ZANKHALANGO ASSOCIATION BAOBAB BRIQUETTE ENTERPRISE COMPANY LIMITED

TURNING WASTE ORGANIC MATERIALS INTO FUELWOOD

An Independent Review of the

BUSINESS ESTABLISHMENT PLAN (DATED MAY 2022)

Undertaken by

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African Baobab Alliance

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1. Executive Summary

1.1. Background

The Zankhalango Association (ZA), a producer organization from Mangochi and Dedza districts of Malawi, has developed a business plan to make biomass fuel briquettes from the residual shells of baobab fruit, as a by-product of the fruit processing. The business aims to produce some 360 Metric Tonnes (MT) briquettes a year, for sale to domestic households in Mangochi Boma, as a substitute for firewood. Estimated firewood demand for Mangochi currently exceeds 7,300 MT/yr. The business plan is based on the output of an MSc Thesis undertaken by Dalitso Kafumbula, a student at the Mzuzu University Dept of Forestry and Environmental Management[1]. The research for this thesis was partly supported by the BAOQUALITY project, a multi-disciplinary research initiative led by the Rhine-Waal University of Applied Sciences in Germany

This report represents the output of a consultant, Gus Le Breton, also hired by the BAOQUALITY project. The consultant was tasked with the following:

- Undertake a market analysis for production of baobab briquettes in Mangochi region of Malawi;
- Identify necessary infrastructure to establish a pilot briquette production unit Output; and
- Develop a business plan for baobab briquette production in Mangochi and recommendations for the establishment of the pilot unit.

The plan to develop a baobab briquette production business is essentially a by-product of a second, much more ambitious business plan that has also been developed by the Zankhalango Association. This other plan, which relates to the establishment of a combined baobab fruit powder and seed oil production facility, has been submitted to the Malawian Agricultural Commercialization Project (AGCOM) for investment. The

[1] Profitability Analysis and Characterization of Non-Carbonized Briquettes from Baobab Fruit Shells and Mixture with other Biomass Materials in Malawi, D. Kafumbula, July 2022

investment has been provisionally approved (at a value of approximately US$165,000) pending the ZA's ability to raise matching funding of some US$70,000. Of this matching contribution, 75% will be "in kind" and the remaining 25% must be in cash. If ZA are successful in raising this funding, the investment is expected to go ahead by the end of Q3 2022.

Through this investment, ZA are planning to construct and equip a baobab processing facility, along with accompanying warehouse storage, on a 2.2 ha site situated 30 kms from Mangochi. At this site, they intend to produce some 30 Metric Tonnes (MT)/yr organic baobab powder, 3.3 MT/yr organic baobab seed oil and a variety of other by-products (manure, press-cake and baobab shells). As a by-product of this, they will have enough baobab shells (550 MT/yr) to produce some 400 MT/yr of pure baobab shell briquettes or as much as 800 MT/yr of a blended briquette combining baobab shells with another agricultural residue in a 1:1 ratio.

1.2. Market analysis

The market analysis, contained in Section 3, reviews the overall scale of market opportunity for briquettes in Malawi as a firewood substitute for domestic cooking, as well as the potential for the planned baobab briquettes to meet the market demand. The analysis concludes that:

- There is a significant market opportunity in Malawi for briquettes, because of the high proportion of Malawian consumers currently cooking on firewood and the superior qualities and price-competitiveness of the briquettes over firewood.
- The baobab shell briquettes are of an exceptionally high quality in terms of both their structural and combustion properties.

- Despite the large unmet demand for briquettes in Malawi, there are certain key criteria for a successful briquetting operation. Few businesses are able to meet these criteria and there is therefore a relative lack of competition in Malawi.

The proposed baobab briquetting business does meet the criteria as follows:

i) The production centre will be located right in the heart of the raw material supply and has a potentially sufficient supply of this material to reach basic economies of scale.

ii) The production centre is within 30 kms of its primary market, Mangochi Boma, such that the transport costs of its final product to market will be kept within acceptable limits.

iii) The planned briquettes are very similar in appearance and user characteristics to firewood, meaning there is not likely to be significant consumer resistance to changing fuels.

The only question mark over the viability of the business from a market point of view relates to the largely untested, Chinese-sourced briquette manufacturing equipment, whose durability will only be known once it has been established and put into operation.

Uncertainties around the technology notwithstanding, the demand appears to exist in Mangochi Boma and it seems likely that the proposed baobab shell briquetting business could sell at least 750 MT/yr non-carbonized briquettes simply in the local market. As this is substantially more than their projected production capacity, the conclusion is that the market conditions are favourable to the establishment of this enterprise.

1.3. Infrastructural requirements

Section 4 of the report outlines the key infrastructural requirements for the business. However, this is predicated on the assumption that raw material will be available from the Association's baobab pulp, seed and powder processing operation. As this operation

is yet to be developed, and is subject to the AGCOM investment, a contingency plan exists to locate the equipment at an existing maize mill some 10 kms away from the site for the planned baobab processing centre. The mill is already electrified and it is assumed (but not confirmed) that a three phase electrical connection will be available to power the briquetting equipment. Should this alternative be needed, an additional budget would be required to finance construction of a concrete base and small lean-to shelter against the side of the mill.

1.4. Business plan

There is an existing narrative and financial business plan for the briquetting operation which has been developed by the Zankhalango Association. The narrative section of this plan is fundamentally sound (see Annex 1), being heavily based around the original MSc thesis on briquetting. However, the consultant has developed a new financial plan (attached as Annex 2). This is a model which can be used to predict responses to changes in key variables and to allow for adaptive management as the business develops and grows.

A summary of the financials in the new model is presented below:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capital expenditure	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**
Sub-total CAPEX	**$44,275**	**$4,050**	**$9,615**	**$7,052**	**$5,674**	**$4,276**
Variable costs		**Total cost (USD/yr)**	**Total cost (USD/yr)**	**Total cost (USD/yr)**	**Total cost (USD/yr)**	**Total cost (USD/yr)**
Sub-total Variable Costs	**$0**	**$29,536**	**$71,654**	**$85,909**	**$102,059**	**$120,358**
Sub-total all costs	**$44,275**	**$33,586**	**$81,269**	**$92,961**	**$107,733**	**$124,634**
Depreciation (10%, straight line)	$0	$2,988	$2,988	$3,539	$3,828	$3,974
Contingency (3% of operating costs)	$0	$886	$2,150	$2,577	$3,062	$3,611

Total Costs	**$44,275**	**$37,459**	**$86,406**	**$99,077**	**$114,623**	**$132,219**

Income		**Total income (USD/yr)**	**Total income (USD/yr)**	**Total income (USD/yr)**	**Total income (USD/yr)**	**Total income (USD/yr)**
Briquettes sales	**$0**	**$81,000**	**$187,110**	**$216,112**	**$249,609**	**$288,299**
Sub-total Income		**$81,000**	**$187,110**	**$216,112**	**$249,609**	**$288,299**

Gross margin (pre-tax and fixed costs)	**($44,275)**	**$43,541**	**$100,704**	**$117,035**	**$134,986**	**$156,080**
Fixed costs	$0	$55,693	$84,245	$93,292	$103,233	$114,156
Fixed costs as % of revenue		69%	45%	43%	41%	40%
Net margin (pre-tax)	**($44,275)**	**($12,152)**	**$16,458**	**$23,743**	**$31,753**	**$41,924**
Profit margin	-100%	-32%	19%	24%	28%	32%

Overall the margins appear good. The business breaks even in its second year of operations, fixed costs remain at acceptable levels and the pre-tax earnings are above 20% by Year 3.

The key indicators for this business plan are as follows:

Economic indicator	**Value**
NPV	$2,929
IRR	22%
ROI	6.6%

All of these indicators are assessed after 5 years.

The NPV is a low US$2,929, but this is largely attributable to the high interest rate used (20%, which is the current market rate in Malawi). Changing the interest rate to 5% would increase the NPV to US$38,561 and the ROI to 87.1%. The IRR is a constant 22%, which substantially exceeds the 6-10% range normally used to guide investment decisions.

From the financial model, therefore, this appears to be a strong investment with significant potential. Assuming the sales projections are realistic, the biggest threat to the

business will come from the fixed costs, which must be kept at below 50% of the gross revenue (and ideally closer to 40%).

1.5. Risks

Section 6 of the report provides a detailed description of the risks associated with this business and suggests some key mitigatory steps as follows:

Risk 1: The AGCOM investment does not materialize. This would have a negative impact on the briquetting business both in terms of the infrastructural requirements and the raw material supply. The obvious way to mitigate this risk is to hold off on any investment decisions in briquetting until the AGCOM investment has been finalized.

Risk 2: Delays in building the warehouse to accommodate the equipment. It would not be desirable for the briquetting equipment to spend an extensive period in storage in Malawi, given the inevitable deterioration that would occur. One alternative, as described above, is to set it up in an alternative location (i.e. the nearby maize mill) as an interim measure. The advantage of this is that the equipment would be in use and generating revenue.

Risk 3: Insufficient capacity within the Zankhalango Association. Currently the Association is effectively in dormancy with no funding. However, there are three new businesses expected to receive imminent investment. This will create an immediate need for the Association to scale up its human resources and administrative capabilities, with all the attendant risks that accompany sudden and rapid expansion. The various investors in these different businesses would be wise to also support some capacity-building and organizational development activities for the Association. It may be prudent to appoint an external technical advisor to work with the team and help them navigate this transition.

Risk 4: Lack of technical back-up from the equipment supplier. It is planned that the briquetting equipment will be sourced from a Chinese supplier. With no previous experience in Malawi. This is a risk in that the supplier may not deliver effective after-sales support and back up once the equipment has been delivered. Although the costs of the equipment would certainly be higher, it would be worth investigating possible suppliers closer to home (e.g. South Africa, Kenya) who might be able to offer guaranteed after-sales service and support.

Risk 5: Delayed or unreliable electricity supplies. The 2.2 ha site at which it is planned the briquetting machine will be installed is currently not electrified. Even if the electrification goes ahead in a timely manner, power supplies can be unpredictable in Malawi. The optimal way to ensure continuous operations would be to fit a diesel engine to the briquetting equipment. Although diesel is more expensive on an hourly basis, it does at least have the advantage of being autonomous and predictable.

Risk 6: Inadequate raw material. Although the planned AGCOM investment will, if fully implemented, deliver enough raw material for the briquetting operation, it would be sensible to mitigate this risk through the production of a blended product from different raw materials from the outset. This would ensure a consistent final product, avoiding quality variations between different blends and making the baobab shells go further.

Risk 7: High fixed costs erode financial viability. High fixed costs are a leading cause of business failure, especially in the world of social enterprises, where many businesses are run by organizations with an NGO background. An excessively high salary burden at an early stage in the evolution of the business may eat into the cashflow available for raw material purchases and other essential operations, with negative impacts on the overall business. It is therefore highly recommended that the salary bill be limited to a fixed percentage of overall turnover, to avoid it becoming too high.

1.6. Conclusion and Recommendations

The report concludes by expressing the author's opinion that the baobab briquetting business, as planned for establishment by the Zankhalango Association in Mangochi, is fundamentally bankable and deserves support and investment. A series of recommendations are made to maximize the likelihood of a successful outcome.

2. Background

2.1. The Zankhalango Association

The Zankhalango Association (ZA) is a producer organization from Mangochi and Dedza districts of Malawi. The Association represents over 350 smallholder farmers, and was established to promote collection, processing and marketing of non-timber forest products and other farm enterprises. It was originally established in partnership with pioneering baobab producer TreeCrops Malawi, and has a long history of working with baobab fruit products.

In 2018, with TreeCrops Malawi having closed down, the Association developed a partnership with another private sector operator from Lilongwe called Naturals Ltd. This partnership unfortunately failed and the Association was left without either any route to market for its members' baobab fruit, or any baobab processing capability of its own. Since then, the Association has developed a detailed and bankable business plan for the establishment of its own baobab processing facilities in Mangochi. The business plan has been submitted to the Malawian Agricultural Commercialization Project (AGCOM), and a positive investment decision has been received. ZA now need to demonstrate that they can contribute their own matching funding and, if successful, the investment is expected to go ahead.

If the business plan is successfully financed, ZA envisage the construction of a baobab powder and oil processing facility, along with accompanying warehouse storage, on a 2.2

ha site situated 30 kms from Mangochi. At this site, it is planned that the Association will produce some 30 Metric Tonnes (MT)/yr organic baobab powder, 3.3 MT/yr organic baobab seed oil and a variety of other by-products (manure, press-cake and baobab shells).

As an addition to this, ZA has developed a second business plan to valorize one of these by-products. This plan entails processing the woody baobab shells into non-carbonized briquettes, for use as a firewood substitute in the burgeoning domestic market for biomass cooking fuels. The business plan is based on the output of an MSc Thesis undertaken by Dalitso Kafumula, a student at the Mzuzu University Dept of Forestry and Environmental Management[2]. The research for this thesis was partly supported by the BAOQUALITY project, a multi-disciplinary research initiative led by the Rhine-Waal University of Applied Sciences in Germany.

2.2. Terms of Reference For This Assessment

The BAOQUALITY project commenced in September 2019. The project aims to generate and co-create knowledge and locally adapted technologies and solutions with local stakeholders from the academic and baobab processing sector with regard to on-site quality assessment, quality and processing technology improvements, better utilization of waste streams, value chain governance and efficiency and support structures to foster technological change in the baobab processing sector in Malawi.

Having supported the MSc Thesis on the production of non-carbonized briquettes from baobab shells, the BAOQUALITY project then identified a consultant, Gus Le Breton, with expertise in baobab sector and value chain development, waste valorization, and information dissemination. The Consultant was tasked to cooperate with the local partner Zankhalango to jointly establish the business plan and assess what is needed to establish

[2] Profitability Analysis and Characterization of Non-Carbonized Briquettes from Baobab Fruit Shells and Mixture with other Biomass Materials in Malawi, D. Kafumbula, July 2022

a pilot processing unit in Mangochi. Specifically the following terms of reference were established:

- Undertake a market analysis for production of baobab briquettes in Mangochi region of Malawi;
- Identify necessary infrastructure to establish a pilot briquette production unit Output; and
- Develop a business plan for baobab briquette production in Mangochi and recommendations for the establishment of the pilot unit.

This report represents the final output from the consultancy.

3. Market Analysis

3.1. Description of the Briquettes

In his thesis research, Kafumbula produced 9 different variations of non-carbonized briquette. The production process is relatively simple. The raw material (in this case baobab shells, either pure or in combination with rice husks, groundnut shells or dried tree leaves) is milled in a hammer mill and then put through a high pressure extrusion process using a simple screw press. The resultant product is long, cylindrical briquette with a hollow centre. The briquettes are broadly similar in shape and size to a log used in a domestic cooking fire, and do not therefore require any changes in fire management practices from firewood. They are convenient and user-friendly, and instinctively familiar to Malawian consumers.

Figure 1: Baobab Shell Briquettes. Credit: D. Kafumbula

Briquette quality is dependent on both the physico-chemical and thermal properties of the raw material and the briquetting technology used. Ideal attributes of a biomass briquette include:

- Low moisture content (since too much moisture will inhibit combustion and cause the briquette to emit high levels of smoke);
- High density (which prolongs burning time);
- Low ash content (which again prolongs burning time);
- High shatter index (meaning that the briquettes are resistant to breaking down during handling and transport); and
- High calorific value (relating to the energy content of the briquettes, effectively the amount of heat given off by a briquette during its combustion).

Kafumbula's 9 variations of briquette were as follows:

No	Mixing Ratio	Raw Material Composition
1	BS (1)	Baobab Shells
2	BS + RH (3:1)	Baobab Shells : Rice Husks
3	BS + RH (1:1)	Baobab Shells : Rice Husks
4	BS + GS (3:1)	Baobab Shells : Groundnut Shells

5	BS + GS (1:1)	Baobab Shells : Groundnut Shells
6	BS + GS (1:3)	Baobab Shells : Groundnut Shells
7	BS + TL (3:1)	Baobab Shells : Tree Leaves
8	BS + TL (1:1)	Baobab Shells : Tree Leaves
9	BS + TL (1:3)	Baobab Shells : Tree Leaves

Table 1: Composition of different briquettes (Kafumbula D., 2022)

When assessed against the main quality parameters, the results were as follows:

		Moisture Content (% w.w.b)	Density (Kg/m^3)	Ash Content (% d.w.b)	Shatter Index (%)	Calorific Value (MJ/Kg d.b)
1	BS (1)	5.500	1357	6.00	99.99	18.75
2	BS + RH (3:1)	7.800	1279	13.63	99.25	16.04
3	BS + RH (1:1)	8.600	1232	18.13	99.16	14.49
4	BS + GS (3:1)	8.300	1316	7.32	99.60	18.14
5	BS + GS (1:1)	7.200	1175	9.36	99.29	17.98
6	BS + GS (1:3)	5.700	1246	17.29	99.14	16.62
7	BS + TL (3:1)	6.000	1121	6.02	99.34	18.28
8	BS + TL (1:1)	7.600	1234	9.32	99.16	18.08
9	BS + TL (1:3)	7.800	1094	8.16	99.05	17.72

Table 2: Main quality parameters of different briquette compositions (Kafumbula D., 2022)

Although the majority fell within acceptable levels, the optimal briquettes were clearly the pure baobab shells (sample 1), the blended baobab and groundnut shells (3:1 ratio, sample 4) and the blended baobab shells and tree leaves (1:1 ratio, sample 8). All three of these blends appear highly suitable for use as a firewood substitute in Malawi, and the high lignin content of the baobab shells results in a firm and well-formed finished product that is durable and that burns well.

In terms of consumer acceptability, briquettes offer the following advantages over firewood as a cooking fuel:

- They do not require any form of drying or curing, and are ready to use immediately;
- Their size and shape are optimized for use in a cooking fire and do not require any labour to prepare them for use (unlike firewood which may need to be cut into useable pieces);

- Their much higher density than firewood means they burn longer and slower;
- They produce less smoke than firewood (a particular concern in urban settings where exposure to wood smoke is a leading cause of lung complaints);
- They fit well into the ceramic *mbaula* fuel-efficient woodstoves that are being widely promoted by NGOs in Malawi for domestic cooking; and
- They can also be used (if broken into smaller pieces) in a charcoal stove.

Figure 2: Baobab briquettes in Mbaula stove (Credit: G. Le Breton)

The principle disadvantage of a briquette over firewood is simply one of price (or rather the perception of price). Firewood is bought in 30 kgs bundles, working out at approximately US$0.28c/kg. Briquettes are bought in much smaller quantities (1,2 or 5 kg bundles) at a price of some US$0.44c/kg. However, because of their density, 1 kg of briquettes provides the equivalent cooking time of 2 kgs firewood, which actually makes them marginally cheaper than firewood.

3.2. Market Potential

Malawi is unusual in that a significant proportion of its population, rural and urban, are heavily reliant on biomass fuel for cooking. Electrification levels are low and, even where electricity is available, supplies are unreliable and unpredictable. Liquid Petroleum Gas

(LPG), which is the most readily available alternative fuel, is viewed with suspicion by many consumers, especially in the lower income brackets, and consequently has very low levels of adoption. As a result, firewood and/or charcoal are the primary cooking fuels for most rural consumers and an astonishing 18% of urban consumers[3].

Of these, charcoal is the preferred fuel, primarily because it is relatively smoke-free and can therefore be used indoors. There are two grades of charcoal in Malawi: "indigenous charcoal", made from wild-harvested indigenous woodlands and forests, and "softwood charcoal" made from plantation forests of primarily eucalyptus and pine. Indigenous charcoal is technically illegal (unsurprisingly, given how the demand for it has led to widespread deforestation in many parts of the country). However, consumers show a marked preference for indigenous charcoal, on the basis that it burns longer, hotter and with less residual ash than softwood charcoal. Efforts to enforce bans on indigenous charcoal have repeatedly failed over many years, and as much as 90% of charcoal consumed is derived from indigenous woodlands and forests.

Firewood is seen as the less attractive but cheaper alternative to charcoal for those urban consumers dependent on biomass fuel. Its primary drawback is that it can only be used outdoors, but it is also highly variable in its cooking quality, depending on the type of wood used and the degree to which it has been properly dried and cured prior to use. Almost all urban consumers using firewood buy it from firewood vendors in the markets, where it is typically sold in 30 kg bags, but is also available in smaller quantities for convenience and price.

[3] *Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) Malawi: Analysis of Woodfuel Demand, Supply and Harvesting Sustainability.* Drigo, R, USAID (2019)

Figure 3: Firewood on sale in Mangochi

As part of his research, Kafumbula interviewed 246 households, randomly selected from five different sites in Malawi (of which two were rural districts and three were major urban centres). Although the interviewees were not exposed to the actual briquettes, they were probed for their willingness to pay for briquettes in lieu of firewood. The results suggested very high levels of Willingness To Pay (ranging from 94% in Mzuzu to 100% in Chiradzulu). Kafumbula then made a simple extrapolation from these figures to suggest that the potential market for briquettes in Malawi was essentially between 94% and 100% of the 18% of urban consumers in Malawi. With average annual per household consumption of firewood in Malawi estimated from multiple sources at some 2,750 kgs per year (working out at 7.5 kgs of firewood per household per day), Kafumbula came up with the following estimates for potential demand for briquettes in the five sites he surveyed as follows:

District	Firewood urban customers (18% of total)	Annual firewood demand (MT/yr	% of HHs WTP for briquettes	Potential HH briquette customers	Annual briquette demand (Mt/yr)

Mangochi	2,720	7,480.00	98	2,666	7,331.50
Chiradzulu	129	354.75	100	129	354.75
Blantyre City	34,421	94,657.75	97	33,388	91,817.00
Lilongwe City	44,127	121,349.25	99	43,686	120,136.50
Mzuzu City	8,750	24,062.50	94	8,225	22,618.75

Table 3: Potential Briquette Demand in Selected Urban Centres (Kafumbula D., 2022)

There is one obvious inconsistency with these figures, which is that Kafambula has assumed the briquettes would substitute firewood on a 1:1 basis (by mass). In fact, because the briquettes burn twice as long per kg than firewood, a more realistic assumption is that, if briquettes were used as a firewood substitute, demand levels would be at 50% of the current mass of firewood.

Nevertheless, this suggests a very substantial unmet demand for non-carbonized briquettes of well over 100,000 MT per year, just in the five sampled areas (which admittedly contain the three largest conurbations in Malawi).

3.3. Competitive landscape

Although there are many companies making briquettes in Malawi, the vast majority are producing carbonized briquettes. Examples include from

- Salima Sugar Factory (https://www.salimasugars.com/), making carbonized briquettes from the waste material in sugar production (bagasse, the sugarcane pulp), supplying urban market in Lilongwe.
- Raiply Malawi Ltd (http://raiplymalawi.com/), a timber company making carbonized briquettes now from sawdust at their timber processing operation (see also: https://allafrica.com/stories/202108230800.html).
- Afribam (https://www.afribam.com/), a bamboo producer making briquettes from bamboo (see also: https://www.youtube.com/watch?v=eOr_IWrnYUc).

These are all major agro-processors, and are all making briquettes as a by-product for waste material valorization.

There are only a few industrial-scale manufacturers in Malawi at present making non-carbonized briquettes using the same technology as is planned for the Zankhalango Association.

- InveGrow (https://www.invegrow.com/products), an industrial hemp producer from Lilongwe using agricultural waste for the briquettes. Interestingly, they are planning to introduce carbonized briquettes in 2022.
- The Mulanje Electricity Generation Company (MEGA) (https://www.mega.mw/), whose press was used to make the sample briquettes for Kafumbula's thesis. They unfortunately have found that the screw press they sourced from China is unreliable and are not currently manufacturing briquettes on a regular basis.
- On a smaller level, Vee General Suppliers (https://www.f6s.com/vee-general-suppliers), a community-based company in Phalombe, are manufacturing briquettes from rice husks, legume stalks and maize stalks.

There have, over the years, been many smaller NGO producers of non-carbonized briquettes. Examples include:

- Paper Making Education Trust (PAMET) (www.pamet.org) , a paper recycling organization from Blantyre, whose briquettes use waste paper as a raw material.
- Wildlife and Environment society of Malawi (WESMA) (https://wesm.mw/), a conservation NGO who also run a similar paper recycling project and also make non-carbonized briquettes from waste paper.

In both these cases, the briquettes from waste paper did not perform well on the market because consumers find them to emit high levels of smoke and a sharp, unpleasant odour.

3.4. Prerequisites for Successful Market Entry

As the above review shows, there are surprisingly few competitors operating in Malawi. This then begs an obvious question. If there is such a huge unmet demand for non-carbonized briquettes in Malawi, and if the technology for their production is so relatively simple, why are there not more large-scale briquette manufacturing operations already in place? Two possible explanations for this are:

- Either the perceived demand does not, in fact, exist;
- Or the economics of briquette production do not make this a viable business in Malawi.

With regard to perceived demand, it is certainly possible that demand projections have been overstated. Malawian consumers are inherently conservative and appear reluctant to substitute a tried and tested fuel (firewood or charcoal) with a new and relatively unknown alternative (briquette). However, the fact that there are successful briquette manufacturers out there, producing and selling briquettes (carbonized and non-carbonized) to Malawian consumers, suggests that at least some Malawian consumers are willing to switch to them if the price is right. Moreover, the similarities of these non-carbonized briquettes to firewood, both in terms of visual appearance and user-friendly characteristics, mean there is less of a mental adjustment required for consumers to switch from firewood to briquettes than with other briquette forms. On balance, therefore, absence of demand does not seem a likely explanation.

In terms of viability, transport costs are almost certainly the key factor. Briquettes are a low value high volume product. Transport costs can quickly make their price prohibitive. On the one hand, the briquetting machine must be close to the raw material supply, otherwise the costs of transporting raw materials become unsustainably high. On the other hand, the final product needs to be produced somewhere relatively close to the market, otherwise the costs of transporting finished product will be unaffordable. The

biggest and most successful briquette manufacturers are those who happen to have an abundant supply of raw material and are located close to their markets (e.g. Salima Sugar, Afribam and Invegrow, all of whom are within 100 kms of Lilongwe, the biggest urban market in the country).

One other contributory factor to the relatively low uptake of briquetting enterprises in Malawi is the fact that, although the processing technology is relatively simple, it is not immediately available in Malawi. The briquetting machines currently operational in Malawi have been sourced either from China or from Denmark.

All of the above suggests certain prerequisites for the establishment of a successful briquetting business in Malawi:

i) The business must be located close to its source of raw material, and must have a sufficient supply of this material to reach basic economies of scale. Although the actual production volumes needed will vary according to the technology used, a safe minimum requirement would probably be a volume of at least 10 MT raw material per month.

ii) The business must be located within easy access of its market. The absolute distance will vary, being dependent on the quality of the roads, but it is hard to imagine a successful briquetting business being more than 100 kms from its target market.

iii) The technology used must be sourced from a reliable supplier and must be proven to work in Malawian conditions and with the raw materials intended for use.

iv) The final briquette must be as similar as possible to the fuel it is intended to substitute (either charcoal or firewood) in order to minimize consumer resistance to the change.

To conclude, it is evident that there *is* demand for briquettes and the business of manufacturing and selling briquettes *is* viable if the above prerequisites are met.

3.5. Market Conditions for Zankhalango Association Briquetting Business

The demand projections contained in the original Zankhalango Association briquetting business plan are highly optimistic. Based purely on the local Mangochi market, they assume a potential market of some 7,331 MT/yr of briquettes. This should be scaled back to a more realistic 3,665 MT/yr (on the basis that briquettes are twice as efficient as firewood and therefore only need to be used in half the quantity). Nevertheless, for a business that envisages producing around 350 MT/yr briquettes from the raw baobab shells, a potential demand ten times higher does look healthy. Furthermore, the business meets several of the prerequisite criteria described above:

iv) The production centre will be located right in the heart of the raw material supply.

v) The production centre is within 30 kms of its primary market, Mangochi.

vi) The planned briquettes are very similar in appearance and user characteristics to firewood.

The one uncertainty relates to the briquetting technology. The original trials for baobab shells were conducted on equipment owned by MEGA in Mulanje. This equipment was sourced from China and had some problems in terms of reliability. Consequently Zankhalango have identified an alternative supplier in China (Henan Olten Environmental Sci-Tech Co), whose technology appears appropriate but has yet to be tested in Malawi. This is discussed in more detail under the risks section later in the report. More information on the technology can be found here:

https://www.oltencharcoalmachine.com/products/Wood_Charcoal_Briquette_Machine.html

Uncertainties around the technology notwithstanding, the demand appears to exist in Mangochi and it seems likely that Zankhalango could probably sell at least 750 MT/yr non-carbonized briquettes simply in the local market. As this is substantially more than their projected production capacity, the conclusion is that the market conditions are favourable to the establishment of this enterprise.

Figure 4: Firewood vendor in Mangochi (Credit: G. Le Breton)

4. Infrastructure Requirements

The primary infrastructure requirements for this business are as follows:

4.1. Production centre

The production centre, being the site at which raw material is received and converted into marketable briquettes, will require the following infrastructure.

- An enclosed shed of approximately 150 square metres space, built on a concrete slab. Ideally the shed should have two entrances, one on each end to allow for smooth flow of raw material in and finished product out.

Figure 5: Example of typical shed suitable for production (Credit: G. Le Breton)

- Ablutions for workers, comprising a minimum of two unisex toilets, hand-washing facilities and, ideally, changing rooms
- A kitchen for staff to prepare meals
- Office space for a minimum of 4 people
- Water supply and a three-phase electricity connection
- Hammer mill for pre-milling the raw material
- Screw press briquetting machine, ideally with a minimum output of 150 kgs/hour
- Digital scales for weighing finished product
- Access to transport (7 – 10 MT truck) for ferrying briquettes to market

4.2. Distribution hub

In addition to the production facility, the business would require a small distribution hub in Mangochi. This will need:

- Storage of at least 25 square metres, to store briquettes prior to their sale
- Office space for at least two people
- Ablutions, comprising a minimum of one unisex toilet

4.3. Discussion

The above describes the bare minimum of infrastructural resources required to undertake this business. However, this is predicated on the assumption that raw material will be available from the Association's baobab pulp, seed and powder processing operation. As this operation is yet to be developed, and is subject to the AGCOM investment, a contingency plan exists to locate the equipment at an existing maize mill some 10 kms away from the site for the planned baobab processing centre. The mill is already electrified and it is assumed (but not confirmed) that a three phase electrical connection will be available to power the briquetting equipment. Should this alternative be needed, an additional budget would be required to finance construction of a concrete base and small lean-to shelter against the side of the mill.

Figure 6: Maize mill identified as potential alternative site (Credit: P. Kandiado)

5. Business Plan

5.1. Description

There is an existing narrative and financial business plan for the briquetting operation which has been developed by the Zankhalango Association. The narrative section of this plan is fundamentally sound (see Annex 1), being heavily based around the original MSc thesis on briquetting. However, the financial plan could usefully be revised. A new financial plan has therefore been developed and is attached as Annex 2. This is a model which can be used to predict responses to changes in key variables and to allow for adaptive management as the business develops and grows. Key points to note from the financial plan include the following:

- The original financial plan was costed in Malawi Kwacha. However, a recent 25% devaluation of the Kwacha has rendered many of these figures outdated. The entire plan has therefore been re-costed in USD dollars.

- For the most part, costs have been taken as indicated by the Zankhalango team. However, some costs that were originally excluded have now been added in (including e.g. rent on the land, which will be owned by the baobab processing enterprise, provision for water storage tanks etc). This has pushed the overall budget up, but has hopefully made it somewhat more realistic.

- There are some elements of both the initial capex and the fixed costs (especially the personnel costs) which could probably be scaled back if needed. Having a vehicle, two motorbikes, a field officer, a driver and various other personnel would be desirable, but not strictly necessary for the successful running of the business, especially in the early stages.

- The plan is currently configured based on a blend of baobab shells (75%) and groundnut shells (25%) as raw material, with 27% losses on each (requiring 1.37 MT raw material to produce 1 MT finished product). This can be changed to suit whatever raw material is used.

- At its projected levels of fixed costs, the business needs to start from a production and sale of 30 MT briquettes/month. This is perfectly possible, although it would necessitate running some 35 X 8 hour shifts in the month (at a production of 876 kgs finished product per 8 hour shift). If this level of production is found not to be feasible, the fixed costs will need a corresponding reduction for the business to remain profitable. As a broad guideline, the fixed costs should not be more than 50% of the sales revenue if the business is to succeed.

- Malawi's interest rates currently range between 20% and 30%. The model uses 20% as the basis for NPV calculations, but this can be altered in the assumptions if needed.

5.2. Analysis

A summary of the financials in the new model is presented below:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capital expenditure	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**	**Total cost (USD)**
Sub-total CAPEX	**$44,275**	**$4,050**	**$9,615**	**$7,052**	**$5,674**	**$4,276**
Variable costs		**Total cost (USD/yr)**	**Total cost (USD/yr)**	**Total cost (USD/yr)**	**Total cost (USD/yr)**	**Total cost (USD/yr)**
Sub-total Variable Costs	**$0**	**$29,536**	**$71,654**	**$85,909**	**$102,059**	**$120,358**
Sub-total all costs	**$44,275**	**$33,586**	**$81,269**	**$92,961**	**$107,733**	**$124,634**
Depreciation (10%, straight line)	$0	$2,988	$2,988	$3,539	$3,828	$3,974
Contingency (3% of operating costs)	$0	$886	$2,150	$2,577	$3,062	$3,611
Total Costs	**$44,275**	**$37,459**	**$86,406**	**$99,077**	**$114,623**	**$132,219**

Income		Total income (USD/yr)	Total income (USD/yr)	Total income (USD/yr)	Total income (USD/yr)	Total income (USD/yr)
Briquettes sales	**$0**	**$81,000**	**$187,110**	**$216,112**	**$249,609**	**$288,299**
Sub-total Income		**$81,000**	**$187,110**	**$216,112**	**$249,609**	**$288,299**

Gross margin (pre-tax and fixed costs)	**($44,275)**	**$43,541**	**$100,704**	**$117,035**	**$134,986**	**$156,080**
Fixed costs	$0	$55,693	$84,245	$93,292	$103,233	$114,156
Fixed costs as % of revenue		69%	45%	43%	41%	40%
Net margin (pre-tax)	**($44,275)**	**($12,152)**	**$16,458**	**$23,743**	**$31,753**	**$41,924**
Profit margin	-100%	-32%	19%	24%	28%	32%

Overall the margins appear good. The business breaks even in its second year of operations, fixed costs remain at acceptable levels and the pre-tax earnings are above 20% by Year 3.

The key indicators for this business plan are as follows:

Economic indicator	Value
NPV	$2,929
IRR	22%
ROI	6.6%

All of these indicators are assessed after 5 years.

The NPV is a low US$2,929, but this is largely attributable to the high interest rate used (20%). Changing the interest rate to 5% would increase the NPW to US$38,561 and the ROI to 87.1%. The IRR is a constant 22%, which substantially exceeds the 6%-10% range normally used to guide investment decisions.

From the financial model, therefore, this appears to be a strong investment with significant potential. Assuming the sales projections are realistic, the biggest threat to the business will come from the fixed costs, which must be kept at below 50% of the gross revenue (and ideally closer to 40%).

6. Risks

There are a number of risks that have to be considered as follows:

6.1. Risk 1: The AGCOM investment does not materialize

The biggest risk relates to the planned AGCOM investment. This investment is in the form of a US$165,00 grant from AGCOM, which must be matched by a contribution of some US$70,000 from Zankhalango. Of this matching contribution, 75% will be "in kind" and the remaining 25% must be in cash. The Association does not currently have the cash to make this contribution itself, but are expecting that their long term NGO partner Welt Hunger Hilfe (WHH) will be able to meet this contribution on their behalf.

Should the AGCOM investment fail to materialize, there would be two separate impacts on the briquetting business. The first would be that the supporting infrastructure described in section 3 above would not be present, requiring an alternative plan. This has already been considered by the Association, and it has been proposed that a temporary shelter could be constructed at a nearby maize mill, which already has three phase electricity. Whilst far from ideal, this might work as a stopgap measure.

The second negative impact would be in terms of raw material. The business plan envisages an abundant supply of raw material from the processing facilities to be financed by AGCOM. Without this, the briquetting plant would be dependent on raw material from other sources, principally the baobab vendors who buy and sell baobab fruit.

Although neither of these associated risks are necessarily deal-breakers in themselves, the obvious way to mitigate this risk is to hold off on any investment decisions in briquetting until the AGCOM investment has been finalized.

6.2. Risk 2: Delays in building the warehouse to accommodate the equipment

Between placing the order for the briquetting machinery and receiving the machinery in Malawi, there will be an approximate wait of up to 60 days for both the manufacture and the shipping of the equipment. Once the equipment arrives, it should ideally be installed in its final setting as soon as possible, and not left lying around gathering dust. The Zankhalango Association are hoping to conclude the AGCOM investment by end of Q3 2022 and begin construction shortly afterwards, with basic infrastructure in place by March 2023. If the briquetting equipment was ordered in September 2022, it would arrive in Malawi in November, and might then need to be stored for only a few months before installation. However, if there are delays in the AGCOM investment, or in the actual construction, there is a real possibility that the equipment might then be stored for a much longer period.

One alternative, as described above, is to set it up in an alternative location (i.e. the nearby maize mill) as an interim measure. The advantage of this is that the equipment would be in use and generating revenue.

6.3. Risk 3: Insufficient capacity within the Zankhalango Association

The Zankhalango Association has been in existence for a decade. During this time its fortunes have ebbed and flowed. At one point it was in a partnership with WHH and the Kusamala Institute of Agriculture and Ecology in a EUR 2.5 million project on food security and forest management. At present the Association does not have any active funding or projects and is effectively in dormancy, with only its director Peter Kandiado working hard to generate new funding. A number of other key personnel, previously employed by the Association in various capacities, are said to be standing by ready to rejoin once resources are available.

There are three separate business opportunities on the point of being activated: the baobab fruit processing, the briquetting and a third one relating to moringa cultivation

and production. When these new businesses do begin, there will be an immediate need for the Association to scale up its human resources and administrative capabilities. This will place a huge strain on the organization and will require careful management. There is a real threat that the current team are overwhelmed and that the briquetting business is negatively impacted as a result.

There is no easy solution to this. However, it would be prudent for the various investors in these different businesses to also invest in some capacity-building and organizational development activities for the Association. An obvious way to do this would be through the appointment of an external technical advisor to work with the team and help them navigate this transition.

6.4. Risk 4: Lack of technical back-up from the equipment supplier

The technology for making briquettes is relatively simple. However, as there are no suppliers in Malawi, the equipment will have to be sourced internationally. This is a potential problem in that, once an equipment supplier has fulfilled their contract to produce and deliver the equipment, they are under no obligation to provide ongoing technical support and backup.

The original trials, from which the briquetting business plan was first developed, were on equipment purchased from a Chinese supplier by the Mulanje Electricity Generation Agency (MEGA). Unfortunately this equipment has proven unreliable and prone to breakdowns. Consequently the ZA have identified an alternative supplier, also in China. Their credentials appear to be solid, and the equipment they are offering appears to be fit-for-purpose. However, until it arrives, has been installed and is operational, there will be no way to predict its durability in a rural Malawian setting, nor to know how responsive the manufacturer will be when required to provide technical back-up, spare parts and consumables.

Although the costs of the equipment would certainly be higher, it would be worth investigating possible suppliers closer to home (e.g. South Africa, Kenya) who might be able to offer guaranteed after-sales service and support.

6.5. Risk 5: Delayed or unreliable electricity supplies

The 2.2 ha site at which it is planned the briquetting machine will be installed is currently not electrified. There is a power line running just past the site, and AGCOM promise that, once their investment has gone through, they will facilitate the installation of a transformer and three phase connection from the national power utility ESCOM. However, until this has happened the current equipment will not be useable at that location. It should also be noted that ESCOM power supplies have been unreliable at times, especially recently given Malawi's current economic woes.

The optimal way to ensure continuous operations would be to fit a diesel engine to the briquetting equipment. Although diesel is more expensive on an hourly basis, it does at least have the advantage of being autonomous and predictable.

6.6. Risk 6: Inadequate raw material

The original briquetting business plan envisages an annual raw material requirement of some 439.2 MT baobab shells, yielding 320.6 MT briquettes (at a 73% recovery rate of raw material to finished product). Once the AGCOM investment has been implemented, the annual production of baobab fruit products are expected to generate over 550 MT of baobab shells, which is significantly more than the briquetting operation would need. However, it is reasonable to assume that the actual production volumes may be smaller than this and there may not be enough pure baobab shells to run the briquetting machines on a daily basis. One way to mitigate this would be to produce briquettes from a blend of raw materials. Kafumbula tested nine different blends in his original research, several of which met the requirements for successful briquettes. In order to ensure a consistent

final product and avoid quality variations between different blends, it would be sensible to produce a blended product from the outset. This would also ensure that the baobab shells go further.

6.7. Risk 7: High fixed costs erode financial viability

High fixed costs are a leading cause of business failure. This is especially true in the world of social enterprises, where many businesses are run by organizations with an NGO background, used to covering fixed costs from grant funds rather than from sales revenue.

The funds available from the AGCOM investment are primarily intended for capital expenditure. Personnel costs are not allowable under this project, and must be contributed by the investee. However, as ZA has almost no financial resources of its own, and as its staff are unlikely to be willing to work without remuneration for an extended period, their salaries must obviously come from somewhere. The generous provision for salaries in the original briquetting business plan suggests an expectation that the briquetting business will also cover some of the salaries for the other baobab processing operation. An excessively high salary burden at an early stage in the evolution of the business may eat into the cashflow available for raw material purchases and other essential operations, with negative impacts on the overall business. It is therefore highly recommended that the salary bill be limited to a fixed percentage of overall turnover, to avoid it becoming too high.

7. Conclusion and Recommendations

Overall, having reviewed all the available information, it is the opinion of the author that the baobab briquetting business, as planned for establishment by the Zankhalango

Association in Mangochi, is fundamentally bankable and deserves support and investment. As with any start-up business, there are a number of risks that warrant close attention, but none of these are deemed to be "deal-breakers", and there is strong evidence to suggest that the business will succeed. The preconditions for a successful briquetting operation in Malawi are not often met, which is why there are relatively few examples of successful briquette businesses in the country. However, in this case these preconditions are, fortuitously, all met, and therefore the chances of success are high.

To maximize the likelihood of a successful outcome, and to minimize the risks, the following recommendations are made:

Recommendation 1: Investment in the briquetting business should be contingent upon the successful conclusion of the planned AGCOM investment.

Recommendation 2: If the briquetting equipment arrives in Malawi before the warehouse has been constructed in which it will eventually be located, it should either be kept in storage at an appropriate facility in Lilongwe or installed at the maize mill in Mangochi. It should not be stored at the ZA offices in Mangochi, which are inadequate for this purpose.

Recommendation 3: All investors in the planned ZA new businesses (baobab fruit powder and oil, baobab briquettes and moringa leaves and seeds) should co-operate to provide technical assistance and capacity building to the Association to ensure it is not overwhelmed by this sudden expansion.

Recommendation 4: Before the final equipment purchase is made, a thorough review should be conducted of potential alternative suppliers, especially those located within relatively easy reach of Malawi (e.g. Kenya, South Africa). Although more expensive, suppliers within Africa are more likely to provide technical back-up and after sales support than suppliers located further away.

Recommendation 5: Consideration be given to the addition of a diesel engine for powering the equipment as aback-up in the event that electricity is not available.

Recommendation 6: Once the equipment has been installed, and before beginning production**,** a further period of product development should be undertaken in which different blends of baobab and other raw material are trialed and tested with consumers. It is specifically recommended that a blended product be produced (combining baobab and another readily available raw material).

Recommendation 7: The budget for fixed costs should be limited to a maximum of 50% of gross revenue, in order to ensure that the business remains profitable.