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Soil Remediation via Inoculated Biochar

Abstract

Contamination of the soil comes from a variety of sources including fires, mining, spills, leeching, and explosions. This project explores how biochar can be used to mitigate these increasingly pressing issues of contamination. Biochar can be made from various feedstocks, however, the widely accessible nature of animal manure in every ecoregion made it the obvious choice. This project stems from the course, Impact Designs: Engineering, Art, and, Sustainability through Student Service (IDEASS) from the 2025-2026 academic year. The purpose of this project is to create an affordable, accessible, simple way for everyday people to remediate their own land, especially those in places where soil contamination poses a serious threat. This is of considerable importance because in places like Gaza and Lebanon, current warfare (explosive residues, unexploded ordnance, etc.) is poisoning the soil and consequently the people ("little farmers") who rely on that soil for food. They don't have the luxury of choice and are in desperate need for a solution as the people there are actively dying from it. The design involves creating manure-based biochar from a TLUD pyrolysis machine made out of oil drums and scrap metal along with consolidated information for use by the inexperienced. This was created through certification at Slugworks in order to acquire the tools necessary and extensive research and networking. Producing biochar from scrap metal and manure will create a solution to implement change and make an effective difference.

Background and Context

Worldwide we currently have the highest number of state-based conflicts since World War 2. Since 2024, there has been a peak in the number of conflicts not seen in over seven decades. The bombings and chemical warfare from these conflicts is having a major impact on the surrounding environment particularly the water and soil. Primarily this is a concern in a general environmental conservation lens yet also through a social lens as this conflict is severely impacting the people of these areas. Not only are they direct casualties from the conflicts but they are also being poisoned by the contaminants left behind in their water and food. These contaminants come in different forms based on what kind of ammunition and other chemicals are being used which is specific to each conflict region. Some of these contaminants include heavy metals, asbestos, white phosphorus, depleted uranium, PFAs, PCBs, and dioxins (Shomer and Darwish, 34:23).

This urgently requires a solution not only to help the people directly affected by the conflicts but also to prevent the spreading of these contaminants to surrounding areas. We need a solution that reverses the damage we have inflicted upon the soil through various methods of bioremediation. It is vital to educate the people on how to conduct these methods themselves while also taking care to not cause panic or greater strain on their already limited resources. The best way to treat these kinds of environmental disasters is through immediate treatment. However, in many of these war-torn areas, especially restricted/blockaded areas like Gaza, the focus is understandably more on the immediate survival of the people through first aid and food supplementation. Trying to get sophisticated bioremediation equipment into these areas is not only a neglected priority, but due to lack of education and access these efforts range from difficult and risky to virtually impossible and potentially deadly for those involved.

The requirements of the key stakeholders define this problem because the ongoing lack of political stability requires that this solution is sustainable from within the country. The lack of access to the country severely limits foreign ability to do any hands-on work. The requirements by Israel for no "dual-use" items (items that could be used for military purposes) to be imported into Gaza cements this need for internal sustainability. Another stakeholder need that defines this problem is that of the people/farmers and their lack of access to information. This requires any information on how to perform a solution to be highly synthesized, simplified, and accurately translated. Another definitive aspect of this is that great urgency is needed due to the people's health problems compounding exponentially. This is exemplified by the effectiveness of biochar being directly linked to how soon after a disturbance/contamination it is applied to the soil. The sooner this solution can be implemented the less risk there is of the contamination spreading or leaching which would limit exposure to the toxins by the citizens.

The creation of the biochar itself is normally done with a pyrolysis kiln. The current exact number of large-scale commercial biochar plants worldwide is unknown but the industry is expected to double in the next few decades (Chalmin, 2025). However, it has been historically challenging to get companies involved in remediation efforts especially if there is no monetary gain for them. Therefore, the best method to help these war torn areas on a small scale is to educate them and volunteers on how to properly conduct this bioremediation on their own soil. This is where this project can make the most difference.

Problem Statement

A significant challenge in war-strewn areas like the Gaza Strip or Lebanon is that access to the kind of woody biomass needed for biochar is very limited and any that is available is likely already contaminated. When we are faced with a context in which access to woody biochar is limited, it forces us to learn more about alternatives. The most widely known and implemented feedstock is wood whether that be in the form of sticks, sawdust, woody vegetation, lumber byproducts, etc. However, there are many other types of feedstock that have different specialities due to their various chemical and physical properties such as porosity, surface area, or pH. Some of these feedstocks include agricultural waste (straw, stalks, husks, nut shells, bamboo, leaves, fruit and vegetable residues), animal manure, aquaculture by-products like seaweed, expired food, and sewage sludge and biosolids (Mengyuan, 2022). Woody biomass is best at carbon sequestration, water filtration, and soil aeration. Agricultural residues are best at soil improvement, moderate carbon sequestration, and crop nutrient cycling. Animal waste is a fertilizer replacement, soil amendment, and composting enhancement. Sewage sludge and biosolids are best for land remediation, heavy metal adsorption, and phosphorous recovery (Klaich, 2025). It is vital to understand what biomass is available in each area that biochar efforts are being made. Thus, just applying biochar is not a guarantee: you need to carefully match feedstock, pyrolysis conditions, soil type, and contaminant profile. It is important to recognize that different feedstocks have different qualities and varying effectiveness for different contaminants.

The prospect of setting up infrastructure to produce or distribute biochar with any kind of consistency or reliability is also daunting. The effectiveness of this solution on high risk areas like Gaza would be unable to be tested for the foreseeable future (likely until the conflict is resolved). This means that the exact methods the people of Gaza will be encouraged to implement should be tested here first. This can ensure the solution's effectiveness and decrease the chance that corrections would have to be made later which would be much harder to communicate after the farmers have already become comfortable with the initial solution method.

Another vital aspect of biochar is the inoculation process. Studies have shown that inoculated biochar is much more effective at immediately improving soil nutrients. According to Down (2024), the advantages of inoculating biochar include promoting quicker growth and improved soil health, enhanced soil microbial activity, enhanced plant resistance to diseases and pests, and faster soil amendment. Some studies showed up to 300% yield increases. There are many different methods of inoculation including mycorrhizal fungi, bacteria, seaweed or fish emulsions and compost tea. This project will focus on compost tea as it is most widely applicable and easiest to do yourself.

Project Overview

This manual outlines the step-by-step process for constructing and operating a low-cost Top-Lit UpDraft (TLUD) pyrolysis system using an oil drum. This system is designed to produce biochar from animal manure in a safe, accessible, and replicable. We will first explain the various user stories that were dissected and then synthesized to better understand the needs of our target audience. Then we will discuss our goals and objectives for the project. After that we will delve into how we plan on executing our project in our methodology section. Additionally we will discuss our anticipated next steps towards completing our project. Lastly we will discuss the limitations and tradeoffs of the project and our particular design choices.

Part II

User Stories

As a small-scale farmer, I want a soil remediation method that does not degrade or contaminate my soil so that I can maintain long term soil health and productivity.

As a small-scale farmer, I want biochar production methods that are safe for human exposure so that I do not put workers or my community at risk.

As a small-scale farmer, I want evidence-based assurance that manure-based biochar will not contaminate nearby water sources so that I can prevent harmful runoff into creeks and ecosystems.

As a small-scale farmer, I want a pyrolysis system that minimizes fire hazards so that I can operate safely without requiring complex permits or risking accidents.

As a small-scale farmer, I want to build a pyrolysis oven using low cost and accessible materials so that it fits within my limited budget.

As a small-scale farmer, I want research backed information on manure-based biochar effectiveness so that I can trust it as a viable alternative to woody biochar.

As a small-scale farmer, I want a biochar production process that minimizes odor and smoke so that it does not interfere with daily farm operations.

As a small-scale farmer, I want a biochar system and product that lasts over time so that I am not frequently replacing materials or wasting resources.

As a small-scale farmer, I want clear instructions on how to inoculate and apply biochar so that I can effectively improve soil health.

As a small-scale farmer, I want a process that is simple to teach and share so that my community can also benefit from sustainable soil practices.

These user stories are the most significant in our project because they directly address the primary barriers that small-scale farmers face when adopting new soil remediation methods: safety, cost, accessibility, and trust. The highest priority user stories focus on ensuring that the manure based biochar is safe for soil, humans, and surrounding ecosystems. Which aligns with our project's main goal of remediating contaminated soils in disaster affected areas without causing further harm. The secondary priorities emphasize affordability and ease of construction. This is reflected in objectives such as building a low cost oil drum TLUD and using widely available materials like cow manure. Additionally, our chosen user stories focused on user confidence, usability, and knowledge which directly support the goal of empowering "little farmers" by guiding the development of clear instructions, experimentation, and soil testing methods (such as spectrometer analysis) to validate effectiveness. Finally, the emphasis on knowledge sharing and community impact connects with our outreach objectives, including collaboration with organizations and the creation of educational materials. Together, these priorities ensure that our project is not just scientifically effective, but also practical, accessible, and scalable in real world disaster contexts.

Goals and Objectives

Goal 1: Remediate contaminated soils in disaster affected areas

- Use inoculated animal manure biochar as a low cost, accessible soil remediation method.
- Ensure the process is environmentally safe and does not introduce additional contaminants.

Goal 2: Empower small-scale "little" farmers

- Increase confidence in soil remediation practices for individuals with little to no prior experience.
- Provide simple, clear, and accessible methods that can be implemented with limited

resources.

Goal 3: Expand collaboration and real-world impact

- Connect with organizations already working on soil remediation in disaster zones (U.S. and internationally).
- Share knowledge, methods, and results to support broader adoption and scalability.

Objectives

Design & Build

- Construct a low-cost oil drum TLUD (Top-Lit Updraft) pyrolysis system in Slugworks.
- Use accessible and locally available materials to ensure replicability.

Biochar Production

- Produce biochar using cow manure as the primary feedstock.
- Develop and apply compost tea to inoculate the biochar and enhance its effectiveness.

Testing & Evaluation

- Determine methods for assessing soil quality and contaminant uptake (e.g., spectrometer use).
- Conduct experiments to evaluate and improve biochar effectiveness.
- Research how different soil types and contaminants affect remediation outcomes.

Research & Development

- Investigate best practices for manure-based biochar production and application.
- Identify how biochar interacts with various contaminants in different environments.

Outreach & Collaboration

- Connect with organizations working in disaster-affected regions (e.g., Gaza, Lebanon, U.S.).
- Engage with individuals and groups who have developed similar pyrolysis systems to learn from their experiences.
- Create a flyer or outreach campaign to document and share the project with broader audiences.

This project is centered on developing a practical and accessible solution for remediating contaminated soils in disaster affected areas through the use of inoculated animal manure biochar. A primary goal is to address soil degradation in regions impacted by conflict or environmental disasters, where traditional remediation resources are often limited or unavailable. By utilizing manure as a feedstock, the project focuses on a material that is widely available even in low resource settings, making the solution more feasible and scalable. In addition to environmental restoration, this project aims to empower the small-scale "little" farmers by increasing their confidence and ability to remediate their own soil without requiring prior technical experience. This will be achieved by designing a system that is simple, low-cost, and easy to replicate, which ensures the individuals that they can adopt the method independently.

To support these goals, the project includes several key objectives that guide both the technical and community- focused aspects of the work. A central objective is the design and construction of a low cost TLUD (Top-Lit Updraft) pyrolysis system in the Slugworks building, which allows for efficient biochar production using accessible materials. Our project also focuses on producing biochar from cow manure and enhancing its effectiveness through inoculation with compost tea, which introduces beneficial microorganisms that improves soil health. In order to ensure the solution is both safe and effective, the project incorporates experimental testing and evaluation, including methods to assess soil quality and the biochar's ability to uptake contaminants, such as the use of a spectrometer. Additional research will explore how different soil types and contaminants influence the remediation process, allowing for more tailored and effective applications.

Beyond the technical development, the project emphasizes collaboration and outreach as essential components of its impact. By connecting with organizations and individuals already engaged in soil remediation efforts in disaster affected regions, both within the continental United States and internationally, such as Gaza and Lebanon. The project aims to learn from existing work and contribute to a broader network of knowledge sharing. Outreach efforts, including the creation of educational materials and documentation of the process, aim to make the project accessible to a wider audience and support the spread of these practices across multiple communities. Ultimately this project is designed to not only create an effective soil remediation method, but to also ensure that it is affordable, user friendly, and adaptable, enabling long-term and community driven environmental restoration and land stewardship.

Procedures/Methodology

a. Metrics (How progress is measured)

To evaluate the success and progress of this project, several qualitative and quantitative metrics are used. These metrics are designed to assess the safety, effectiveness, accessibility, and scalability of manure-based biochar as a soil remediation method.

Soil Health & Remediation Effectiveness

- Changes in soil quality (pre vs. post biochar application), including:
  - Nutrient levels (N, P, K)
  - Organic matter content
  - pH levels
- Reduction in contaminant concentration (measured using XRF/spectrometer analysis where available)
- Observed improvements in plant growth or soil structure (if applicable)

Biochar Performance

- Ability of biochar to retain moisture and nutrients
- Effectiveness of compost tea inoculation (visible microbial activity, plant response)
- Consistency and quality of produced biochar (color, porosity, burn completeness)

System Efficiency & Safety

- Time required to produce biochar per batch
- Amount of smoke/odor produced during pyrolysis
- Presence or absence of safety risks (uncontrolled flames, excessive heat)

Accessibility & Cost

- Total cost of materials for building the oil drum TLUD system
- Availability of materials (locally sourced vs. specialized)
- Ease of replication by individuals with limited experience

User Confidence & Adoption

- Feedback from small-scale farmers (if surveyed/interviewed)
- Clarity and usability of the instructional guide/manual
- Willingness of users to adopt or share the method

b. Set-Up (Environment & Resources Required)

The project was conducted primarily in a workshop and outdoor environment suitable for safe biochar production and experimentation.

- **Workspace:**

    - Slugworks (or equivalent workshop space) used for constructing the oil drum TLUD system
    - Outdoor/open-air area required for pyrolysis to ensure proper ventilation and safety
- **Environmental Conditions:**
    - Open space away from flammable structures
    - Access to soil for testing and application
    - Ideally located in areas where manure and organic waste are readily available
- **Project Scope Environment:**
    - Designed for use in **low-resource, disaster-affected settings**
    - Adaptable to rural or small-scale farming environments
    - No reliance on advanced infrastructure or electricity
- **Outreach & Research Set-Up:**
    - Communication conducted via email or online platforms to connect with farmers and organizations
    - Informal surveys/interviews used to inform user stories and design priorities

c. Materials

The following materials were used for the construction of the pyrolysis system, biochar production, inoculation, and testing.

Pyrolysis System (Oil Drum TLUD)

- Steel oil drums (standard 55-gallon drum and 30-gallon drum)
- Metal piping or chimney attachment
- Drill and drill bits (for airflow holes)
- Metal cutting tools (angle grinder or equivalent)
- Heat-resistant gloves and safety equipment

Feedstock & Inoculation

- Cow manure (primary biochar feedstock)
- Organic materials for compost tea (e.g., compost, water, microbial sources)
- Containers for mixing and fermenting compost tea

Testing & Analysis

- Soil samples (pre- and post-treatment)
- Spectrometer/XRF (if available) for contaminant analysis
- Basic soil testing kits (pH, nutrients)

General Tools & Supplies

- Buckets and containers
- Water source
- Fire-starting materials (kindling, matches, etc.)
- Personal protective equipment (gloves, masks, eye protection)

d. Procedure

Overview of Methodology

The methodology for this project is divided into four main phases: research, system construction, biochar production and inoculation, and testing/evaluation.

Phase 1: Research & Planning

- Conducted background research on:
    - Biochar and its role in soil remediation
    - Differences between woody and manure-based biochar
    - Pyrolysis systems (with focus on TLUD design)
- Reviewed existing literature and case studies
- Identified constraints relevant to disaster zones (cost, material access, safety)

Phase 2: User Research

- Reached out to small-scale farmers and relevant communities
- Identified key concerns (safety, cost, usability, trust)
- Developed user stories based on these needs
- Used findings to guide design decisions

Phase 3: Pyrolysis System Construction

Part 1: Materials & Tools

Tools Required

- Drill
- Drill bits (1/8” and 1/2”)
- Pliers
- Marker
- String
- Metal cutting tool (angle grinder or equivalent)

Materials (Recycled & Purchased)

Recycled Materials:

- 2 steel oil drums (One 55-gallon barrel and another 30-gallon barrel)
- 2 sheets of roofing metal
- 2 meters of 1” steel box tubing

Purchased Materials:

- 12 self-tapping screws (1/2”)

Part 2: TLUD Drum Construction

Step 1: Mark Airflow Hole Locations

1. Wrap string around the circumference of the 55-gallon barrel.
2. Use a marker to divide the barrel into halves, quarters, and eighths.
3. Draw vertical lines connecting these marks.
4. Mark intersection points with “X”s.

Step 2: Drill Airflow Holes (55-gallon)

1. Drill pilot holes at each “X” using a 1/8” drill bit.
2. Re-drill each hole using a 1/2” drill bit to allow airflow.

Step 3: Drill Airflow Hole (30-gallon)

1. Drill pilot hole on bottom of barrel.

Step 4: Construct Chimney (Stack)

1. Cut two sheets of roofing metal to 1 meter in length.
2. Roll and shape into a cylindrical tube (45–55 cm diameter).
3. Secure with 4 self-tapping screws.

Step 5: Create Star Vent (Top Opening)

1. Mark two center lines across the top of the 55-gallon barrel.
2. Drill a small hole at the center.
3. Measure circumference with string and divide into 8 equal sections.
4. Draw lines to create an 8-slice pattern.
5. Cut along these lines to form an 8-point star.
6. Use pliers to bend the metal flaps upward.

Step 6: Remove Barrel Top

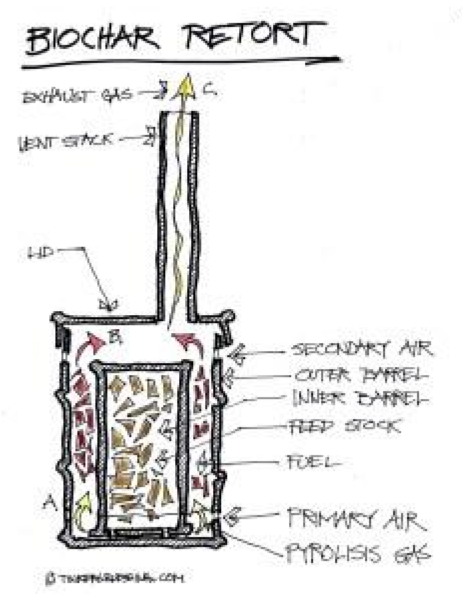
1. Wrap string around the barrel approximately 1 inch below the rim.
2. Mark a straight cutting line.
3. Cut along the line to remove the top.
4. Set the top aside (this will be reattached).

Step 7: Install Spacers

1. Cut two 1-meter lengths of 1” steel box tubing.
2. Place spacers across the top opening of the barrel.

Step 8: Assemble Chimney System

1. Place the star-cut top onto the spacers.
2. Fit the chimney (stack) over the star opening.
3. Bend the star flaps until the chimney sits securely.
4. Attach with 8 screws to secure the structure.



Part 3: Biochar Production (Burn Process)

Step 1: Prepare the Base

- Place the barrel on three bricks or stones to allow airflow underneath.
- Ensure the system is stable and level.

Step 2: Load Feedstock

- Fill the 30-gallon barrel with dry animal manure (cow patties).
- Place 30-gallon barrel inside 55-gallon barrel.

Step 3: Ignite

1. Cover the top layer with very dry leaves or kindling.
2. Light the material evenly across the surface.
3. Ensure the entire top layer is burning.

Step 4: Start Pyrolysis

- Place the top and chimney onto the barrel once ignition is established.
- Allow the TLUD system to burn from the top downward.

Step 5: Monitor Burn

- Observe smoke and flame behavior.
- The system is complete when:
- Tossed water instantly turns to steam on the lower barrel

Step 6: Quenching

1. Remove the top using spacers or tools.
2. Pour a large amount of water into the barrel.
3. Empty contents onto the ground.
4. Continue adding water until no steam remains.

Step 7: Maintenance

- Spray down the barrel after use to prevent rust
- Proper cleaning significantly increases system lifespan

Part 4: Post-Burn Processing

Step 1: Crush Biochar

1. Place biochar on thick plastic sheeting
2. Drive over it with a vehicle (car, truck, or tractor)
3. Aim for particle sizes ranging from:
4. Corn kernel size → fine granules

Step 2: Inoculation (Charging Biochar)

Before applying biochar to soil, it must be “charged” with nutrients and microbes:

Option 1: Compost Mix

- Mix biochar with compost or manure (50:50 ratio)

- Let sit for ~1 week while aerating. (Through available methods such as a small pump or manual movement)

Option 2: Liquid Inoculation

- Soak biochar in:
- Compost tea
- Effective microorganisms (EM) solution
- Animal urine (cow, pig, or horse)

Note: Biochar absorbs liquids efficiently and reduces odor

Step 3: Soil Application

- Apply inoculated biochar directly to soil
- Mix into topsoil for best results

Safety Considerations

- Always operate in open, ventilated areas
- Keep water nearby during burns
- Use protective equipment (gloves, eye protection)
- Ensure full quenching to prevent re-ignition

General Steps:

1. Prepare and clean oil drum
2. Drill airflow holes to support TLUD design
3. Install chimney or ventilation system
4. Ensure structural stability and safety

Phase 4: Biochar Production

- Loaded cow manure into the pyrolysis drum
- Initiated combustion at the top (TLUD method)
- Monitored burn process to ensure controlled pyrolysis
- Allowed system to cool before collecting biochar

Phase 5: Biochar Inoculation

- Prepared compost tea using organic materials
- Applied compost tea to biochar
- Allowed time for microbial colonization

Phase 6: Testing & Evaluation

- Applied biochar to soil samples
- Conducted soil testing (pH, nutrients, contaminants)
- Observed changes over time
- Compared results across different conditions

Phase 7: Outreach & Knowledge Sharing

- Connected with organizations and individuals working in similar areas
- Documented process and findings
- Developed outreach materials (e.g., flyer/manual)

e. Progress to Date

The project is currently in a mixed stage of development, with several foundational steps completed and others ongoing.

Completed:

- Background research on biochar, manure-based biochar, and pyrolysis systems
- Development of user stories based on farmer needs
- Initial design planning for oil drum TLUD system
- Outreach efforts initiated with organizations and individuals in related fields

In Progress:

- Construction of the oil drum pyrolysis system in Slugworks
- Development of compost tea inoculation method
- Continued research on soil contaminants and remediation strategies
- Drafting of instructional materials and user manual

Pending:

- Full testing of biochar production system
- Soil quality and contaminant analysis (spectrometer use)
- Experimental trials comparing treated vs. untreated soil
- Expanded outreach and collaboration with organizations in disaster-affected regions
- Finalization and distribution of outreach materials

Next Steps

Looking forward into the Spring quarter, the remaining work that needs to be done is the actualization of our planning and preparations. The process now would be to make the oil drum pyrolysis machine, burn the biochar, inoculate it, and then test its efficiency on various soils and contaminants. In order to make the oil drum kiln, a second oil drum needs to be acquired, however funding for which is still pending. In order to actually build the kiln, the lid would be cut to fit the metal tubing and holes drilled into the oil drum sides. Once the drum is constructed, the manure must be acquired via outsourcing from the UCSC East Lower Field and dried. Then a burn location must be determined. As it stands, Maya Eldon may allot us her yard but further communication needs to be made. Once the biochar is produced, it must be inoculated with compost tea in order to integrate beneficial microbes into the porous biochar. In order to create the compost tea, all that is needed is a barrel/bucket, old tubing, some compost, a sugar source (likely fruit scraps), water, and ideally a small air pump like ones used for aquariums or one created from junk (there is also a shake method in the likely event a pump is unavailable). This process can be easily completed within a day or two. At that point, the biochar will be ready for testing. A multitude of tests will be performed to determine its effect on soil acidity, contaminations, water retention, nutrients, and microbial balance. Our testing should include the use of an XRF to be as precise as possible. An XRF (x-ray fluorescence) will be used to determine contamination levels through identification of present elements, especially heavy metals. This whole process will be documented through photos and videos that will be compiled along with information regarding the process and reflections.

<u>Limitations & Tradeoffs</u>

Over the course of this project there has been much room for learning. One of the important concepts uncover the importance in the difference between a single and double stack biochar kiln. A double stack biochar kiln produces much cleaner, higher quality biochar with fewer emissions and is self-regulating. Another important factor that was discovered was the vitality of inoculating the biochar. There are various methods but after further research compost tea was decided upon.

The information learned impacted our design choice as it was opted to use the double stack kiln design over the original single stack design. It also became apparent that the existing oil drum for the single stack design was missing a lid so the original design couldn't be implemented.
This shift in design plan greatly increased our limitations. The greatest limitation was the lack of a second oil drum. Due to lack of individual finances, funding had to be applied for in order to purchase another oil drum. The anticipated cost of this endeavor was estimated to be $100. Another limitation was coordination accessing slugworks. Unfortunately, Nick Koutali, the head manager, was frequently unwell on days that were planned for beginning construction. This was especially a challenge considering the constricted schedules of the group members.

Our solution begins to break down when it is applied to areas in which scrap metal or any sharp enough tools is completely unavailable. This is highly likely in active-war zones. However, there are existing alternatives to the metals design that would be more suitable or accessible tot here areas. This includes the trench-method or potentially a cob oven.

This clearly employs some trade offs. In order to get cleaner biochar we had to take on further challenges. If we had gone with just the single stack design we would have likely been able to make the biochar within the Winter Quarter. However our results would not have been ideal. Additionally had we wanted to switch directions later, we would have then needed to acquire two more oil drums.

Conclusion

The anticipated outcome of this project is the increased confidence of the little farmers to decrease the contamination of their soil and consequently improve their people's health. Our project will achieve this through the creation of a double stack pyrolysis kiln to produce animal manure based biochar inoculated with compost tea. Our product is intended to not only remove contaminants but also add nutrients, microbes, and moisture, overall improving and remediating the soil. This improved soil will no longer poison the food grown in it and will amplify its nutritional value. This project is not only vital to the health of the earth and those in these war-torn areas but to the whole planet. Education on these methods and the consolidation of information on types of biochar and methods of production into easily accessible and straightforward documents is vital to anyone in the world who has contaminated soil whether that be from explosives, fire, chemical spills, etc. This way we can all work together towards a healthier planet full of happier people who can rest easy knowing they are no longer eating poison.

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