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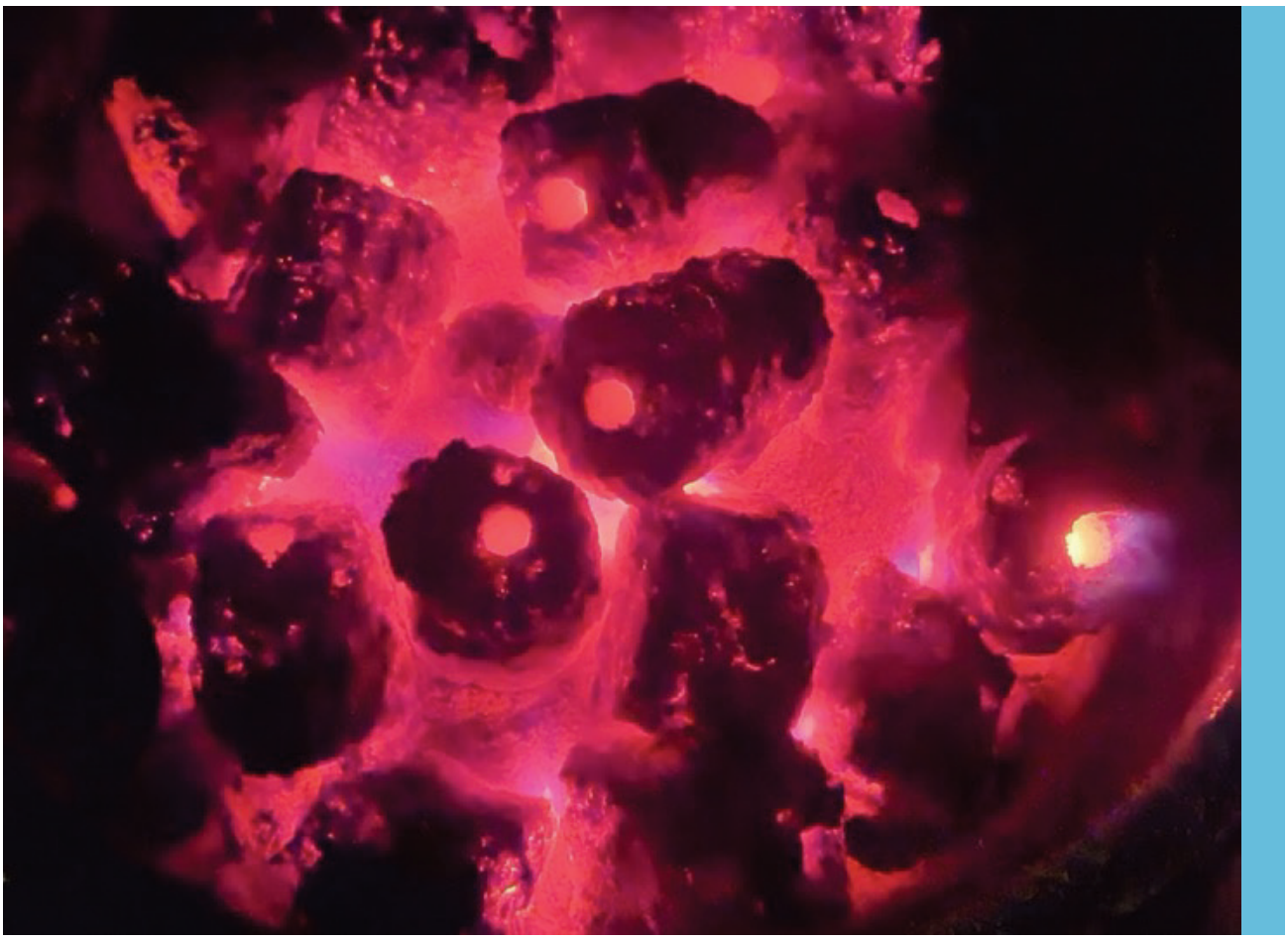

BRIQUETTES PRODUCTION TRAINING MANUAL

FUEL BRIQUETTES MAKING MANUAL FOR APPLICATION IN COMMUNITY TRAININGS IN UGANDA

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ABOUT THE MANUAL

The fuel briquettes manual aims to equip young people and the informal sector in general with knowledge of fuel briquettes making from waste and their marketing. This manual has been tested against communities operating through the structure of communal cooperatives in Uganda – the CBS PEWOSA – where members, including young people, were trained to convert waste into briquettes and invest in enterprise-driven production. They then invested in expanding production through the use of briquettes machines. The manual answers the expectations of trainees, and at the end of the training, trainees are expected to have: Learned the idea of making fuel briquettes and, as a climate action viable enterprise, have gained a new technology for application in their village savings and loans association groups, have learned how to save the environment and reduce deforestation and work as a team, cooperate around the solution of fuel briquettes machines in their VSLAs, have the knowledge to turn waste into money, have information on briquettes marketing to the community.

INTRODUCTION TO FUEL BRIQUETTES THEORY

Pyr

The superior performance of briquettes over charcoal and firewood arises from three critical properties that briquettes have. The first is their affordability, where on average, fuel briquettes can be up to 2 times cheaper than charcoal. This arises from the fact that, unlike charcoal, briquettes are made primarily from agricultural waste. Second is non-smokiness, which arises from the higher carbon purity, free from organic matter, that is achieved with briquetting. The third is better fuel quality, or higher energy density, which can traditionally or anecdotally be estimated as a better burning flame that cooks faster than traditional charcoal; all other factors held constant. This also arises from the purity of carbon that is burned. Fourth is the longevity of burning, where fuel briquettes are considered to burn longer than charcoal, and this is because of their formulation. Fifth is the resistance to breakage, where well-made briquettes are better are resisting breakage compared to charcoal.

This manual is to enable the production of fuel briquettes that match the above criteria. The most important steps to this end are primarily four. First is the conversion of agricultural waste to carbon – what is called carbonization or pyrolysis - that is as free as possible from organic matter. This is the char, which is the main source of energy. Second is the use of an appropriate binder and, where need be, a filler. Third is crushing the char into a fine material that binds easily. Fourth is the full mixing of all ingredients and their adequate compaction.

Consequently, briquettes are made by mixing a binder material with carbonized material (Char) in water to form a paste that is then compacted into a uniform solid and dried into shape to form the briquette pellets. The process diagram below summarizes these steps:

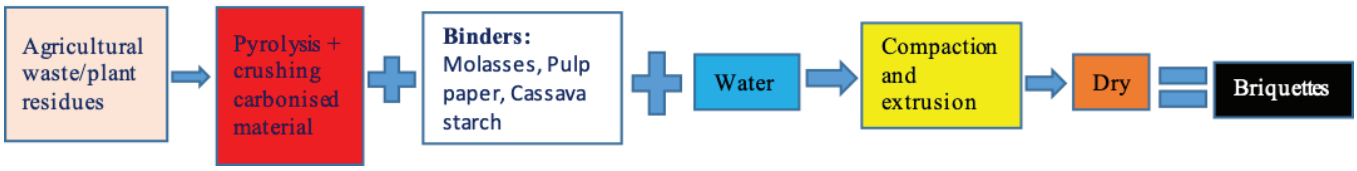


Fig 1: process schematic for briquettes making process

The key elements of the above processes are expounded below:

Pyrolysis/carbonization is simply the conversion or decomposition of an organic substance into carbon in the absence of oxygen using heat. In this case, agricultural waste is burned in a controlled process that is free of oxygen to burn off organic matter and then have carbon remain as a residue. The ideal pyrolysis temperature range is between 450-650°C. The char produced within this range makes briquettes with the highest energy density or best fuel quality or, anecdotally, what would be considered briquettes that will cook the fastest. A pyrolysis kiln, made traditionally with metallic drums, is required to make the most appropriate char raw material. See the figure below for the set-up of pyrolysis.

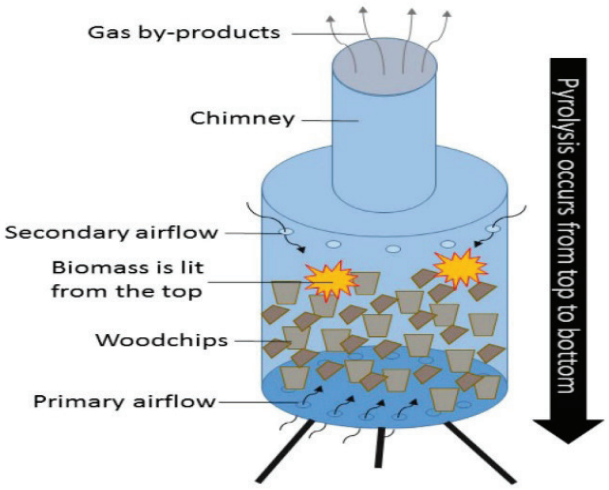


Fig 2: pyrolysis

The substrate/carbonized residue is then crushed into fine particles to enable effective binding when binder material is added.

Binder: This is material used to hold the carbonized material together when mixed with water to form a paste that is then compacted and extruded to make the briquettes. Care needs to be taken to ensure the binder used does not lower the flammability of the briquettes. The best binder is cassava starch.

Mixing ratio: there is a need to ensure that the mixture of binder, carbonized material, and water is optimal to make a cohesive paste that makes stable briquettes that are also highly flammable and not easily consumed. Ideally, mixing binder and carbonized material should work, but if they are consumed too fast, then a filler can be used, and clay or molasses can be used as a filler material. Molasses is preferred to clay because it is not

inert, unlike clay. The inertness of clay causes the generation of undesirable levels of ash and slows down the burning excessively. In such a case, the ratio of the mixture is 2:3:30 for binder, filler, and carbonized material, respectively. However, it is best that the final mixing ratio is determined on-site, which will be practically done during the hands-on training.

Compaction and extrusion: the paste is then pressed through a machine – either manual or electric – or if pressed by hand and shaped into the final desired briquette shape, which is then dried under the sun.

More is elaborated on in the succeeding sections of this manual.

This manual is for training youth and informal sector communities to develop skills in making briquettes and thereby unlock enterprise opportunities for themselves even as they address challenges of degradation, indoor pollution, and emissions that result from charcoal burning and use. The training is implemented through organized structures of communal cooperatives – specifically the CBS PEWOSA Cooperative – where trained members can proceed to access affordable capital – in the form of briquettes making machines - and invest in expanded briquettes-making to serve a wider market and displace more charcoal.

WHAT ARE FUEL BRIQUETTES?

Charcoal briquettes are made by combining a binder (cassava starch, molasses) with char and water. The mixed materials are then compressed into a uniform solid unit (either by hand or in a mechanized press) to form briquettes.

PRODUCTION PROCESSES OF FUEL BRIQUETTES

The Production stage, you must put in your mind

- Which total production output do you aim for?
- To which kind of production technologies do you have access?
- Is there any briquetting plant which fits to your quantity of production?
- Do you need to consider any pretreatments of the raw material and therefore invest in further machines?
- Can you calculate your foreseen capital and operational costs?

This section explains the detailed production process of briquettes and techniques developed by the UNEP – EBAFOSA Initiative and Africa Farmers Media Centre.

Briquetting. Briquetting is one of several compaction technologies to form a product with better material properties, such as uniform shape and size, higher density, and low moisture content. The mixture of the clay, cassava acting as the binder, and char is then made into briquettes using an extruder machine. The extruder is a screw-type press machine made from sheet metal welded on a solid steel shape, designed to produce quality briquettes. In this case, the raw material is mixed well, and at the same time, it is transported to the end of the extruder. Finally, the briquettes are dried first in a cold, dry shade for one day, then transferred to the briquettes solar dryer to dry for 3 hours/ briquettes can be dried under the sunlight for about 2 days.

RAW MATERIAL COLLECTION

Fuel briquettes can be produced from any appropriate agricultural waste. Cassava peels can be used as raw material for fuel briquette making. Waste agricultural biomass is collected from different sites for carbonization. Agriculture must be dried first to make sure they carbonize in order to get char.

Examples of carbonized agriculture waste include; cassava peels, corn cobs, palm fronds and coconut shells, but other crop wastes may also be used to make char. The raw material can be acquired from municipal and industrial wastes.

Classical examples are trees, grasses, agricultural crops, agricultural wastes, wood waste and their derivatives, bagasse, municipal solid waste, waste paper, waste from food processing, aquatic plants, and algae animal wastes.

collecting of agriculture waste

Transport cost are crtical and may be the main item in the cost structure if attention is not paid to this necessary production step. This is why it has to be carefully documented: price and capacity of truck (volume) to collect raw material and products (carbonized powder or briquettes), including loading and offl oading.

CARBONIZATION OF WASTE

Carbonization and Mixing. Carbonization occurs in the absence of oxygen and at high temperatures to ensure any organic matter is burnt off. For this, a cylindrical kiln made from sheet metal of 2 cm thickness is used. The biomass agriculture waste is carbonized using the conventional drum method[1]. The carbonizer is a simple cylindrical design fabricated to provide a means of creating a low oxygen environment, and it was fabricated using a drum of about 100 cm in height and 60 cm in diameter with an opening at the top for loading the waste. After loading, the waste is lit, and the drum is covered to allow carbonization

1 Carbonization process https://drive.google.com/drive/folders/12WkaEoRATXWgA9RlPDKSBm0sy5IT7RRM?usp=share_link

Igniting of agriculture waste

The drum is covered to enable

Smoke is seen in the pipe . this means waste is being carbonized

After 3-5 hours the waste carbonized turned in char ready to be crushed

Organic waste can be collected from markets, homes, schools, local traders, vendors, businesses, households, gardens or branches from invasive trees collected around the local area. The community can also play a vital role by raising awareness in the local area for homes to sort waste at home into organic and non-organic waste. The briquettes enterprise can also arrange a fee system for collecting organic waste directly from markets, institutions or households to allow raw material sustainability.

The process of carbonization removes most of the volatile content that is responsible for smoke emissions during the burning of raw biomass when it is not properly mixed with air.

CRUSHING OF CARBONIZED WASTE

The carbonized material must be crushed into fine particles that can easily bind before briquette making. This requires a crushing machine; UNEP-EBAFOSA Uganda trained youth to make those machines to enable the production of briquettes.

A crusher is needed in production to ensure all the carbonized raw material is crushed[2]. The carbonized material must be ground prior to briquette making. Manual crushers are common on the market and easily accessed because they operate without the need for grid access, are easy to maintain, and they a cheap

The carbonized material is then crushed into small and medium particles. This can be done using a manual crusher or an automated electric crusher.

2 Crushing of raw material https://drive.google.com/drive/folders/10EQbQAajXS6oT3GxQHMWcbOOKqwNHO_V?usp=share_link

Figure 1 Crushing of charcoal dust to fine particles to easy production of briquettes

SORTING, SIEVING CHARCOAL DUST AND COMPOST (CHAR)

Impurities must be removed from raw materials to prevent briquette smoking. This can be done by hand for larger particles or by sieving. Normally a wire mesh is used for sieving when mounted at the raised ground.

Sorting removes stones and other particles that have refused to turn into charcoal after carbonization.

Sieving Charcoal Dust and Compost (Char

BRIQUETTE MAKING USING A MACHINE PRESS

After sorting and Sieving Charcoal Dust and Compost (Char), we have to start organizing raw materials to start mixing them

Steps to follow

Prepare material for press-making using available measurements from the trainer

Raw material	Quantity
Char	30kgs
Water	10 litres
Clay/molasses	1 kg
Cassava flour/starch	2 kg

After organizing the raw materials, you need a clear surface to help you mix the raw materials and make a paste.

Note: others use an electric or manual mixer in drum shape to ensure all the raw materials are mixed evenly.

Pour 30kgs of char on the clear ground (you can use black polythene), use 2 litres of the 10 litres to mix clay and 2 litres with boiling cassava flour.

Weighing of char on the measuring scale

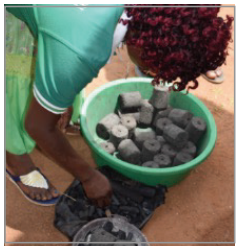
Mixing of char with clay, water and cassava flour porridge

Using briquettes machines to make briquettes by youth

Briquettes dried in the solar dryer

After pouring 30kgs of char on the ground, now pour the mixed clay and cassava flour into the char, mix evenly. Use the remaining water in the 10-litre jar can to help you mix properly for water to circular evenly.

Table 1 Village savings and Loans Association, making fuel briquettes



- Use the press machine to compress the mixed char to make fuel briquettes into uniform shapes and sizes better than bare hands
- When raw material is ready, start fuel briquetting. Let different groups produce different blends. Note; different formulas can be used, and also briquettes can be made in various shapes
- 5 people can produce 750 –1000 fuel briquettes per day, daily
- Holey briquettes dry faster and burn effectively
- Follow procedures for making quality fuel briquettes (e.g. right blending and ingredients; measuring, pressing, drying, storage, and protection from wetness.)
- After making fuel briquettes using a press machine, place them in a cold, dry place to make sure they lose moisture before taking them to the sunlight. The reason is to avoid cracking the briquettes.
- Handle wet fuel briquettes with care and dry them in the direct hot sun for 3–5 days in an electricity or solar dryer or in a dark well-aerated place (but this takes time)
- Using solar dryer briquettes can dry for only 2 -3 days, according to the day's weather conditions.

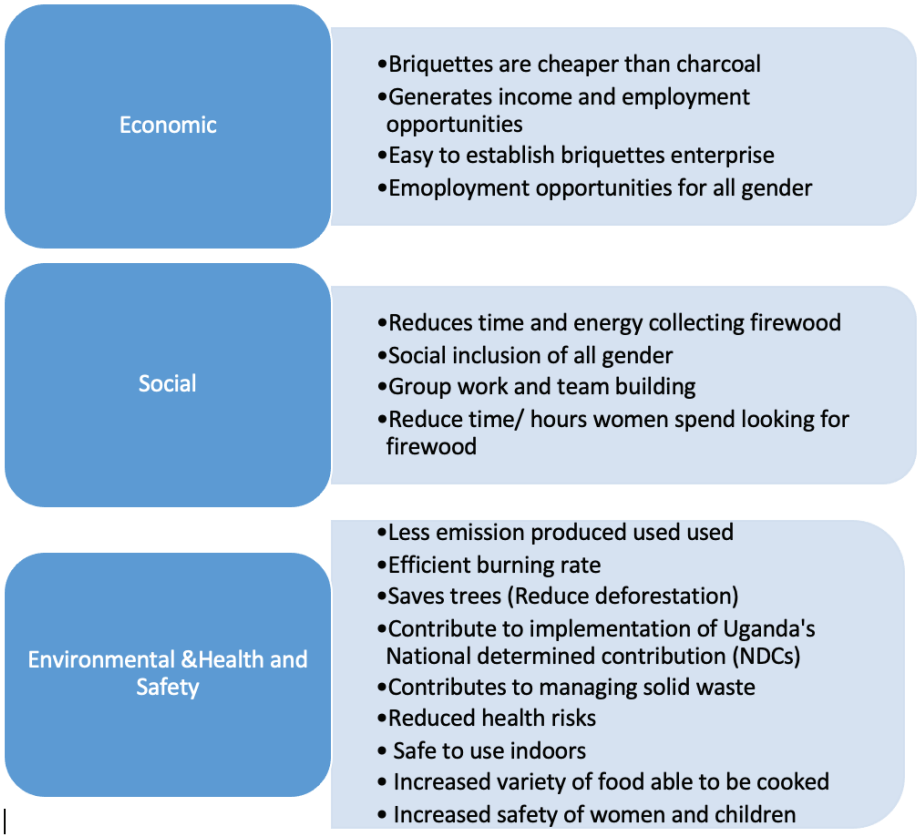
PRESS MAINTENANCE

- Ensure care to lengthen the lifespan of the briquettes machine
- Do not dry it in the sun to avoid cracking
- Preserve it with waterproof paints
- Oil or grease the nuts
- Keep it under shade or cover it when not in use
- Clean the briquettes machine after making briquettes
- Record keeping of major activities: the date when the material is carbonized, number of fuel briquettes produced and quantities sold, price and total cash, balances in stock, handing/taking over, etc.

Sample of the table to be used for documenting production and marketing of briquettes

Date	Qty made	Qty sold	Total cash (ugx)	Stock Balance	Remarks (Market Comment)	Signature
Total						

BENEFITS OF FUEL BRIQUETTES



FUEL BRIQUETTE MARKETING AND DISTRIBUTION CHANNELS

What questions do you ask yourself when marketing briquettes

- Who will be your clients?
- Where is your target market?
- Do briquettes fit their fuel requirements and the cooking appliances? Is there a high number of charcoal users in your target market?
- Can you use a mirroring strategy – where you position your briquettes selling booth next to charcoal stalls?
- Who will be your salesmen?
- Do you have access to the fuel market or need to build up new selling structures?
- Does the price of your briquettes compete with traditional fuels/how do you make briquettes cheaper than charcoal in your target market?

Who to approach and how? There are methods:

- List prospective consumers (e.g. boarding, institutions, restaurants, chips sellers, fish mongers, etc.)
- Door-to-door briquettes marketing

- Providing samples to consumers who buy in large quantities.
- Recruit regular buyers into referrals who are rewarded with a price offer for every new buyer they bring on board,
- Establish sales centres in the market
- Buying large quantities (buying in bulk) can receive discounts or a gift
- Exchange some fuel briquettes for raw materials delivered
- Use pro-environmental conservationists
- Conduct open-air cooking demonstrations (e.g., in market centres, community)
- Participate in shows and exhibitions
- Buyers of large quantities can receive discounts or a gift
- Some fuel briquettes can be exchanged for the delivery of raw materials
- Pro-environmental conservationists can be included in marketing briquettes.

Packaging and Pricing

- The price structure must be explained to the trainees to ensure they know how to cost. Currently, on the market, 1kg of briquettes is sold at 1,000UGX.
- Pricing should ensure the final price remains below that of charcoal,
- The control production process to ensure the cost of production +mark-up is lower than the market price of charcoal to ensure profitability at a lower selling price
- The price of fuel briquettes is normally low and is based on local costs and the target customer group in the community. Briquettes can be packaged in the following ways:
    - Costumers bring their own bags or containers
    - Individual pieces
    - In tins, metal buckets
    - Recyclable sacks or bags
    - Paper bags labelled with your company details.

Note: When briquettes are removed/ picked from the solar dryer. They are packed in sacks or bags.

It is advisable to place the sacks on the pallets to ensure that the briquettes are kept safe.

To keep in mind when running a fuel briquettes enterprise!

- Briquettes are consumption goods which means consumers must trust in their reliable availability.
- Briquettes are also a competitive good to traditional solid fuels. The price per unit of energy competes with the range of other conventional fuels.
- In general, briquettes can easily substitute wood in traditional cooking appliances.
- When using carbonized briquettes in traditional charcoal stoves, consumer acceptance may play a crucial role and should be checked before starting production.
- Briquettes and pellets show big advantages when used in gasifier stoves.
- The characteristics of briquettes and their marketing should be adapted to the targeted market: domestic use, business or institutional market or premium consumers

BUSINESS DEVELOPMENT MODEL

This chapter aims to give a fuel briquette business startup the tools they need to assess and enhance their business models. The business model takes a business-oriented approach to the technical facets of the briquettes production chain. The goal is to create firms that can compete in a sustainable, scalable, and economically successful competitive market. The Lean Canvas Model (built for startups) and Business Model Canvas are two tested methods for developing a business model that can be used to achieve this (designed for already existing businesses).

Lean canvas business model

The **Lean Canvas** is a business modelling tool created to help deconstruct a startup idea into its key and most risky assumptions. Deeply influenced by the lean startup methodology, the Lean Canvas serves as a tactical plan to guide entrepreneurs from ideation to building a successful startup.

Lean Canvas Business Model

The Lean Canvas Model (LCM) is designed for startups. Before embarking on a briquette production, a producer needs to determine if there exists a business opportunity, the risks and the uncertainties involved in the business. The tool focuses on the problems-solutions approach. It has 9 core components, as discussed below: Problem, Solution, Unique Value Proposition, Unfair Advantage, Customer Segment, Key Metrics, Channels, Cost Structure, Revenue streams,

How does the Lean Canvas work in fuel briquettes enterprise?

An example of a filled-out LCMP template

PROBLEM List your top 1-3 ▶ Sub-standard briquettes ▶ Low supply of briquettes (quantities and consistency) - Lack of consumers awareness **EXISTING ALTERNATIVES** List how these problems are solved today ▶ Use of alternative cooking solutions, e.g. charcoal	**SOLUTION** Outline a possible solution for each problem ▶ Use stipulate procedures/ standards to produce quality briquettes that meet consumer specifications. This will be influenced by suitable raw materials and technologies ▶ Ensure that the production of briquettes is consistent by having sufficient raw materials and the suitable briquetting machines ▶ Create consumer awareness campaigns (road shows, demonstrations and providing trial briquettes to the target market)	**UNIQUE VALUE PROPOSITION** Single clear, competing message that states why you are different and worth paying attention ▶ Provide quality briquettes (smokeless, low ash content, high calorific value etc.) **HIGH-LEVEL CONCEPT** List your X for Y analogy, e.g YouTube-Flicker for videos	**UNFAIR ADVANTAGE** Something that cannot easily be bought copied Large energy output over a period of time. Thus, ideal for cooking foods that take a long to cook, space heating and cooking of large quantities of food as experienced in hotels or institutions	**CUSTOMER SEGMENTS** List your target customers and users ▶ Households ▶ Poultry ▶ farmers ▶ Space heating for hotels ▶ Small eateries such as Kiosks ▶ Institutions

<table>
<tr><td></td><td>KEY METRICS

List the key numbers that tell you how your business is doing
▶ - Quantities sold
▶ - Repeat consumers
▶ - New consumers</td><td></td><td>CHANNELS List your path to customers (unbound or outbound)

- Direct sales from the production site (consumer going to the producer) and consumer delivering to the consumer at a cost
- Business to Business</td><td></td></tr>
<tr><td>COST STRUCTURE
List your fixed and variable costs
Fixed cost
- Cost of machinery (this will be guided by discussions in
- Chapter 2)
- Cost of premises Protective clothes
- Business Permit
- Cost of testing of briquettes
Variable costs
- Cost of labour
- Cost of feedstock
- Renewal of business permit</td><td></td><td colspan="3">REVENUE STREAMS

List your streams of revenue
▶ Sale of briquettes</td></tr>
</table>

VILLAGE SAVINGS AND LOANS ASSOCIATIONS/ GROUP GOVERNANCE AND LEADERSHIP

Before starting a fuel briquette making by VSLA/ group, certain decisions need to be made:

- What are our group's name, address and other contacts?
- What are our mission, vision, goal and objectives for the fuel briquette project?
- What are our group values?
- What by-laws (rules and regulations) should govern our relationships as members and work as a group? (Constitution of the group)
- Sharing roles and benefits and how to deal with members who fail to honour their obligations?
- How to conduct meetings?
- Leadership election criteria for each office, e.g. education, experience.
- How to establish a project committee for briquettes enterprise.

CONCLUSION

Briquettes are used to replace fossil fuels by households and industries for they are green, environment-friendly, sustainable and easy to handle; fuel briquettes provide employment opportunities for youth and women, reducing deforestation and the use of firewood and charcoal. Fuel briquette making is an environmentally friendly technology which needs adoption and promotion by both rural and urban groups/individuals. After the training, each group/individual is required to own a fuel briquettes press to start an enterprise. They can access those machines through climate action finance facilities.

This, therefore, means that fuel briquettes can address the multiple needs of our society and our environment.

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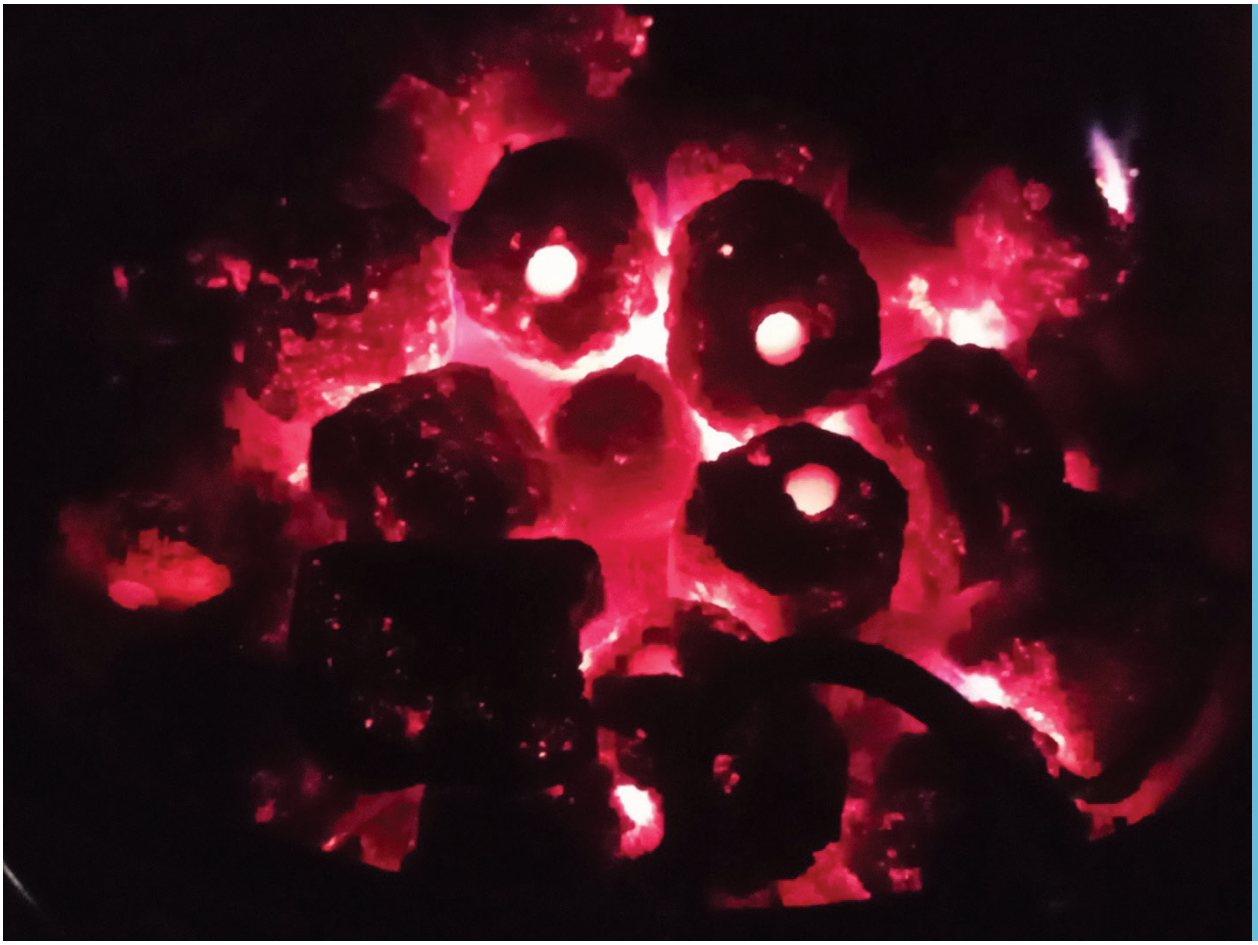

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