poultry waste into a valuable opportunity for cost savings, profits, and environmental stewardship. Our system generates and collects biogas while separating litter into usable, marketable components, creating value from waste.



The circular flow

We use the Anaerobic Sequencing Batch Reactor (ASBR) for our operations. The ASBR works in a cycle of four phases, namely: fill, react, settle, and decant. During the fill phase, the digester is fed with poultry litter. Mixing of these is done during the react phase. The settling phase allows the solids to settle while the effluent is drawn off during the decant phase. Hydraulic retention times are as short as five days, leading to almost continuous biogas production. It takes about 30 days for complete digestion of poultry litter.



ASBR diagram

CUSTOMER VALIDATION

Our solution provides a win-win for Mozambican poultry farmers. By selling their farm waste to us, i.e. poultry litter, poultry farmers generate additional income and offset the costs of waste management and energy. This not only provides financial benefits but also reduces the environmental impact of their operations. We are currently conducting a market validation campaign, actively presenting our MVP to our potential target poultry farmers and farmers. Overall, the results of the market validation campaign we are conducting help to better understand our market, customers, and competition, which informs our business idea to them and also helps us to gather feedback on the products, improving our market strategy.

INCENTIVE

Environment

The solution reduces the environmental impact of poultry farming by turning it more circular, and promotes the use of biofertilizers that are far less aggressive to the environment

Economy

By offsetting waste management and energy costs and generating additional income by selling poultry waste to us, farmers can potentially improve their bottom line

Energy

Instead of relying on an unstable and expensive electrical grid, poultry farmers will have access to renewable energy from the waste their farms produce

CREATING EFFECTIVE FLOWS

Our solution goes beyond addressing the environmental and financial challenges of poultry farmers. It also creates a positive ripple effect that benefits the wider community. Our introduction of biochar (as explained in the innovation section) has numerous environmental and economic benefits. This sustainable and natural approach improves soil health, increase crop productivity, and reduce greenhouse gas emissions and pollution. By improving soil quality, promoting plant growth, and increasing nutrient retention, biochar provides a range of benefits. The potential for our solution to create social and environmental benefits, in addition to benefiting poultry farmers, makes it a game-changer for promoting sustainable agriculture and improving the overall well-being of Mozambican communities

ECONOMIC FEASIBILITY

Green Poultry Farm's solution is designed to not only meet its set goals, but also generate profits, remain viable in the long term, and withstand the risks it will encounter. We are confident in our investment's success as we have seen similar success with companies like **SimGas**, **Biogas International**, and **BURN Manufacturing Co** in other African countries.

These companies design and manufacture biogas systems that use organic waste to produce biogas for cooking and lighting in East African households, schools, and businesses.

INNOVATION

The biogas produced in anaerobic digesters is comprised of approximately 50 to 70% methane (CH_4), 30 to 50% carbon dioxide (CO_2), and trace amounts of hydrogen sulfide (H_2S) and other gases. To be considered a viable fuel source, it is necessary to minimize the CO_2 and H_2S content, as higher concentrations of CO_2 result in lower heating capacity of the biogas. Currently, this is accomplished by costly downstream processing to remove these undesirable gases (Shen et al., 2017). We propose an innovative and economical solution to reducing CO_2 and H_2S concentrations in biogas, which is the use of biochar, a charcoal produced through pyrolysis (thermal processing of biomass in the absence of oxygen). Due to its porous structure and surface chemistry, biochar is highly effective in adsorbing and removing CO_2 and H_2S.

This leads to the production of high-quality biogas with a high concentration of methane, reducing the expenses associated with downstream processing. In our case, we utilize some of the solid digestates generated from our biodigester to produce biochar. Once utilized to purify the biogas, biochar is further used in agricultural applications to enhance soil fertility, improve plant growth, and provide crop nutrition.

PART FOUR - IMPACT ASSESSMENT

UNIQUE VALUE

Our solution is inspired by circular economy concepts and principles, which seek to eliminate waste and optimize resource use by designing closed-loop systems. The circular economy framework influences our approach to using poultry waste as a resource and converting it into biogas, biofertilizers, and biochar, thereby reducing waste and improving the sustainability of poultry farming. Our solution goes beyond this inspiration by offering an integrated approach to managing poultry waste.

OUTCOMES

Socio-economic

Our solution improves the health and well-being of local communities by reducing exposure to harmful pollutants

Environ-mental

Our solution reduces GHG emissions, preventing land degradation and pollution of water resources

Economic

Our solution provides poultry farmers with an additional source of income and reduce their reliance on expensive fossil fuels

PART FIVE – PROTOTYPING

PROGRESS

We tested our idea by building small biodigesters using locally-sourced and recycled materials, including plastic bottles, PVC piping, and a butyl rubber air chamber. Each biodigester processes 60kg of poultry waste per cycle, producing around 26 m3 of biogas and 55 kg of digestates. We evaluated biochar's CO2 adsorption capacity in the lab and found that it adsorbs 970 mg of CO2 per gram of adsorbent while absorbing trace amounts of H2S (less than 10 ppm) and water vapor. The purer the biogas, the hotter (and bluer) its flame. 1 m3 of biogas can produce approx. 2.4 kWhe of electricity and 2.7 kWth heat. We conducted a trial of biochar and biofertilizers on a cabbage plantation. After 30 days, using biofertilizer and biochar resulted in bigger and healthier cabbage plants, while only watering the plants produced smaller and less healthy ones, showing the efficiency of poultry-based biofertilizers. We are currently conducting a market validation campaign, actively presenting our MVP to our potential target poultry farmers and farmers.

Prototype system

Prototype operation

Granulation of dry digestates

Thermal processing of dry digestates (pyrolysis)

Solid and liquid biofertilizer and biochar

Biogas before (left) and after (right) biochar adsorption

Biogas generator (Credits: BOSE)

Cabbage treated with: water (left), 50% biofertilizer + 50% biochar (middle), and 75% biofertilizer + 25% biochar

Team members conducting a market validation to local poultry farmers

Team members conducting a market validation to local farmers

PERSPECTIVE

Our team's collaboration with Prof. Paulino Muteto, Mr. Arlindo Chaúque, and Mr. Santos Mucave provided technical expertise and insights that allowed us to optimize the construction of our solution prototype. Our partnership with the Innovation Centre at UEM also provides us with valuable exposure to stakeholders and the academic community through participation in exhibitions, allowing us to gather feedback and insights that help us further develop and refine our solution.

Team members exhibiting the system at an innovation fair

LEARNING

During the construction of our prototype, we learned the significance of controlling the H2S concentration in our biogas. Elevated H2S levels can pose risks to both human and plant health, and it's recommended to maintain them at or below 50 ppm. We're currently conducting experiments to determine the safety of using biochar briquettes as cooking fuel.

PART SIX - BARRIER ACKNOWLEDGEMENT

Challenges our solution faces include a lack of funding and awareness among some farmers. To address these, we are applying for funding opportunities and participate in exhibitions to reach farmers and pitch our solution to them. Barriers to implementing our solution include reluctance to change traditional practices. We are working with poultry farmers closely, conducting market validation directly with them to build trust and credibility, and establishing partnerships with them as stakeholders to overcome these barriers and achieve common goals.

PART SEVEN - DETAILED MATERIAL ANALYSIS

Material	Purpose	Reason for selection	Source	Material value management	Upcycling potential	Social equity considerations
Poultry waste	Feedstock for anaerobic digestion	Abundant and low-cost waste material	Local poultry farms	Conversion of waste to biogas and biofertilizerst	Residual waste can be used as organic fertilizer	Collaboration with local farmers to source waste and provide economic benefits to them
Steel	Construction of biodigester plant and piping	Durable and long-lasting material	Local suppliers	Maintenance to prolong lifespan and minimize waste	Can be recycled or repurposed for other applications	Collaborating with local suppliers and ensuring fair labour practices
Compressor and gas cylinders	Compress the gas in cylinders for storage/transport	Necessary for biogas compression storage and transport	Local suppliers	Regular maintenance to prevent leaks and damage	Can be repurposed for other applications or recycled	Collaboration with local suppliers and ensuring fair labour practices
Biochar	Sequesters CO2 and H2S in the biogas	Highly effective and low-cost biofilter	Digestates and other organic poultry waste	Efficient conversion of digestates to biochar	Can be used as a soil amendment and source of heat	Collaboration with local farmers to increases crop yields
Control System Components (sensors, valves, etc.)	Electronic components used for monitoring the process	Necessary for maintaining good conditions in the plant	Commercial suppliers	Components will be regularly maintained	Can be recycled or repurposed for other applications	N/A

PART EIGHT- DETAILED ECONOMIC ANALYSIS

BUSINESS MODEL CANVAS

Key Partners
- AMIA
- UNAC
- MADER
- UEM
- Matola City Council
- Sasco Mozambique
- Lusotradutores
- Local Communities

Key Activities
- Operation of biodigester plants
- Sale of biogas, biofertilizers and biochar

Key Resources
- Poultry waste
- Anaerobic digestion technology
- Skilled team
- Strategic partnerships

Value Propositions
- Sustainable solution for the treatment of poultry waste
- Renewable source of energy (biogas)
- Affordable and sustainable biofertilizers and biochar

Customer Relationship
- Direct sales and marketing
- Collaboration with customers on sustainability initiatives

Channel
- Direct sales and marketing
- Online platforms and social media

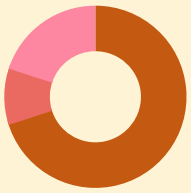
Customer Segments
- Poultry Farms
- Agriculture companies
- Energy companies
- Government agencies
- Subsistence farmers

Cost Structure
- Poultry waste collection and transportation
- Biodigester plant construction and operation
- Skilled labor and technical expertise
- Marketing and sales costs and operational costs

Revenue Stream
- Sale of biogas, biofertilizers and biochar
- Potential revenue from public-private partnerships and government grants/funding

COST ANALYSIS

Startup Cost

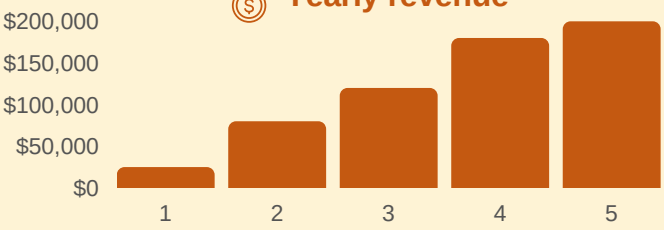


- 72% Biodigester plant
- 9% Feedstock acquisition
- 19% Labour

Total: $46,500

Our solution can generate an annual revenue of $25,390, benefiting both us and poultry farmers. They sell their farm waste to us instead of paying for disposal, saving up to $800 and earning a profit of $1,200 per year by adopting our solution.

Yearly revenue



Logistics

The logistics of our biodigester plant involve sourcing, transporting, and processing poultry litter, and distributing biogas biofertilizers and biochar. Additionally, we invest on establishing long-term contracts for marketing and awareness campaigns with relevant entities. Recently, our solution appeared in the magazine **Economia & Mercado** (https://lnkd.in/dREUbhUU),a renowned magazine about economy and markets in Mozambique.

SWOT ANALYSIS

Strengths

- Strong partnerships with local communities, universities, and government agencies
- Expertise in anaerobic digestion technology

Weaknesses

- Dependence on the availability of poultry waste as the primary input for the biodigester plants
- Limited awareness among potential customers

Threats

- Limited access to funding due to political and economic instability in Mozambique
- Volatility of poultry waste availability

Opportunities

- Growing demand for sustainable solutions in agriculture and renewable energy sectors
- The market for biogas and biofertilizers is relatively new

Team members meeting the Dean of UEM, and E&M magazine publication

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