C H A R

B A N N I

CARBON CYCLES

BANNI CHAR

Metabolic Office

Ahmedabad 2022

Metabolic Office is a contemporary ecological design practice that use integrated and whole systems thinking - utilizing existing patterns and resilient features observed in topographies and eco-systems to create regenerative forms of production, inhabitation and wilderness.

M.O. have been working on a variety of land design projects in Gujarat at various scales - from master planning, rewilding, water management, and real estate projects, that rely on effective design solutions that are highly contextual and case specific.

M.O. have an advanced working knowledge of Geographical Information Systems - having worked on projects that process planetary scale remote sensing data from various sources to connect disparate institutions and research groups to be able to develop strategies of Climate adaptation, mitigation and resilience.

This report was produced by Metabolic Office.
Team: Sahir Patel and Ahana Rao

Ahmedabad 2022

CARBON CYCLES

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A Jheel in Hodko Village, Banni,
February 2022

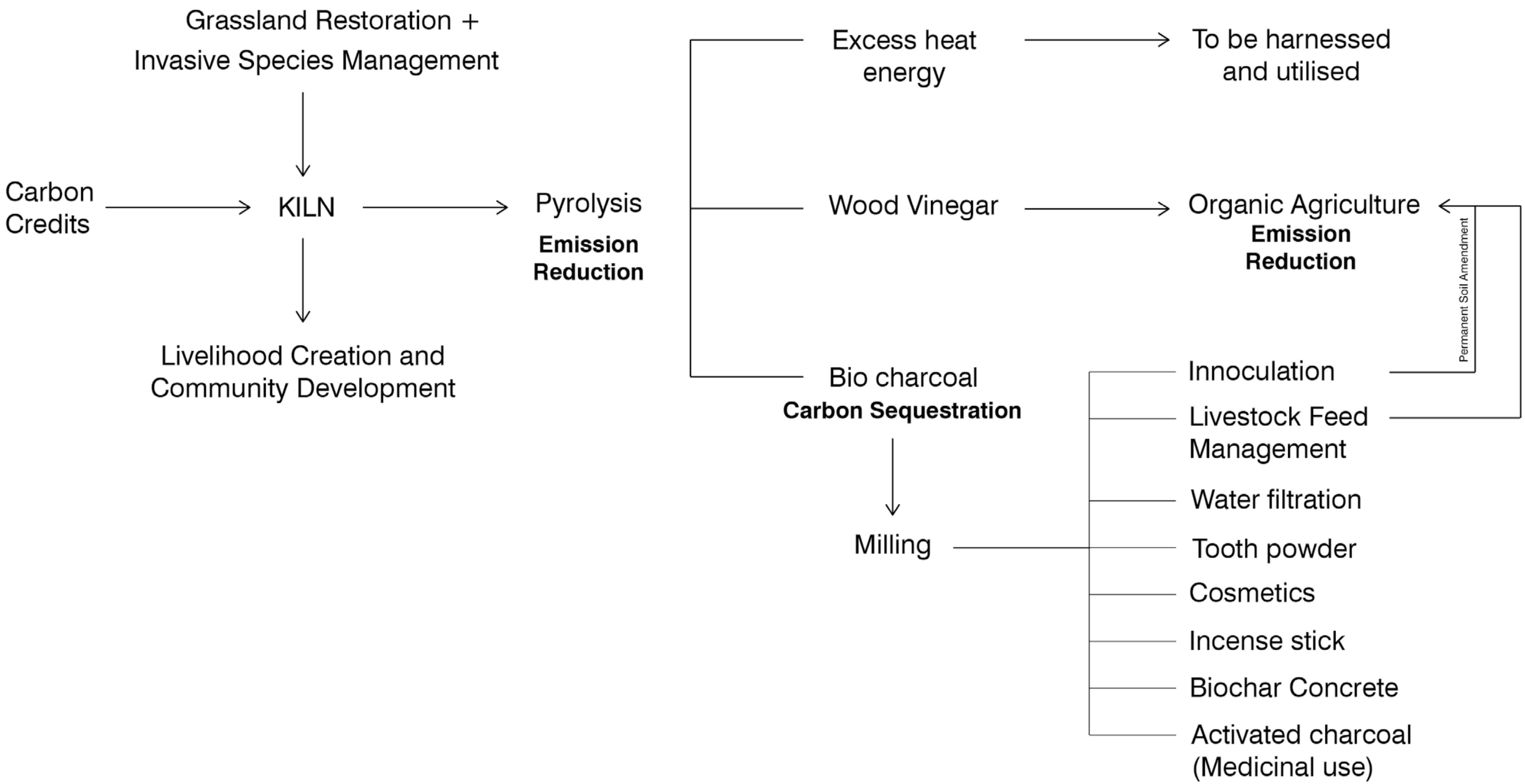
The project aims at Banni Grassland Restoration through Invasive Species Management, Improving Soil, Ecosystem, Agriculture and Livestock Health and Productivity, by utilising a Permanent Carbon Capture scenario to reliably remove atmospheric Carbon and sequester it into soils as a Permanent Soil Amendment using BioChar Technology.

The project proposes to use Prosopis juliflora to create Biochar through the development of two prototype machines - a mobile Kiln and a smokeless Stove which are able to recover by-products.

Additionally, the project aims to map and understand ecosystem dynamics of the Banni Grassland region through Remote Sensing Technology and GIS to study various factors such as Elevation Model, Land-use, Flooding, Drainage, Scale and Extent of the invasive species, as well as Seasonal and Multi-temporal transformations of the grasslands.

This will help in creating a new cartographic representation of Banni and strenthen the understanding of the Grasslands.

The Project also explores various land management paradigms that can be deployed to restore grasslands and livelihoods in this region.


Grassland Restoration +
Invasive Species Management
Carbon Credits
KILN
Livelihood Creation and Community Development
Pyrolysis
Emission Reduction
Excess heat energy
To be harnessed and utilised
Wood Vinegar
Organic Agriculture
Emission Reduction
Permanent Soil Amendment
Bio charcoal
Carbon Sequestration
Milling
Innoculation
Livestock Feed Management
Water filtration
Tooth powder
Cosmetics
Incense stick
Biochar Concrete
Activated charcoal (Medicinal use)

1.0 Project Information

Date	Location	Activity
21/02/2022	Ramble Centre, Hodko village, Banni	First/Initial study visit to Banni to understand charcoal economy and existing cooking practices
26/02/2022	Ahmedabad	Manufacturing Prototype 1 of the Anila Stove
28/02/2022 - 10/03/2022	Ahmedabad	Remote Sensing and GIS Mapping of Banni
05/03/2022 - 12/03/2022	Thol, Ahmedabad	Testing Prototype 1 with a peri-urban community to analyse its performance and compilation of data produced
15/03/2022	Ahmedabad	Manufacturing Prototype 2 of the stove after refining the design
15/03/2022 - 22/03/2022	Thol, Ahmedabad	Testing Prototype 2 with a peri-urban community to analyse its performance and compilation of data produced
24/03/2022	Ahmedabad	Manufacturing Prototype 3 of the stove after refining the design
24/03/2022 - 31/03/2022	Thol, Ahmedabad	Testing Prototype 3 with a peri-urban community to analyse its performance and compilation of data produced
25/03/2022	Ahmedabad	Manufacturing the first Kiln Prototype

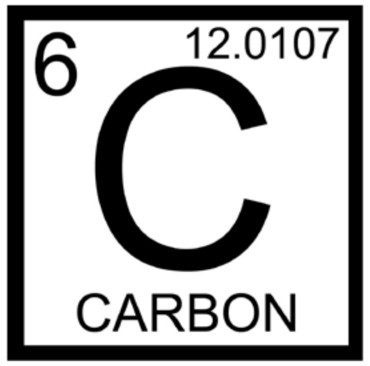
The project began with a visit to Banni to study the informal charcoal making industry. The Principal Investigator is Sahir Patel and the Research Assistant is Ahana Rao. The team was involved in the Remote sensing and GIS mapping of Banni and supervised the Anila stove and Kiln manufacturing and analysis. This also included prototyping of both machines and associated field work in Ahmedabad.

The project proposes to use Prosopis juliflora to create Biochar through the development of two machines that can recover by-products through Pyrolysis.

The Fund provided by RAMBLE was utilised in the manufacturing and prototyping of these machines as well as on-ground documentation and research on the response of a peri-urban community in Thol, 35 kms from Ahmedabad. The main aim was to reduce emissions and improve the quality of life of the community by producing clean cooking fuel as well as to test and investigate the quality of the biochar produced for usage and income generation.

Part of the fund was used for Remote Sensing and GIS analysis to further the understanding of the Banni region through a series of maps and to propose appropriate land management strategies.

2.0



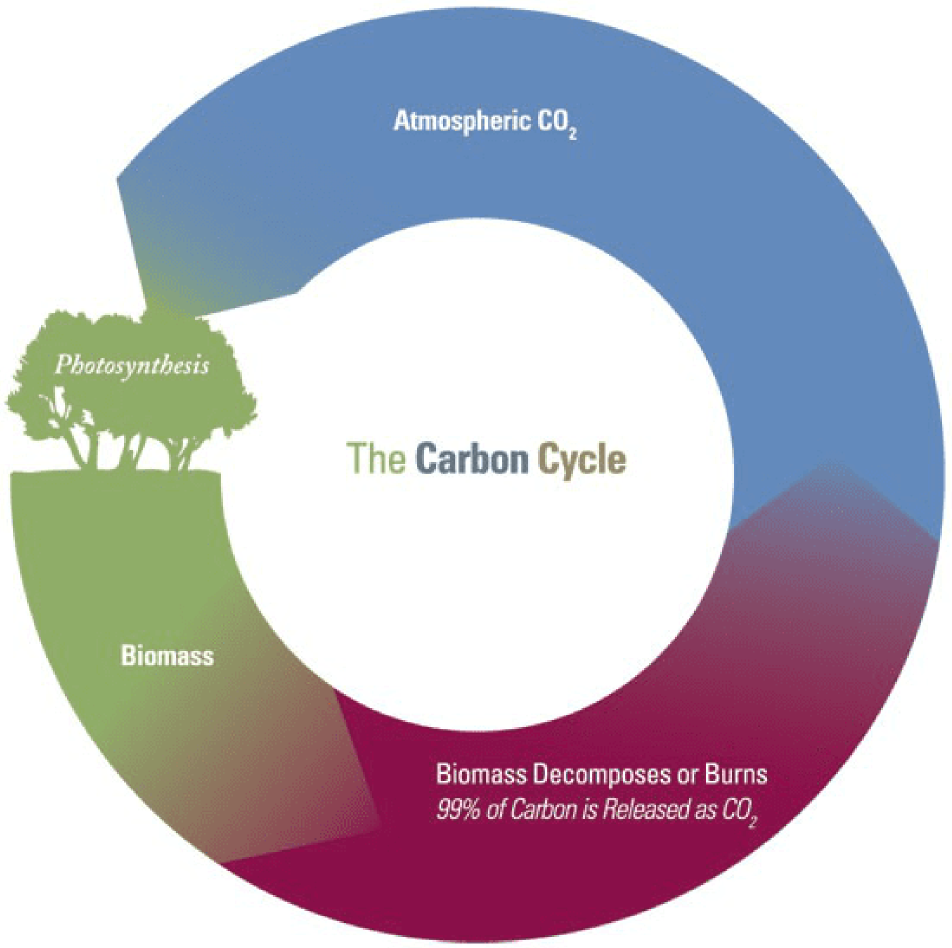
The Carbon Cycle

A stable carbon base is the key to having stable conditions for complex societies and the flourishing of human and non-humans entities. Over the long term, the carbon cycle seems to maintain a balance that prevents all of Earth's carbon from entering the atmosphere (as is the case on Venus) or from being stored entirely in rocks. This balance helps keep Earth's temperature relatively stable, like a thermostat.

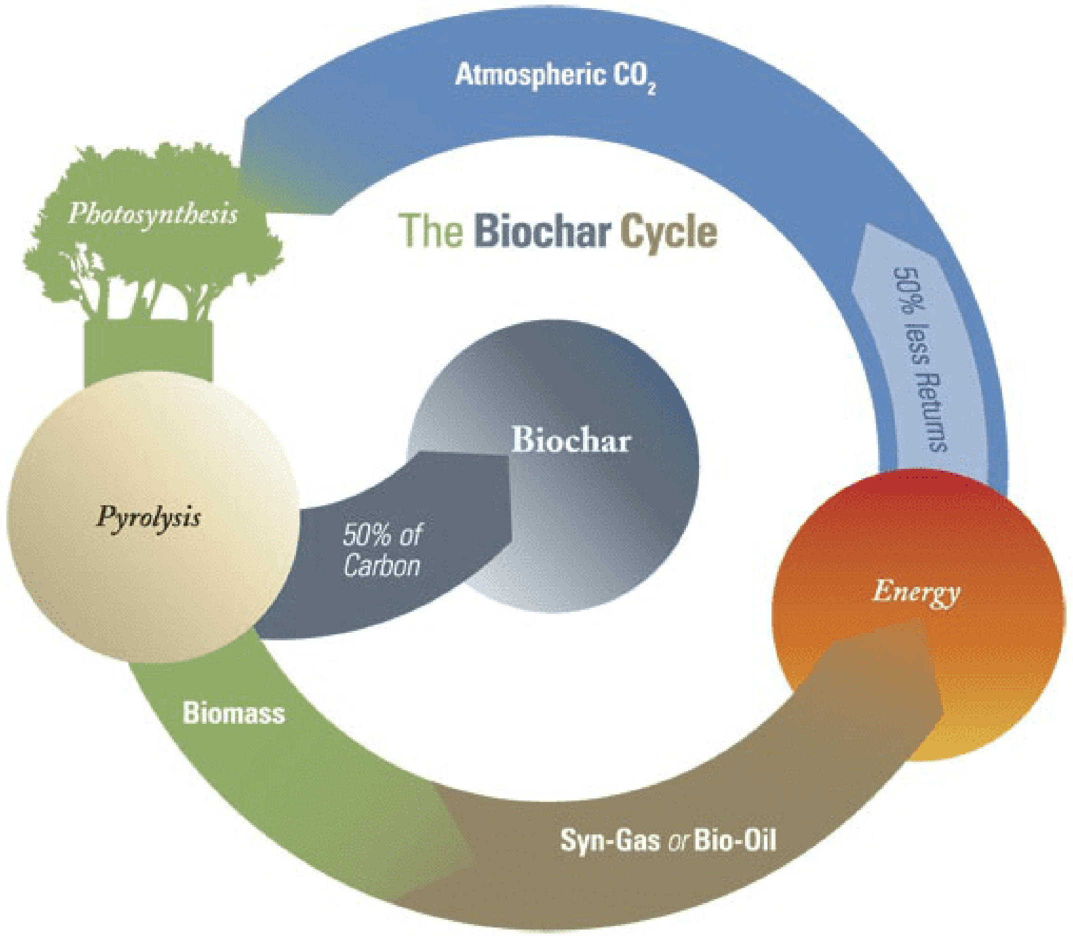
As carbon-based life forms, human beings have caused environmental catastrophe and mass extinction through the disruption of global circulations of carbon.

The project attempts to take carbon and nutrients that have accumulated in the form of invasive species Prosopis juliflora or other 'biological waste', by utilising a Permanent Carbon Capture scenario to reliably remove atmospheric Carbon using Pyrolysis.

This process arrests the end emissions of the traditionally produced coal, by not only producing clean cooking fuel, but also Biochar as a by-product, which in turn can be used as Livestock Feed and Soil Management. Since Banni is dominated by cattle-based pastoral communities, Biochar can be extremely useful to reduce CO2 and methane emissions from livestock, as well as improve their digestion and overall health.



Organic Carbon is the key building block of life and a driver of of ecosystems. Carbon's abundance, its unique diversity of organic compounds, and its unusual ability to form polymers at the temperatures commonly encountered on Earth enables this element to serve as a common element of all known life.



BioChar is one of the few technologies that can remove atmospheric carbon and store it in the inactive carbon pool.

Additionally, whenever BioChar is used in Soil, the productivity of the ecosystem i.e. the rate of Biomass production and therefore Carbon Sequestration increase.

3.0

A Jheel in Chachla Village, Banni,
February 2022

Context | Banni

The project focuses on the Banni region of Kutch, Asia's largest grassland with an expanse of 2,497 square kilometres. It has multiple habitats within the grassland ecosystem, such as seasonal wetlands, saline-mixed grassland with highly nutritive grasses which has resulted in the evolution of many indigenous pastoral breeds and shaped pastoralism in Banni. These unique habitats and compositions of various grasses support almost 150 floral species, 100 plus avifaunal species, 20 reptiles and mammals, etc.

Over the last 50 years, Banni has witnessed land use changes and land degradation owing to Prosopis invasion and increasing soil salinity, which poses a severe threat to existing floral and faunal biodiversity. A study showed that the invasive species Gando Bawal (Prosopis juliflora – a naturally hybridised mesquite species) has taken over about 50% of the 2,497 sq kms of Banni. It has not only altered the productivity, biodiversity, and soil conditions of Banni grassland resulting in huge ecological implications, but also led to a parallel P. juliflora-based fuelwood and charcoal economy, with socio-economic implications.

Currently, the major economic drivers in Banni include Animal Husbandry - Milk production, cattle trading and P. juliflora based Charcoal Making. Village level institutions assist the process of managing and lopping Prosopis, through Community Forest Management Committees (CFMC). The Forest Management Plan proposes the removal of Prosopis, and until now, 30 sq km (3000 hectares) out of 354.16 sq km of dense Prosopis cover is cleared off from the grassland (Vaibhav et. Al, 2012). There are 22 CFMC sites currently.

Pictures from a 1000 x 500 m CFMC site near Hodko village in Banni

4.0

Charcoal making

Existing Practices

Charcoal-making is the pre-dominant secondary occupation in Banni after Cattle rearing. Although socially and ecologically degrading, it has proven to be economically sustainable for locals. **According to a study done on different occupations in Banni, charcoal production is a primary occupation to 20% households and secondary occupation to 80% households** (Manjunath BL, et al, 2019).

A community called the Vada Kolis concentrated in a few villages of Banni are traditionally engaged in producing coal from the excavated bush/tree. It is mostly done during the dry seasons - Summer and Winter. Some people migrate during monsoon months and come back for the production. The negative impacts of traditional charcoal making include:

1 **Tedious labour** – Cutting and collecting Prosopis from the interiors of the wastelands on foot in the scorching heat and transporting them to the charcoal making site. At the site, it is broken down into smaller pieces and one has to continuously tend to the smoking fires over 3 days till they are completely charred. Then, the wood, now turned into charcoal, is cured for 3 days with soil and water. After this, it is stuffed into gunny sacks and then loaded on to trucks.

2 **Health hazards** – The thick smoke spewing out of the charcoal fires is the cause of respiratory diseases and eye ailments in the area.

3 **Socio-economic impact** – Although charcoal making is one of the major economic drivers in Banni, most of the profit is made by the middlemen as it is not regulated.

4 **Ecological impact** – Charcoal production not only affects land where it is produced, but is highly inefficient, does not recover any by-products, contributes to air pollution, and the charcoal is eventually sold to factories for furnaces, where it is burnt - leading to the removal of the Carbon from the ecosystem and putting it back in the Atmosphere.

ECONOMY OF CHARCOAL PRODUCTION:

ANNECDOTAL FIGURES SUGGEST THAT 7.5 TONS OF CHARCOAL IS PRODUCED EVERY DAY IN BANNI

IT TAKES 5 PEOPLE TO LOAD 1 TRUCK OF 400KGS PROSOPIS WOOD PER DAY

THE DAILY WAGE PER LABOURER PER DAY IS RS. 300

1 BORI OF COAL RANGES FROM 40 - 45 KGS

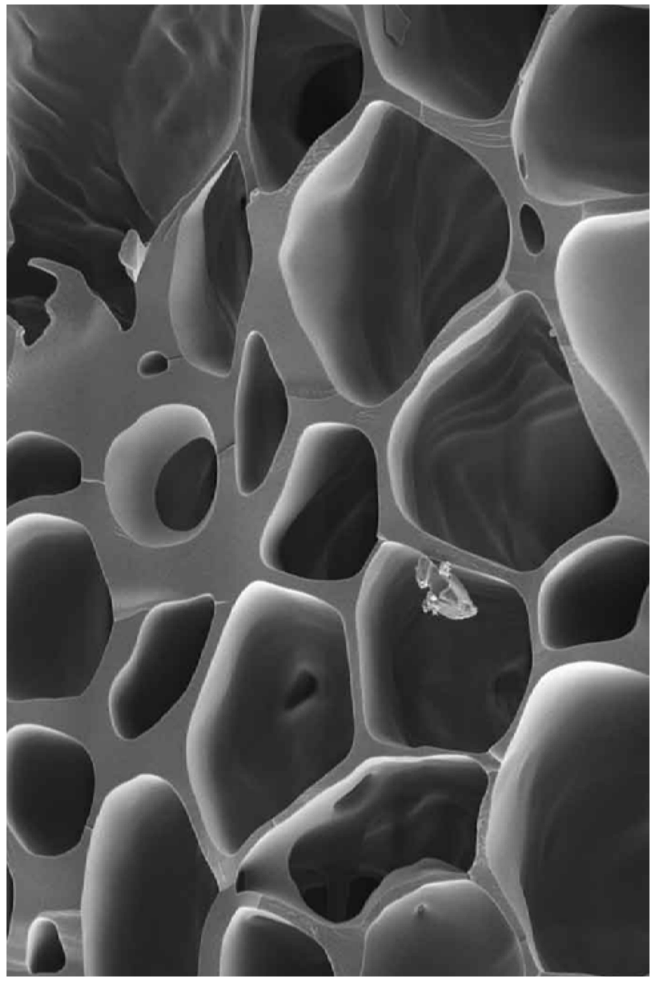
IT TAKES A TOTAL OF 6 DAYS TO PRODUCE 20 BORIS OF CHARCOAL IN A BHATTO OF SIZE 1.5X1.5X1.5M

IT IS SOLD AT RS.7-10 PER KG

Biochar

Charcoal and Biochar are produced by similar processes, but by controlling the temperature and duration of the reaction, a molecular structure that performs differently can be produced. Pyrolysis - the process to produce Biochar is a carbon negative process that takes CO2 accumulated in the biomass and thermally decomposes it into a stable form - can eventually be used to sequester carbon in the ground.

Pyrolysis is the process of decomposing plant or animal residue through the application of heat in a low-oxygen environment. During pyrolysis, organic material is broken down into smaller compounds and converted into gases. As some of the organic gases condense, a mass of carbon, ash, and oil is formed. Modern pyrolysis and carbonization technology offers significant improvements in terms of energy efficiency and levels of pollution over traditional charcoal production technologies. In modern plants, different quantities of heat, bio-gas, bio-oil, and biochar are produced depending on the technology and key **production parameters such as temperature and aeration.**



LEFT.
Microscopic Biochar showing its highly porous nature. ©Google Images

RIGHT.
Some ways that biochar helps improve soil quality. (Das et al., 2021)

ENHANCING SOIL STRUCTURE

INCREASING WATER RETENTION AND AGGREGATION

DECREASING ACIDITY

REDUCING NITROUS OXIDE EMISSIONS

IMPROVING POROSITY

REGULATING NITROGEN LEACHING

IMPROVING ELECTRICAL CONDUCTIVITY

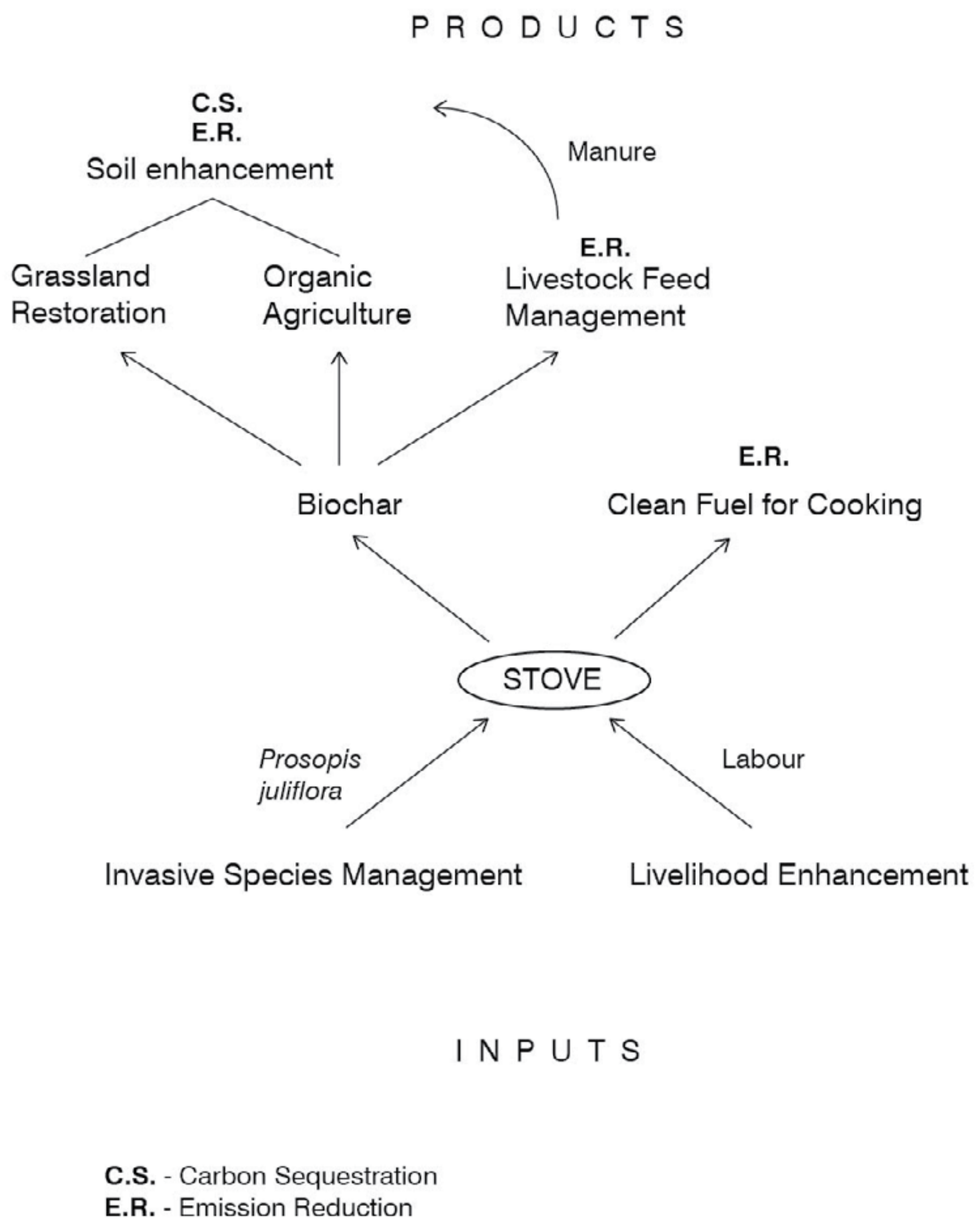
IMPROVING MICROBIAL PROPERTIES

5.0 Exploring Alternatives

The project explores the possibility of introducing two iterative and scalable machines into the existing Charcoal economy to make the process more efficient and sustainable such that the community can also benefit from the process:

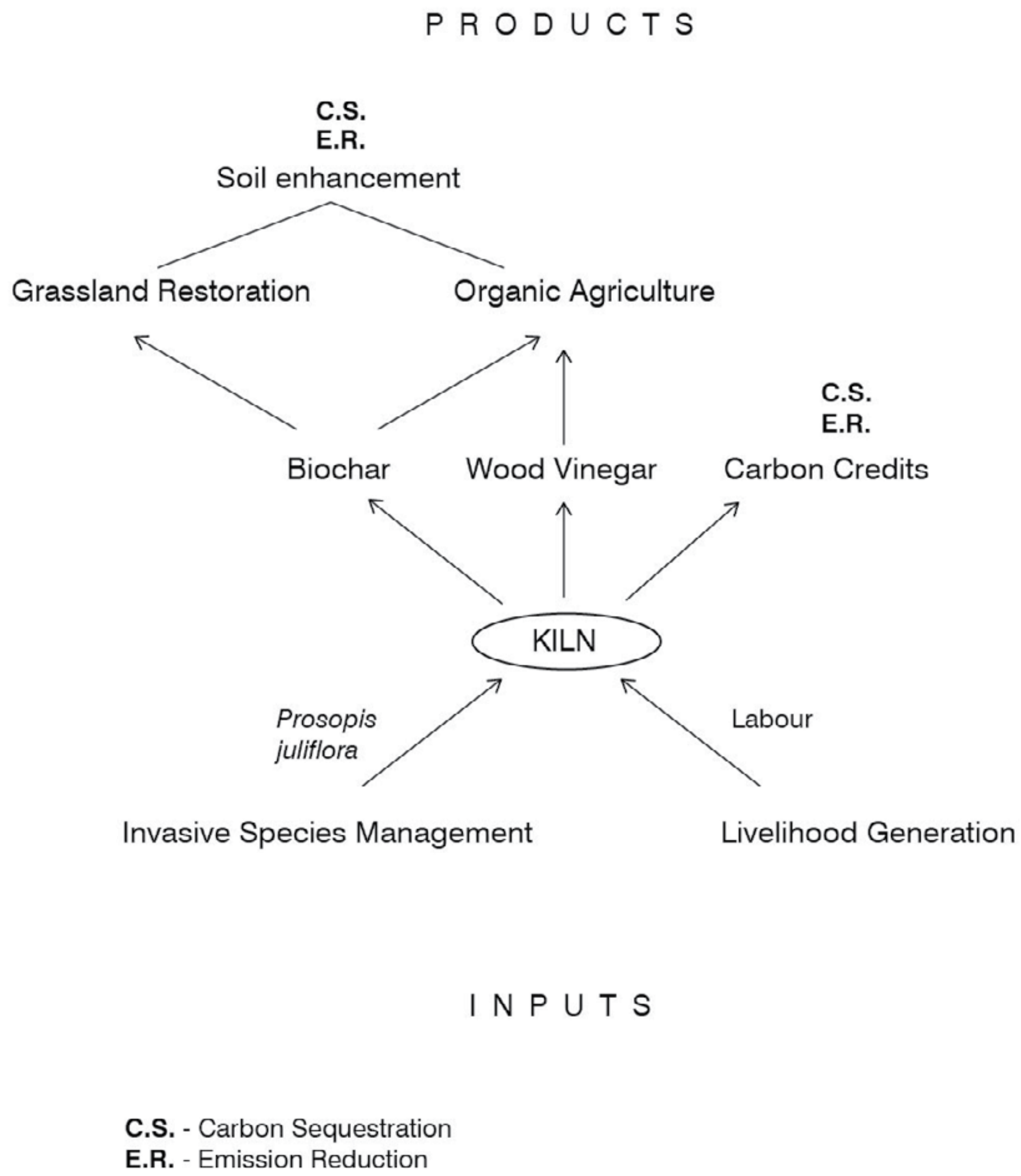
1. Biochar Stove - A home-based ultra decentralised unit to produce clean energy and biochar as a by-product while cooking, to keep in check polluting indoor cooking environments, as well as a source of high quality biochar that can be incorporated into cattle feedstock management, which can increase the health and productivity of the cattle.

2. A Small Scale Kiln - An efficient and mobile machine to produce Biochar, manage invasive species and recover byproducts of the process. This model would be designed in such a way so that it can also condense the Wood Vinegar + Bio-Oil and can also serve as a demonstration device.



5 Kg of Biomass in Anila Stove can produce approximately 1.6 Kg Biochar, also providing clean fuel for cooking.

Source. The Schumacher Institute, 2008



1 ton of Biomass in a Kiln can produce approximately 300 Kg Biochar, 180 Kg Wood vinegar, sequestering 900 Kg CO_2

Source. biocoal.org

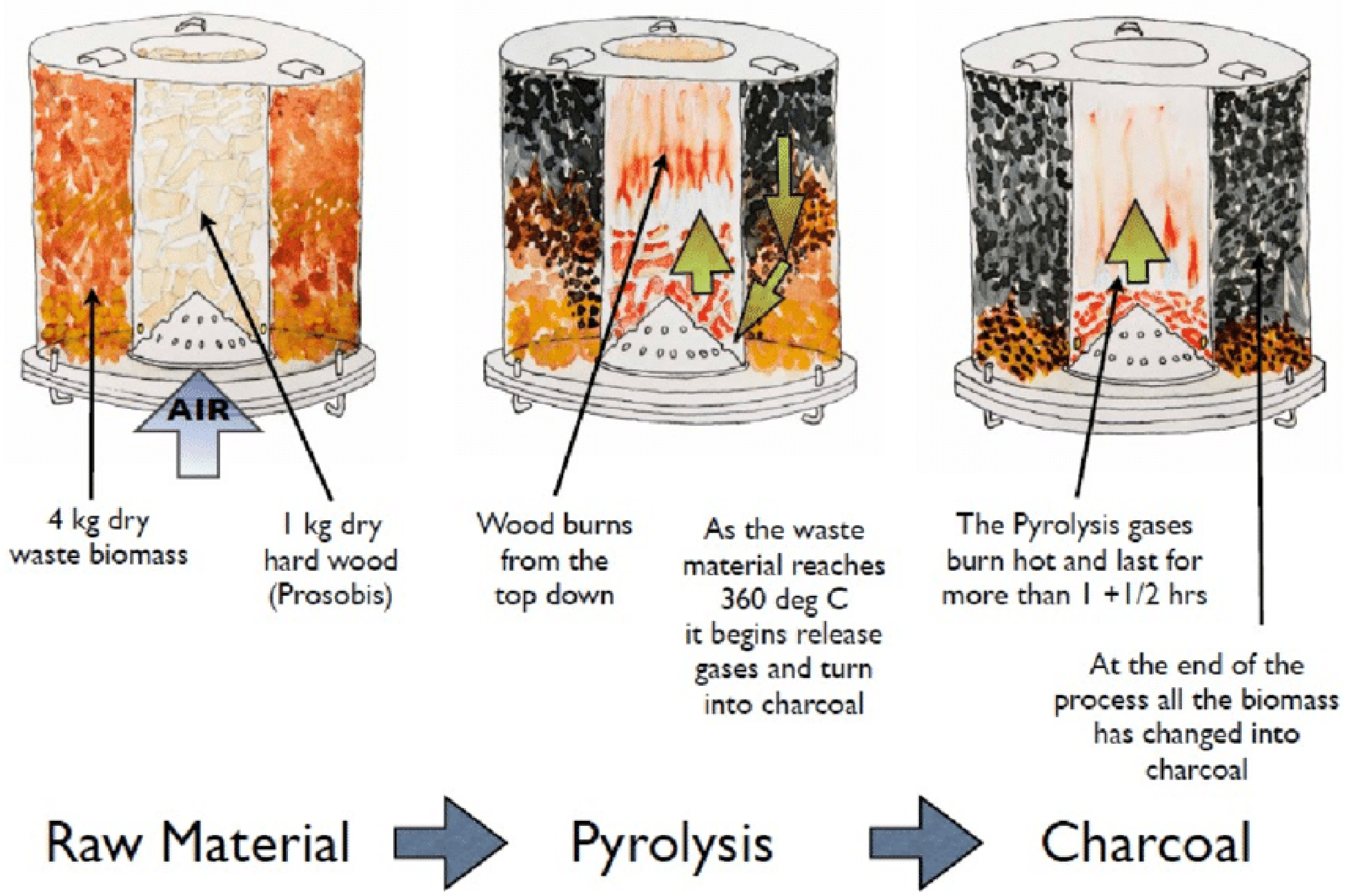
5.1 Machine | Stove

Decentralised Biochar Cook Stove

The use of traditional Indian cooking stoves or Chulha - the main energy source in rural India, raises serious health and environmental concerns. As women are primarily responsible for cooking, and children often spend time with their mothers — women and young children are disproportionately affected by the indoor air pollution caused by the use of solid fuels and traditional stoves. **The traditional cookstove produces carbon dioxide, methane and particulate matter that contributes to global warming. Its emissions and rate of wood consumption is highly unsustainable (Venkataraman et al., 2010).**

In a study by the University of Edinburgh, Biomass micro-gasification, i.e. in which part of the biomass is converted to a clean 'synthesis gas' and burnt, and a solid charcoal residue is produced, emerges as one of the key contending options for improved stove designs. Gasification stoves involve two processes. First, solid biofuel is pyrolysed into a mixture of hydrocarbon-containing gases and charcoal. Second, the gases are burnt with a clean (smokeless) flame. When the stove is used to make charcoal, the operation of the stove is stopped at this stage and the charcoal is removed as a by-product. A primary air flow is required for pyrolysis, while a secondary air flow is introduced into the hot gas above the fuel in order to assist the gas burn (Shackley & Carter).

The Anila stove, which chars biomass placed in an outer fuel container, is an alternative design from the perspective of biochar production. The project identified it as an efficient design and experimented with 3 prototypes.



TOP. The working of the Anila Stove (a Top Lit Updraft Gasifier Stove) designed by Prof. Ravikumar - a prototype that we developed and tested during the research.

Anila Stove Testing
Protoype 1

Observations - Prototype 1:

1. Reduced emission than from traditional cookstoves, however there is still some smoke that is released from the bottom.
2. It is much more efficient than traditional chulha in wood usage.
3. Different feedstocks were used in both chambers like twigs, branches, hardwood, leaves, barks, roots balls etc.
4. The charcoal prepared is undercooked and of low quality.

Suggestions for improvisation:

1. The holes in the inner chamber need to be smaller but more numerous so that there is proper secondary airflow.
2. The height needs to be reduced as it does not work ergonomically - both the legs as well as the overall height; the width can increase to accomodate for the volume.
3. Even after adding a mud seal, the gases from the outer chamber escape. Therefore, it has to be made airtight.
4. The flame is too high so the TLUD bottom needs to be regulated for airflow.
5. Holes in the bottom need to be larger for the Ash to fall through.
6. A seat needs to be made next to it as the stove is taller than the normal chulha.

RIGHT. The first prototype of Anila stove was produced by an artisan using 18 gauge galvanised steel.

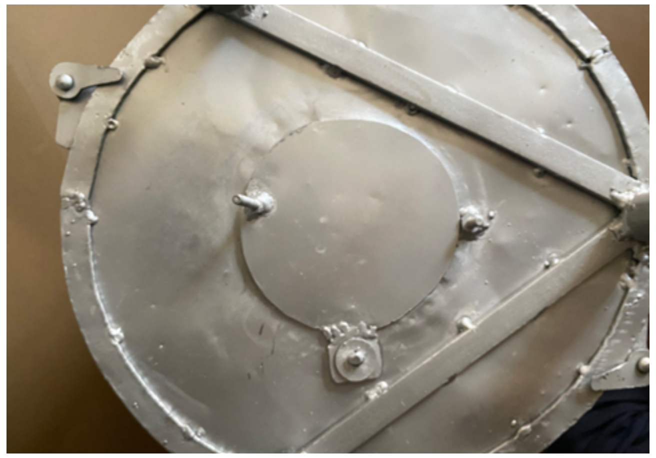
Anila Stove Testing
Protoype 2

Observations - Prototype 2:

1. There is still some smoke that is released.
2. It is efficient than traditional chulha in wood usage though not so efficient in burning and producing charcoal.
3. The size is too large and not suitable ergonomically.
4. Although we added a metal panel below for regulating the flame, it did not work as we thought.

Suggestions for improvisation:

1. The size of the entire stove can be much smaller so that women can squat as they are generally used to.
2. The seal below needs to be made much tighter as there are still some gases being released.



Anila Stove Testing
Protoype 3

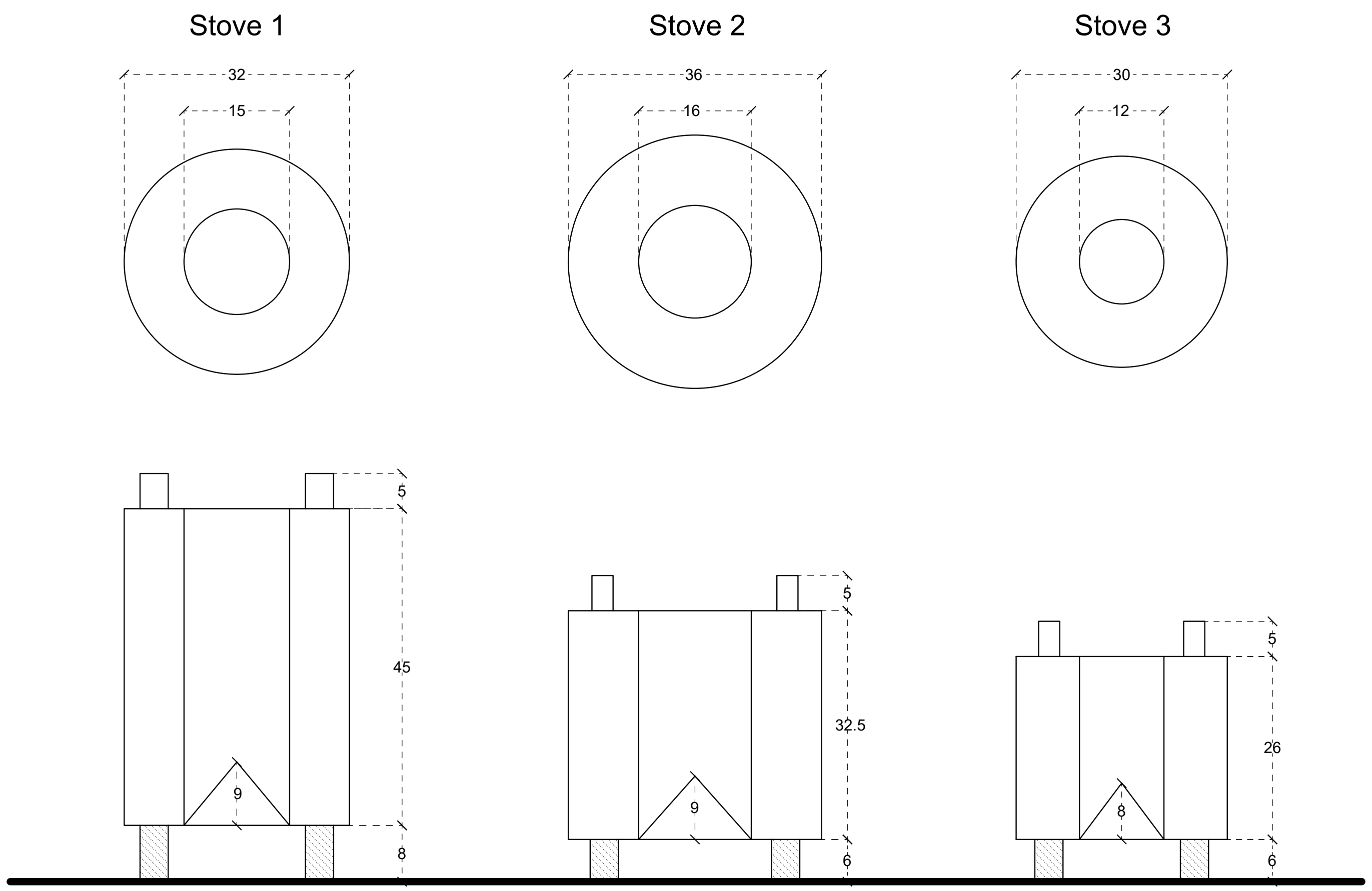
Observations - Prototype 3:

1. Significantly reduced smoke, as the lid is tight from below.
2. Much more efficient than traditional chulha in wood usage.
3. The stove size is compact and appropriate in that women can easily squat while cooking, as they are used to.
4. Burning efficiency is very high, and can be effectively used for boiling water and making tea.

Stove Prototype	Weight (Kg)	Overall height (cm)	Inner chamber volume (cu cm)	Outer chamber volume (cu cm)
1	13	58	7,950	28,240
2	10	43.5	6,535	26,550
3	6.5	37	2,940	15,440

Stove Prototype	Weight of wood in Inner chamber (Kg)	Weight of Biomass in Outer chamber (Kg)	Weight of Charcoal produced (Kg)	Time taken for charcoal production (min)
1	2	4	2	60
2	3	5	1.5	45
3	1	2	1	40

ABOVE. Comparative study of the three stove prototypes fabricated for testing purposes. All dimensions given are in cms.



After prototyping and testing three stove designs, we observed that:

1. Although it is much more efficient in burning than traditional stoves, there are some extra steps needed to be taken in order to use to stove efficiently, and the users do not see the value addition done by this extra effort.

2. The amount of biochar produced is very less and of low quality.

3. Burning efficiency is very high, and can be effectively used for boiling water and making tea. The stove can be used as one of the alternatives to meet energy requirements in peri-urban or rural areas.

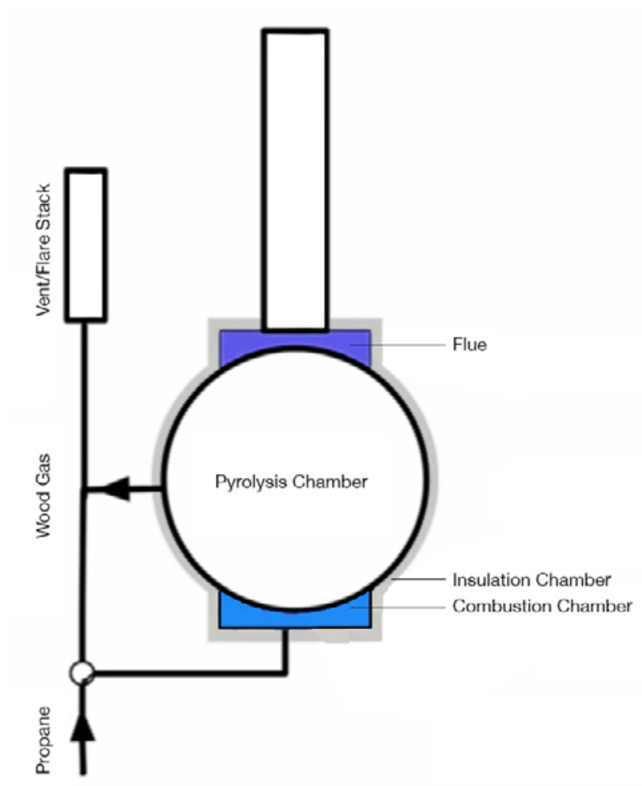
5.2 Machine | Kiln

Small/Medium Scale Mobile Device

As part of the project, we experimented with a low budget prototype device that is efficient and can effectively produce Char on a local scale whilst recovering all the byproducts. The Mobile Retort can be mounted on a trailer, towed behind a car or tractor, and taken to the sources of the biomass - Farms, CFMC sites and other sites where Prosopis is found. This model would also be able to condense the wood Vinegar + Bio-Oil, and can serve as a demonstration device as well.

It is imperative to have an appropriately sized Hammer or Ball mill to Crush the Char into fine particulate sizes. The smaller the shards of char, the more exposed surface area is available and the more effective the product.

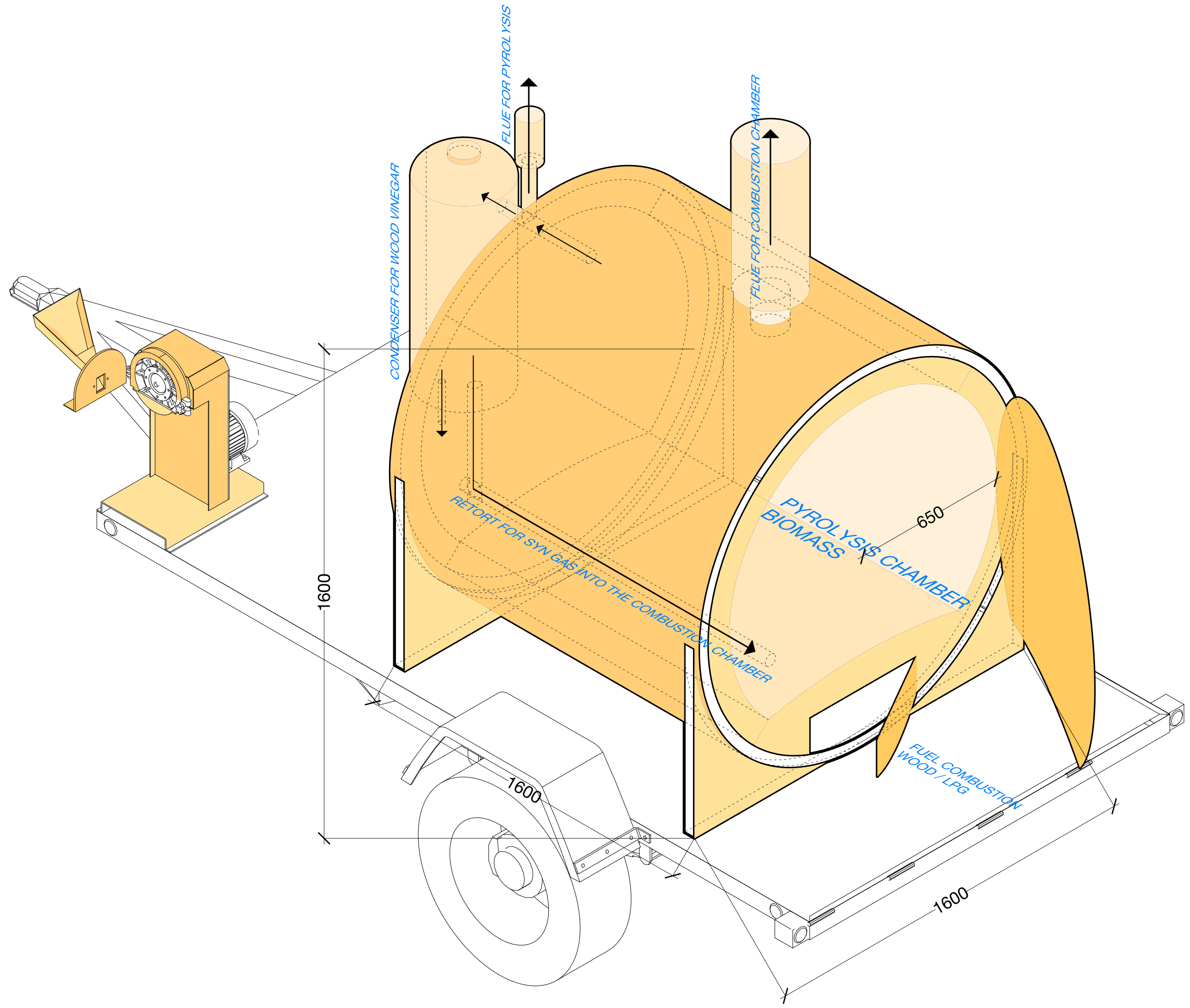
It is necessary for the design to optimise and maximise the size of the unit in relation to the trailer and the cost of materials and manufacturing, so as to increase the yield per run. It is also necessary to create space on the trailer to store the hammer mill, the packaging equipment and storage and soaking (Innoculation) space for the char.



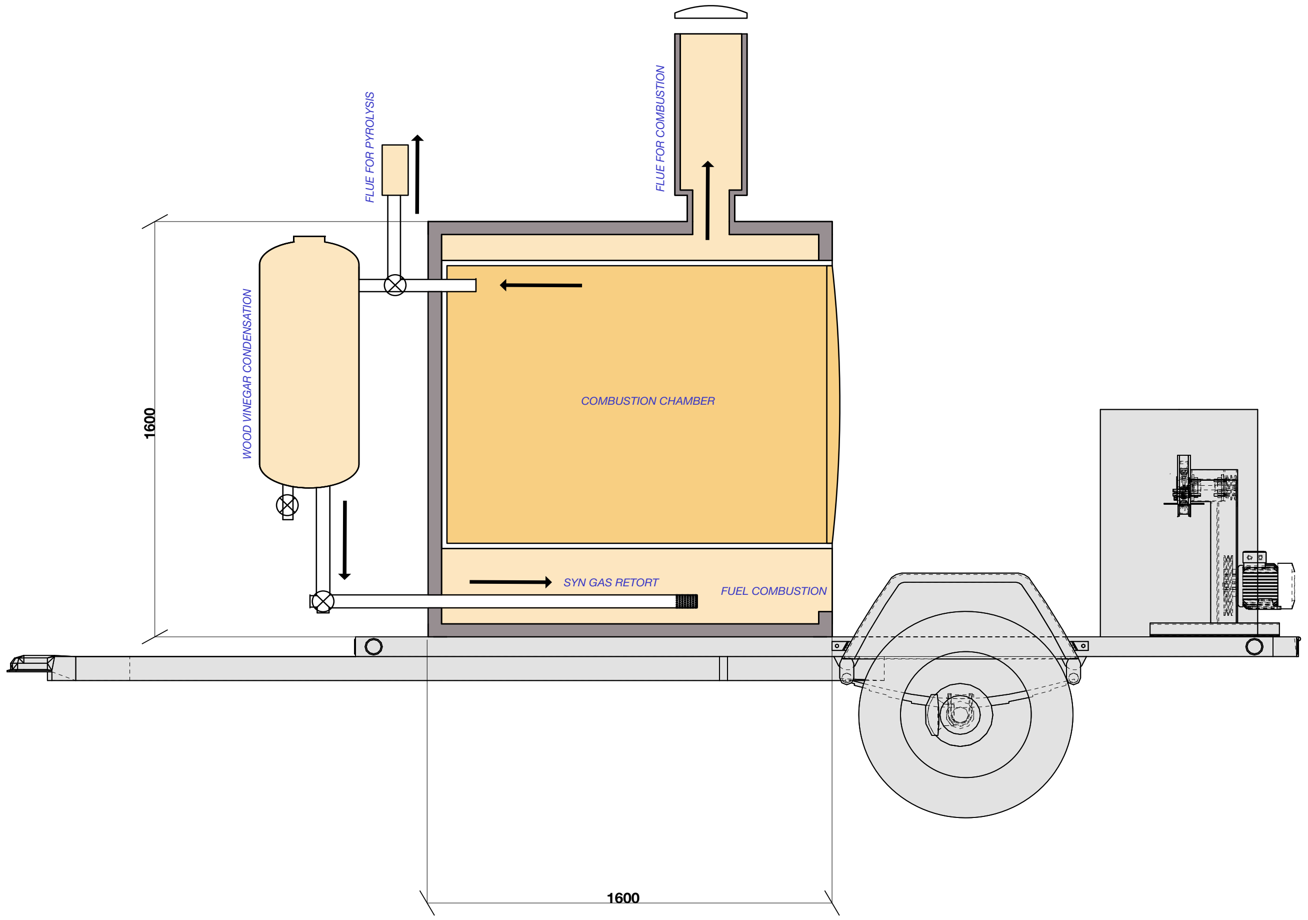
Input:
Biomass from primary and secondary sources

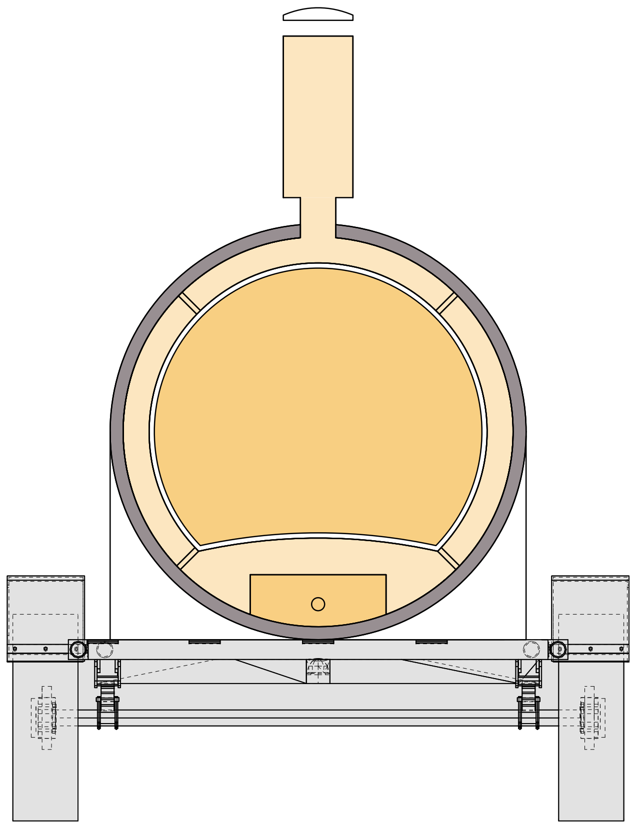
Process:
Pyrolysis
Condensation
Retort

Output:
Biochar
Wood vinegar
Syngas



*This machine has been designed by Sahir Patel.





1 m³ of cylindrical Kiln Volume will yield 100 - 135 kg of BioChar and approximately 60 kg of Wood Vinegar.

1 m³ of Kiln Volume might contain 500 - 600 kg of Wood.

1 Ton of Biomass will yield approximately 300 Kg of BioChar.

Source. https://www.biocoal.org/adam-retort-kiln/

Post Processing

To enhance biochar properties

MILLING

- Grinding and Milling down to sub-millimeter sized particles to increase surface area, aid handling and biochar application.
- Aggregation will enhance the effects of biochar, retaining water and nutrients, often providing islands of habitat for microbial life, and it will make the biochar stable
- The increase in total exposed surface area and the quantity of particles if a 1 centimeter cube of biochar is reduced in size by half 10 times is exponential. Therefore, we significantly increase the effectiveness of the biochar though milling.

Size	Quantity	Total Surface Area cm^2
1 cm	1	6
5 mm	8	12
2.5 mm	64	24
1.25 mm	512	48
625 µm	4,096	96
312 µm	32,768	192
156 µm	262,144	384
78 µm	2,097,152	768
39 µm	16,777,216	1536
20 µm	134,217,728	3072
10 µm	1,073,741,824	6144

Source. Biochar.info

Various types of Agro-based pulverising machines which can be used to grind the charcoal into a fine powder.

ACTIVATION

Techniques can include treating:

- Infuse with organic or inorganic nitrogen compounds e.g. urine or Jeevamrut to enhance N content
- With nutrient-rich organic material eg Manure or Compost.
- Add minerals e.g. rock phosphate, gypsum, dolomite, iron oxides, lime to address specific soil constraints
- With Phosphoric acid to enhance functional groups, reduce pH and make a slow-release phosphate fertilizer
- With alkali (e.g. potassium hydroxide) to increase pH and increase K content

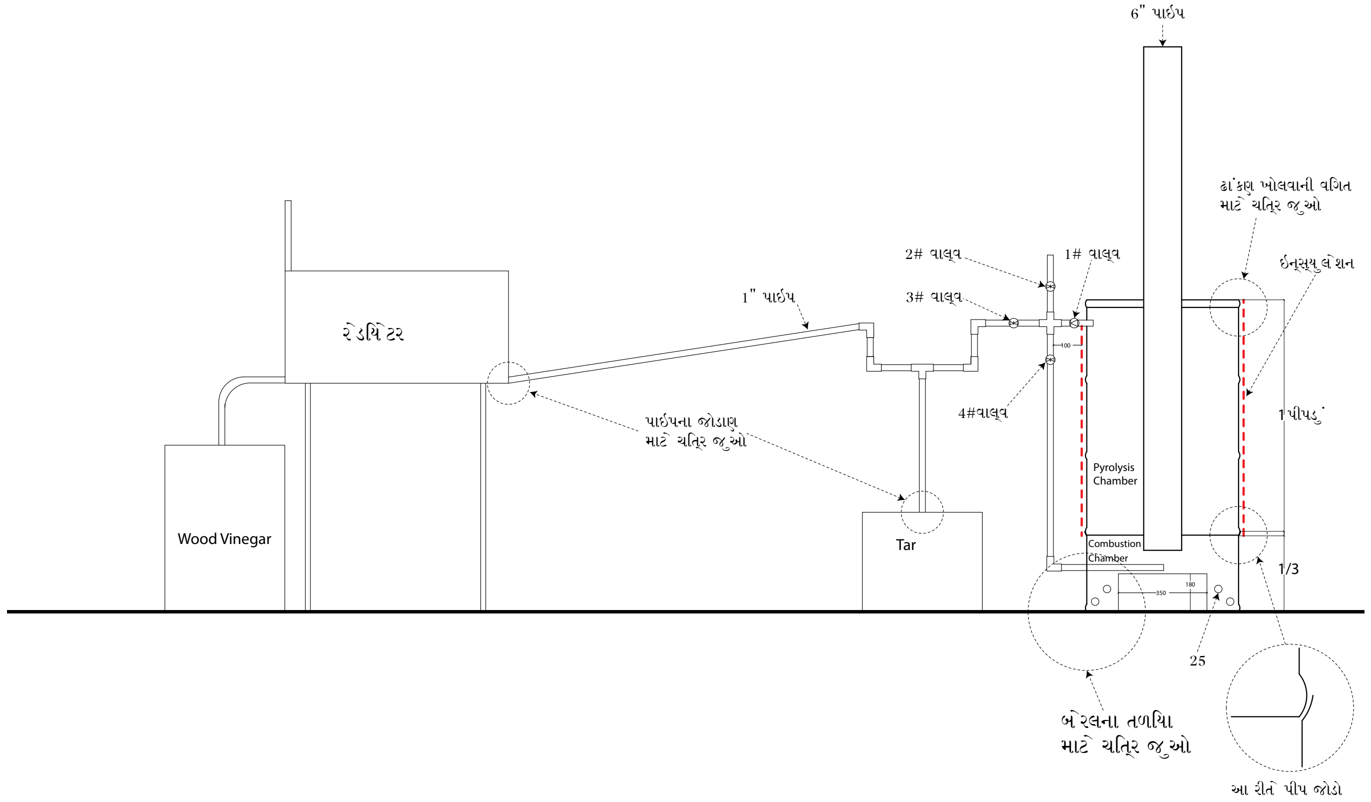
We experimented with a low cost kiln to understand the charcoal making process in order to design a more efficient version using the same principles.

Kiln Testing

Kiln Prototype 1	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
Weight of wood in Pyrolysis chamber (Kg)	52	53	50	48	50	48	51	50
Weight of Wood in Combustion chamber (Kg)	70*	15	12	14	15	16	18	15
Weight of Charcoal produced (Kg)	20	18	14	15	15	14	16	14
Wood vinegar condensed (L)	0.5	1	3	4	4	5	5	5
Time taken for charcoal production (hr)	8	8	6	7	8	6	7	6
Efficiency % (Direct)	38.5%	34%	28%	31.2%	30%	29.2%	31.4%	28%
Efficiency % (Compound)	16.4%	26.5%	22.6%	24.2%	23%	21.9%	23.2%	21.5%
Quality	Low quality	Low quality	High quality	Low quality	High quality	High quality	Low quality	High quality
Comments								

RIGHT. Drawing made for fabricator and process images for Prototype 1

NEXT PAGE. Experimentation with different condenser designs for better production of wood vinegar.









ABOVE. Tar derivative while extracting wood vinegar. The later condensers were designed to avoid the tar formation.

Observations

After prototyping and testing designs for the kilns, we observed that:

1. The Kiln performs much better than traditional method of charcoal making as it produces lower emissions giving a higher burn efficiency, produces good quality char and wood vinegar, ability to burn off and utilize the Syn gases (which would be high greenhouse gases like methane, etc). The drawback is that the cost of building the kiln is too expensive in comparison to the recovered materials as only a small quantity being produced, takes man power, and the kiln is not durable as it degrades quite quickly with the rain and the elements as it is a metal barrel. More research is required to make a totally efficient condenser that is able to fully recover the wood vinegar and also to utilize the excess heat generated for other purposes.

2. We also experimented with bone char, which is an exciting new material that needs to be experimented and explored for its properties as there is a potential abundance of cattle bones in the Banni landscape.

6.0

Revenue Generation

BioChar itself retails anywhere between Rs.11/Kg (Whole Sale) to Rs. 200/Kg.

1 m^3 of cylindrical Kiln Volume will yield 100 - 135 kg of BioChar and approximately 60 kg of Wood Vinegar.

1 m^3 of Kiln Volume might contain 500 - 600 kg of Wood.

1 Ton of Biomass will yield approximately 300 Kg of BioChar.

Wood Vinegar can be extracted and sold at Rs. 85/ Kilo to be used in varying dilutions based on the application.

The Carbon Cycles Project aims to create and market the Biochar Production Unit as well as end products such as Biochar and Wood Vinegar. Using effective invasive species management local governments and communities can form Co-operative to increase their income and effectively manage their land and cattle by using as well as selling these products directly to the end users.

Products (Char and Vinegar) can not only be used for Grassland Restoration in the region itself, but be marketed and sold via Landscape Architects and Designers, can be sold to 'Home Growing Enthusiasts' for a premium,to Large Agricultural Operations - Particularly with high value products to along with compost makers to incorporate with their compost as it is being Decomposed - to create a super fertilizer.

6.1 Biochar

Applications

Charcoal is a stable form of carbon that has been a part of natural soil ecosystems for as long as natural fires have existed (Kai Hoffman Krull).

Biochar can enhance regenerative agriculture by increasing carbon sequestration from composting, animal rotations, cover crops, and no-till farming methods. Biochar applied to agricultural soils has been found to decrease carbon off-gassing by up to 68.8%. Increasing carbon retention in agricultural soils can improve crop endurance, and biochar's potency as a soil amendment could be a critical step toward climate resilience (Kai Hoffman Krull).

When incorporated into a soil, biochar is more resistant to microbial decomposition than the original organic materials used to produce the biochar. In addition, biochar additions may improve soil fertility by improving soil nutrient retention capacity and by enhancing water infiltration (Lehmann et al. 2006). Therefore, the production of biochar and its subsequent incorporation in agricultural soils has been proposed as a potentially effective way to sequester carbon while improving soil fertility.

Biochar can also be used to regenerate collapsing ecosystems and for forest management. Its capacity to increase soil nutrient retention and effectively sequestering carbon can be very useful in approaching ecological management.

1 SUPER-FERTILIZER

- Permanent soil amendment to improve soil health
- Nutrient and microbial carrier
- Improves composting process by significantly reducing nutrient losses and greenhouse gas and ammonia emissions.
- A finished biochar compost will retain much more of the nutrient content of the biomass feedstock in an ideal, plant available, slow release form.

2 CATTLE FEED

- Feed supplement to improve animal health and nutrient intake efficiency, thus productivity.
- Effective, economical means of suppressing pathogenic intestinal bacteral loads in animals.
- Reduces methane emissions for cows by 20%.
- Improves quality of cow manure.

3 WATER FILTRATION

- Immobilising agent for remediation of toxic metals and organic contaminants in soil and water.

4 CLIMATE CHANGE MITIGATION

- Effective way of managing largescale biomass and issues such as Crop burning.
- A simple, sustainable means to sequester historic carbon emissions that is technologically feasible in developed or developing countries alike.
- Improving Ecosystem Functioning
- Increase in Agricultural Productivity

6.2 Wood Vinegar

Applications

Wood vinegar, also known as pyroligneous acid, contains over 200 organic compounds, decomposed and extracted from biomass using a moderate amount of heat in the absence of oxygen.

Plants have evolved to produce these compounds over the last 470 million years. **They resist attacks by insects, fungi and bacteria, and keep themselves healthy and thriving by selectively and synergistically utilizing these organic compounds.**

It is a highly effective pesticide and fungicide that nurtures soil microbial life, stimulates plant growth and is optimally biodegradable.

1 GROWTH STIMULANT

- Improves Soil quality and assists plant growth by being able to accelerate the development of plants
- Used to increase yields in fruit orchards
- Nurtures soil microbial life

2 BROADSCALE INSECTICIDE AND FUNGICIDE

- Resist attacks by insects, fungi and bacteria, and keep themselves healthy selectively and synergistically utlizing these organic compounds

3 ANIMAL HEALTH

- An ingested mix of activated charcoal and wood vinegar kills the cryptosporidium parasite in calves and cattle, curing the related diarrhoea in one day.
- Effective repellant and biocide against poultry mites

7.0

Solutions to Existing Charcoal Practices

Shifting Cultivation

Permaculture-based Land Management

Effective Design Strategies

Strengthening Rural economy through Co-operative Creation

Shifting Cultivation

A pattern of shifting land use could be Charcoal Making > Cattle Stocking > Removal of Prosopis > Introduction of native grasses > Monitored and Controlled grazing, such that it is decentralised and benefits all parties involved.

Permaculture-based Land Management

Creating gradients and ecotones to accumulate salts and water at certain areas and creating raised ground to create zones of low salinity - Creating greater water infiltration through earthworks and having living roots in the ground.

Effective Design Strategies

Assisting the process of Lake formation or other water management structures and effective design through CFMC.

Strengthening Rural economy through Co-operative Creation

Creating a co-operative to produce, market and sell Biochar and wood vinegar from Banni, thereby increasing the number and earning potential of people engaged in charcoal economy. The project proposes to use Prosopis juliflora to create Biochar through Improved Charcoal Production Systems.

Jheel in Gorewali Village surrounded by Kutchi salt-tolerant Mango trees, Banni

For the process to be more efficient, it will be necessary to scale up the functions and form a collective/co-operative for producing, selling and marketing Biochar/Charcoal into high value commodities.

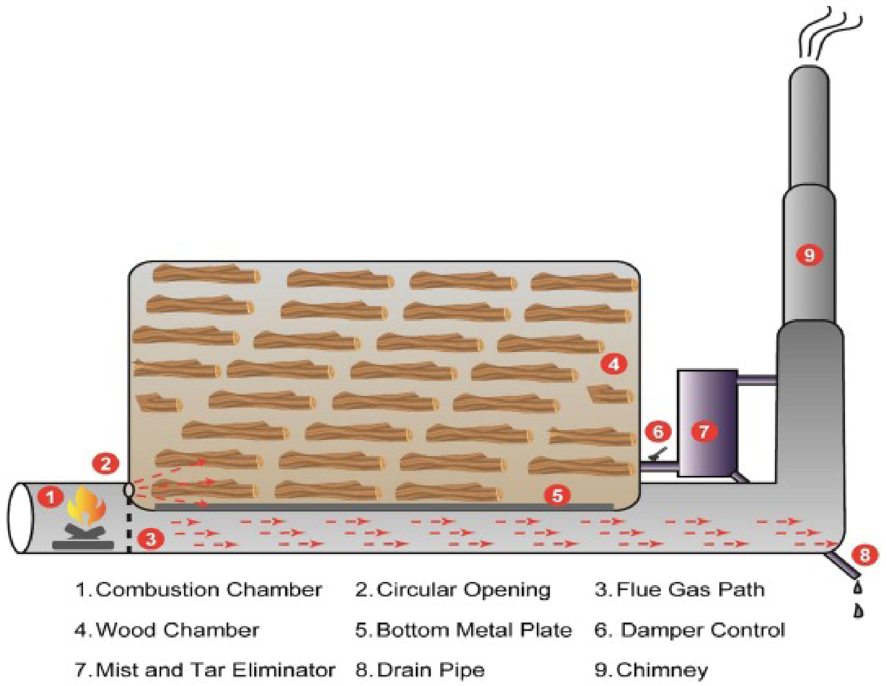
Instead of the portable kilns we have experimented with, we need a bigger on-site setup of Improved Charcoal Production System such as the Adam Retort, so that there can be a sizeable and continuous supply of biochar produced.

Additionally, this would enable the community to derive Carbon Credits in the voluntary market from the biochar itself as opposed to Grassland Restoration work.

7.1 Adam Retort Kiln

1. High economy and better efficiency of approx. 35% as compared to 18% efficiency of the traditional systems. About 3m³ of biomass (corresponding to approx. 600kg to 900kg wood, coconut shells, compacted saw-dust briquettes, etc., dry weight, water not counted, or ~1-1,5 tons of wet wood) can be converted to ~250kg charcoal per batch.
2. A retort system reduces the emission of harmful volatiles into the atmosphere to about up to 75%, compared to a traditional earth-mount kiln). Recycling and clean combustion of the pyrolysis gas during the 2nd phase of operation (retort-system) results in a low emission of carbon monoxide, methane, etc. during the charcoal production.
3. The effective operation of the retort and carbonization of the biomass takes only ~10 hours.
4. Low investment costs of about ~1000Euro and a simple construction with locally available materials.
5. Per week about 2-3 batches of biomass can be carbonized which is corresponding to about ~ 1/2 ton or more of charcoal per week and unit.
6. The right system to be used at forest projects, sustainable energy-wood plantations and charcoal makers in rural areas or for semi-industrial production.
7. Only waste wood or residual biomass needs to be burnt (~50kg) in a separate fire box to dry and heat the wood and initiate the carbonization process during the 1st phase.The production of “wood vinegar” is possible during the 1st phase of operation.

Source. https://www.biocoal.org/adam-retort-kiln/



Source. Carbonization using an Improved Natural Draft Retort Reactor in India

Source. ICPS

7.2 Carbon Credits

A carbon credit is a permit that allows a company that holds it to emit a certain amount of carbon dioxide or other greenhouse gases. One credit permits the emission of a mass equal to one ton of carbon dioxide. Companies voluntarily purchase carbon credits to offset their emissions.

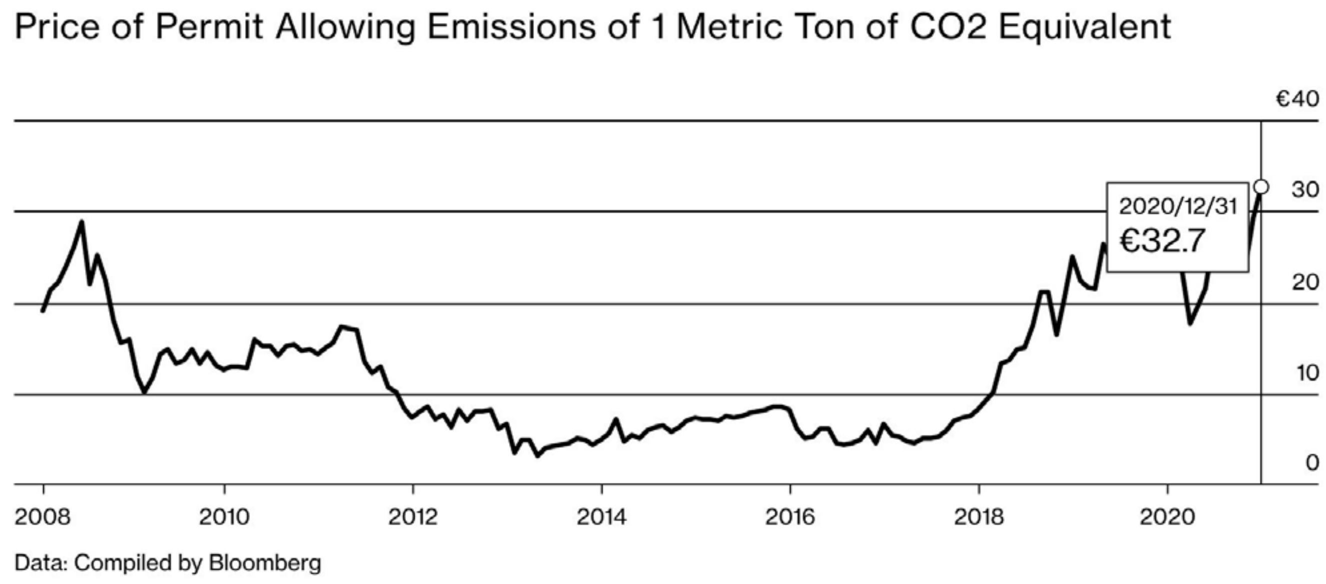
A carbon offset broadly refers to a reduction in GHG (Greenhouse gases) emissions – or an increase in carbon storage (e.g., through land restoration or the planting of trees) – that is used to compensate for emissions that occur elsewhere. **A carbon offset credit is a transferrable instrument certified by governments or independent certification bodies to represent an emission reduction of one metric tonne of CO2**, or an equivalent amount of other GHGs

The Carbon Cycles projects can create a market for companies to offset their carbon emissions by restoration of soil through carbon capture.

The price of one metric tonne of CO2 in Europe is approximately €32.7

Although in India, the carbon market is still to pick up steam there are a few groundbreaking examples. Powerguda, a company in Andhra Pradesh was selling 147 tonnes equivalent of saved carbon dioxide credits. The company has claimed having saved 147 MT of CO2. This was done by extracting bio-diesel from 4500 Pongamia trees in their village. (DowntoEarth, 2003).

Startup nurture.farm has sold 20,000 carbon units from agricultural waste. It is the largest participant in the use of “Pusa bio-decomposer”, an organic solution developed by the state-run Indian Agricultural Research Institute, and is designed to melt away leftovers from paddy cultivation in Punjab and Haryana, thereby preventing their burning, a cause of deadly annual smog across north India (HindustanTimes, 2022).



Source. ICE Endex, Bloomberg

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Links

Global Carbon Project
https://www.globalcarbonproject.org/carbonbudget/19/infographics.htm

Different Types of BioChar Production
https://biochar.international/guides/biochar-reactor-to-meet-needs/

BioChar Classification Tool
https://biochar-international.org/biochar-classification-tool/

BioChar Information
http://biochar.info

Small Scale Biochar Kiln
http://biochar.ch/?p=en.small_scale_biochar_kiln

Medium Scale Biochar Kiln
https://www.carbongold.com/trade/

Large Scale Horizontal Biochar Kin
http://biochar.ch/?p=en.horizontal_bed_kiln

Verification Standards
C Verify - https://verify.lsce.ipsl.fr
Verra - https://verra.org

Carbon Zero Project
http://carbonzero.com/index.cfm?view=44.14&lan=en

BioChar Preparation
http://biochar.ch/?p=en.biochar_preparation

Carbon Gold BioChar Company Kiln by Carbon Gold
https://www.carbongold.com/case-studies/

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Appendix

Costs of the Prototypes

STOVE

Cost of first iteration : Rs. 7,000
Cost of second iteration : Rs. 8,000
Cost of third iteration : Rs. 6,000

KILN

Cost of first iteration (with a rudimentary condensor) : Rs. 30,030
Cost of 4 different condensors with first drum : Rs. 40,910
Cost of final iteration of the drum and condensor : Rs. 40,580

1 Ton of Bio-Char put into the ground

≈

3 Tons of CO2 permanently removed from the Atmosphere.