TECHNO-ECONOMIC FEASIBILITY REPORT

LANTANA BRIQUETTING IN TWO SITES AROUND THE MUDUMALAI TIGER RESERVE

By The Shola Trust, February 2016

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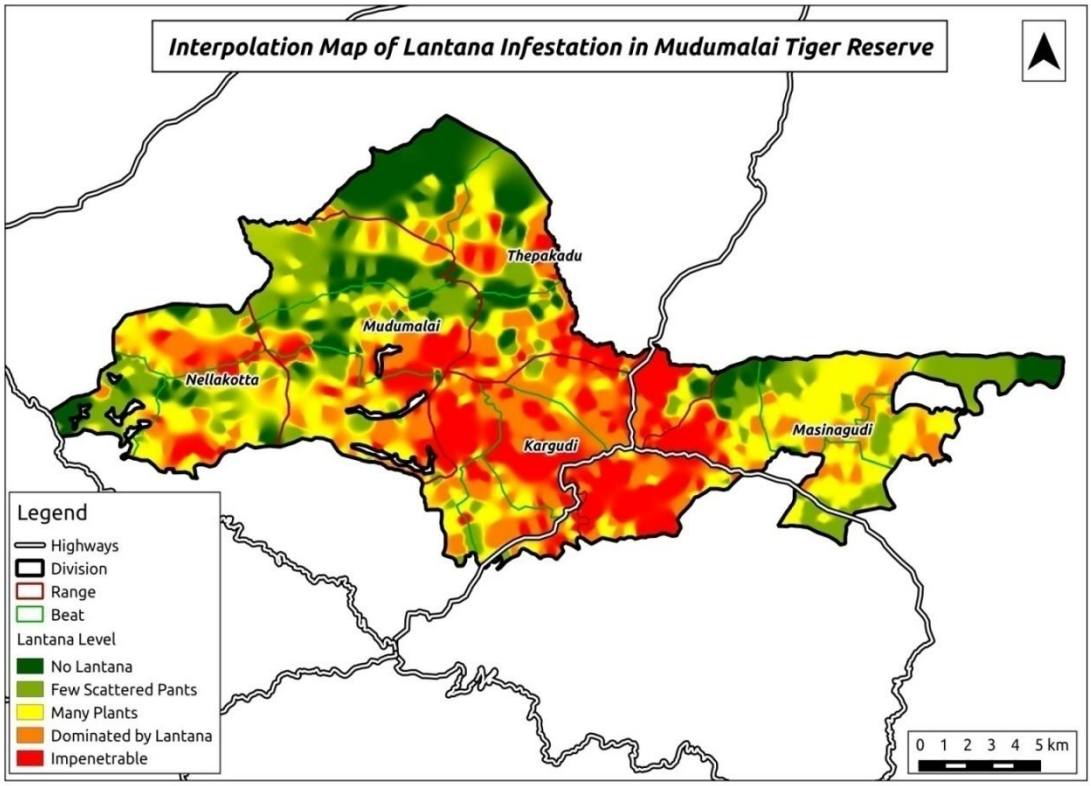
Extraction Sites and Raw Material Availability

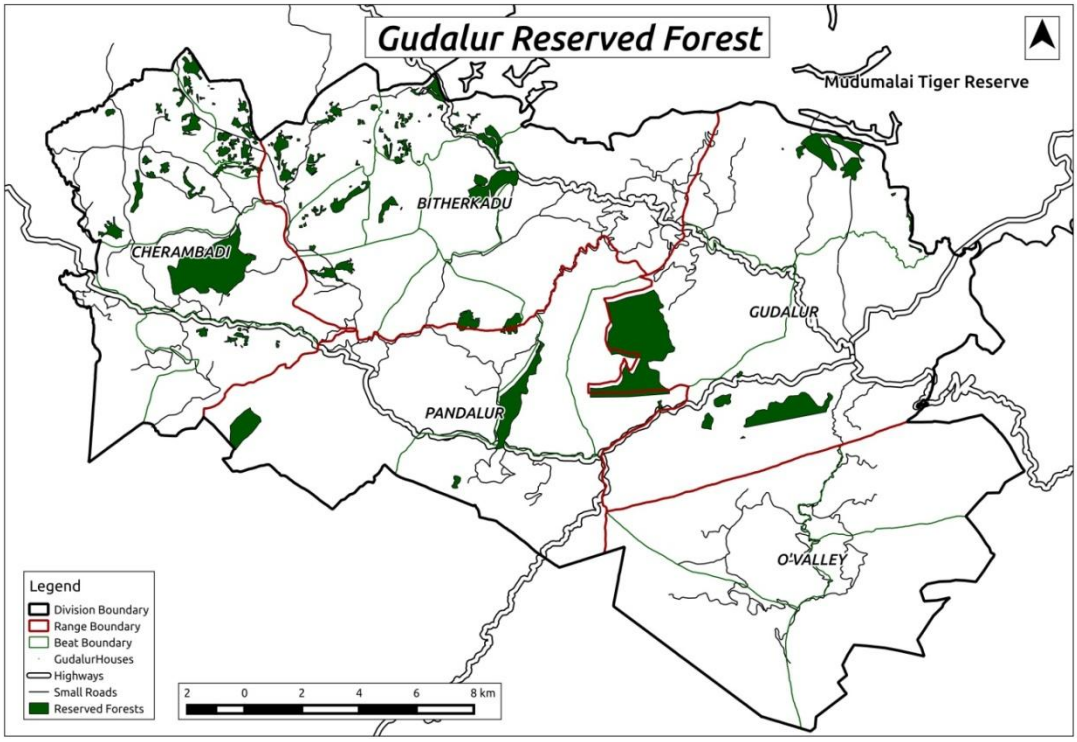


Our initial plan was around briquetting using Lantana from the Mudumalai Tiger Reserve (MTR). About 14,000 hectares, or 44% of the Mudumalai Tiger Reserve is either 'dominated by Lantana' or 'Impenetrable', and only about 4000 hectares, or 12% of the reserve being completely Lantana-free (based on our field research).

The biomass density is about 30 tons per hectare for dense Lantana and 10 tons per moderate Lantana. Therefore the total biomass available is approximately 4,20,000 tons from the dense areas alone. The raw material availability presents positively towards the future viability of the project.

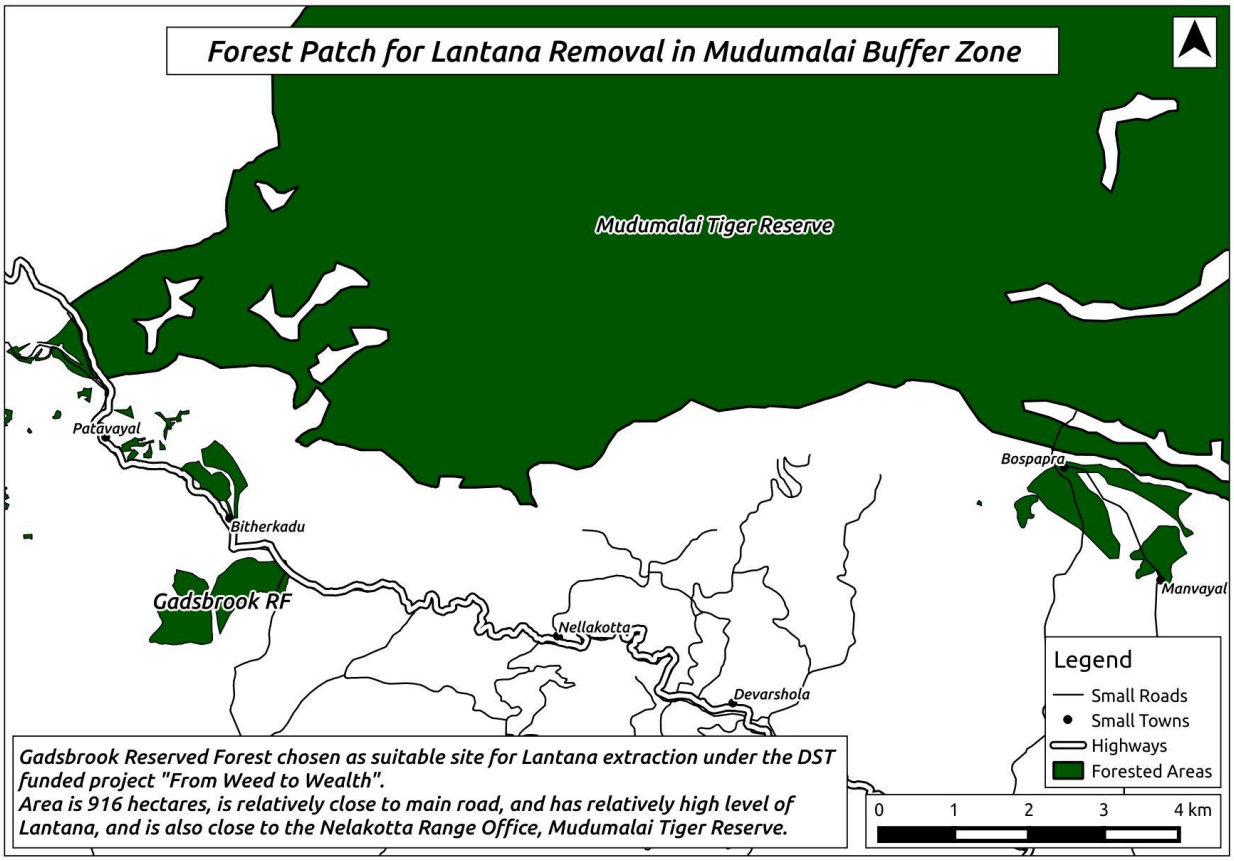
New Scenario: However, since permission has been denied for removal of Lantana from MTR, we have to now look into the buffer zone of MTR, which is the Gudalur Forest Division.

Here the forests are very patchy (see map below).



The intensity of the Lantana spread was not known in these patches. The large patches were visited, and it was found that the 'Gadsbrook RF' (Bitherkadu Range) was possibly the most suitable in the Buffer Area. Other large patches like the Needle Rock RF (Gudalur Range) and Cherambadi RF (Cherambady Range), were mostly swamps and grasslands, and had very little lantana.

This has been discussed with the District Forest Officer (Gudalur Division), and Conservator of Forests (Coimbatore Circle), and they have agreed to give written permission for extraction of Lantana from Gadsbrook RF through the Tribal Eco Development Committee, subject to approval of the updated work plan from The Department of Science and Technology.



The area of the Gadsbrook RF is about 96 hectares, and with a moderate intensity of Lantana (estimated to be about 10 tons per hectare), the total biomass availability is much less, at about 960 tons.

This needs to be born in mind for overall project feasibility.

Briquette Process: Overview and Costing

Using the above graphic, we provide a step by step assessment of each stage of the briquetting process including costing and challenges/risks, comparing extraction from the Mudumalai Tiger Reserve and Gadsbrook RF in Gudalur Forest Division/Buffer area of the Mudumalai Tiger Reserve.

Raw Material Extraction (Lantana uprooting)

The first step in this briquetting project is the process of extraction of raw lantana, which is best achieved through the cut-rootstock method.

A simple and cost-effective manual method for the removal of *Lantana*, is known as cut rootstock method. As the name suggests, it involves cutting the main tap root of *Lantana* plant beneath the 'coppicing zone' (transition zone between stem base and rootstock) This method of removal involves the engagement of 2–3 individuals to work in a group for the removal of *Lantana* if the clump is large enough that it cannot be handled by one individual after the rootstock is cut.

The steps involved in the cut rootstock method are:
(i) The person, who engages in removal of *Lantana*, is positioned in a way that he stands near centre of the *Lantana* clump with his back facing the clump and holding the handle of digger
(ii) Using the specially designed digger, the person cuts the main rootstock of *Lantana* 3–5 cm below the soil surface by hitting the rootstock 3 or 4 times while hitting the rootstock the blade of the digger gets lodged into the main tap root, and at this point it is useful to move the handle of the digger in the forward direction away from the body of the person so as to severe the connection of the clump with the main tap root. In case the clumps of *Lantana* form impenetrable thickets, it is advantageous to cut the rootstocks of 3–4 contiguous clumps to make the removal operation convenient.

Challenges

- *Access to the raw material* – Considering that majority of Lantana is present in dense forest area; getting access to the raw material is a challenge. Many parts of the forest, there are no access paths to get closer to the Lantana and the presence of wildlife etc makes many parts of the forest in-accessible to extract Lantana.

Therefore the effective biomass available for this project purpose would be far lesser than the actual quantity available in theory.

- Also the *thorny nature of the weed,* makes it very challenging to handle manually. People involved in cutting lantana frequently experience cuts and scratches which make it difficult to involve people in this activity. This is also one human resource constraint for this project.

- The established method of extraction is that group of tribals take on a contract to remove lantana. It takes about 100 man days per hectare. They usually work in about groups of 15, taking about one week to clear one hectare. *Extraction is therefore the slowest step in the process,* since the maximum manageable rate of extraction is only about one ha/week. This implies 30 tons/week in Mudumalai and 10 tons/week in Gadsbrook RF.

Cost of Raw Material Extraction

Based on the currently available estimates Rs 30,000 (labour charges) is spent on clearing one hectare of Lantana of dense Lantana (30 tons per hectare. However, since the lantana is only moderate in Gadsbrook (10 tons per hectare), the cost per hectare will come down slightly to about Rs.20,000 per hectare

Extraction Site	Cost/ha	Density of Lantana	Cost/Kg
Mudumalai	Rs.30,000	30 tons/ha	Rs.1.0
Gadsbrook	Rs.20,000	10 tons/ha	Rs.2.0

Pulverizing and Transport of Lantana

Pulverizing is the process where the loose biomass is crushed to suitable size of 8mm or less. A pulverizer is fitted behind a tractor which can be moved to different locations. This mobile pulverizer is used to chop up lantana to smaller pieces of 8mm size. The machine is powered by the motor (50 HP and above) of the tractor and is connected to the tractor using the power take off (PTO).

In our field trials we found that the plant has to be cut and fed into the machine while it is still wet, if it is dry sticks the machine does not 'pull' the plant into the machine.

The standard capacity of the pulverizing machine is 2.5 tons/hour. However in our field trials with Lantana we found that the rate is only about 1.5 ton per hour, since the plant is very bushy. Time taken /work days to clear one hectare of Lantana does not vary greatly irrespective of density of Lantana – about one week with about a 15 member team.. Rented tractor costs about Rs.2000/day, running for about 10 hours, pulverizing about 15 tons per day.

Cost of Pulverizing of Lantana

Site	Lantana mass	Tractor rental (Rs)	Cost/kg
Mudumalai	30 tons/ha	4000 – 2 days	0.13
Gadsbrook	10 tons/ha	2000 – 1 day	0.20

Challenges associated with pulverizing

- It requires a private vehicle to enter the protected area/Reserved forest, and permissions for RF are much simpler.
- The noise created in the machine (due to friction) can be very high and therefore create disturbance to the wildlife in the area, but this is not that significant in RF/buffer area.
- There will be leakages/wastages in pulverized material due to winds.

Transportation of Raw Material

Lantana is a bulky and bushy raw material which makes it challenging to transport in raw form to the briquetting unit. Therefore, the pulverised lantana has to be transported. As per the initial plan, the briquetting unit was to be setup in Thorapally town at the edge of MTR, since it requires 3 phase electricity to run, and it is reasonable distance from Thepakadu and Chembakolly, the project villages. This location cannot be changed. The cost of transportation therefore changes accordingly.

Cost of Transport of Raw Material

Extraction Site	Distance	Cost per trip	Tons per trip	Cost/Kg
Mudumalai	5 km	Rs. 800	1.5	Rs.0.53
Gadsbrook	30 km	Rs. 3600	1.5	Rs.2.40

Drying of Raw Material

The crushed/powdered lantana is brought to the briquetting unit. Drying is a very important step in the briquetting process. High moisture levels reduce the calorific value drastically. The pulverized lantana has to be dried to reduce moisture content to around 10% ideally, or less than 20% at minimum.

Challenges in the Drying Process

Drying is one of the biggest challenges that face this project from a techno-economic perspective.

- Nilgiris being a very high rainfall district with the rainy season lasting for as long as 6 months at a stretch.
- Also the cold and chilly weather makes drying further challenging.
- Lantana as a raw material has very high contents of water which necessitates extensive drying.
- There are huge space requirements for drying in the open (shown in the image below). Also important to understand environmental impact of heaping pulverized lantana in the open.

It is important to conduct a study to track changes in moisture levels in lantana in the climatic conditions of Gudalur. Based on interactions with stakeholders drying in local climatic conditions appears as the single most challenging factor for briquetting in the region. It is important to note that in coorg which has similar climatic conditions many briquetting projects have failed mainly because the raw material could not dry in the cold and rainy climatic conditions.

Two methods for drying

1) Open Sun drying – This could be a challenge due to the above mentioned conditions. Also there can be a loss of powdered raw material due to winds which could result in raw material leakages.
2) Solar tunnel drier- The capital cost for a solar tunnel drier has not been budgeted for in the project. But there exists no valid data for performance of solar tunnel drier in Gudalur climatic conditions.

Even industrial boilers are being used for drying, but we are not including that in the scope of this study due to capital constraints.

Seasonal calendar

Gudalur experiences very high rainfall for almost as much as 5-6 months in a year. In addition to this the temperature levels are lower as compared to the plains. Both these factors will have an impact on the moisture levels of lantana and the drying process. It is yet to be tested how the local climatic conditions would have an impact on briquette production.

Month	Rainfall(high/low)	Sunlight availability	Production levels
Jan	Low	High	High
Feb	Low	High	High
Mar	Low	High	High
April	Low	High	High
May	Low	High	High
Jun	High	Low	Low
Jul	High	Low	Low
Aug	High	Low	Low
Sep	High	Low	Low
Oct	Moderate	Moderate	Moderate
Nov	Moderate	Moderate	Moderate
Dec	Low	High	High

The tentative plan was to construct a low cost poly shed with funds leveraged through the Forest Department and Eco development committee that could be used for drying.

There is no recurring cost involved in the drying process, and no particular change in the drying cost with the different sites. However, the risk involved in this step is high, and to be noted.

Pressing/Compacting

To produce briquettes with high density the raw material needs to be less than 8mm and dried (10%). The powdered/pulverized material is continuously fed to the pressing machine. The machine is run by a 60 HP motor and has two flywheels to propel the piston and ram the incoming material against the die and it leaves the die in the rhythm of piston action. Through pressure and friction inside the pressing machine the fed material is strongly heated and the lignin from within the biomass is released to strongly bond the material together. This process is also called binder-less technology as it requires no external binders to bind the material together. The capacity of piston presses depend both on the diameter of the die and pre-treatment of the raw material (size and moisture). . Electricity requirement for a pressing machine would be in the range of 50 units per ton of material processed. A screw conveyor is used to gravity-feed the powdered material from the top of the pressing machine as shown in the figure.

Challenges in the Pressing/Compacting

- Stakeholders including scientists felt that Lantana cannot be briquetted without any binder material. We need a test to determine whether 100% Lantana without any binders (like saw dust etc) can produce briquettes of good quality. From discussion with experts well versed with the briquetting industry were convinced that Lantana could not be briquetted without a binder. The economics of the project would alter significantly if there arises a need to use binders in the pressing process. Our experiments with pressing Lantana without any binder proved that the quality of the briquettes were very poor even with a small quantity of saw dust. (Below image).

- Running a briquetting machine is extremely challenging from a technology perspective in terms of frequent wearing of press, jamming of ram etc. Also availability of spare parts is another issue that was reported by briquette.
- Even though these challenges are within control, it would be tough for community members to run and maintain the machines given their limited exposure in handling complex machinery
- Another additional challenge is the erratic power supply. There is a strong possibility of frequent down-times due to maintenance and power supply issues.
- Presence of stones, mud etc. significantly impact the quality of end briquettes and hence affect marketability. Therefore auxiliary equipment like cyclone dust separator might be a crucial addition. Also for good binding it is important to maintain uniform size of particles which makes it necessary to have a hammer mill as an additional auxiliary equipment.
- The rate of extraction of Lantana is slowest step in the entire process, and limits the final briquetting process to 30 tons/week (mudumalai) or 10 tons/week (Gadsbrook).
- Briquetting machine suppliers cater to the private market which requires machines with a minimum capacity of 1ton/hour (as private market has to pay significantly for raw material). The Tamilnadu Agricultural University previously

manufactured a small scale machine (250kg/hr), but they have since discontinued this machine. The private supplier (Real tech. agro industries) who had committed to providing the machine refused to make a low capacity machine. There would be a need to identify alternate suppliers who can make low capacity briquetting machines.

Electricity Cost of Pressing/Compacting

The electricity consumption of a briquetting machine comes to 50 units (@Rs 4/unit) per ton of raw material processed. Therefore the cost of briquetting is:

Number of units	Quantity	Cost per unit	Cost per kg @ Rs 4/unit
50	1 ton	Rs. 4/unit	Rs. 0.2

Cost of Transportation to Customer Site and Packaging

Packaging:

Generally packaging is minimal, more for convenience of loading/unloading. One gunny bag @ Rs 5 can accommodate 50 kg of briquettes which comes out to **Rs 0.1/kg.**

Transport:

Transportation to customer site - 8 tons per truck trip plus loading/unloading @ 6000/trip which is 6000/8000 = **Rs 0.75/kg**

Total Cost of Briquettes

Activity	**Cost in MTR (Rs.)**	**Gadsbrook RF (Rs.)**
Cost of extraction (uprooting)	1.0	2.0
Pulverizing cost	0.13	0.40
Transportation to unit	0.53	2.40
Drying	0 (High Risk)	0 (High Risk)
Briquetting Electricity	0.20	0.2
Packaging	0.1	0.1
Transportation to customer	0.75	0.75
Total Cost/Kg.	**Rs 2.71**	**Rs.5.85**

Marketing Notes

The various segments for sale of briquettes in the region are as below.

Community members living around the tiger reserve:

Many briquetting projects have failed in areas where firewood is available free and close by. Comfort with firewood and its free availability makes it extremely difficult to hinge this project on this segment. So briquettes will be provided to tribal communities, but other avenues of marketing will also be looked into, to ensure long term financial viability for the project and the Eco Development Committee once support from The Shola Trust is withdrawn.

Tea factories:

Tea factories are regular users of briquettes and present a good opportunity subject to suppliers being able to meet their requirements.

The challenges with this segment are as below.

Marketing of briquettes in tea factories

25% of the total cost of tea is on thermal energy which is currently obtained from firewood. For making one kg of tea approximately 1.5 kg of firewood is required and typically in a day 7-10 tons of firewood per factory is required based on production schedules. There was a UNDP funded project (2008-12) in the Nilgiris to reduce energy consumption in tea factories and one of the major thrust areas was the use of briquettes. So Tea factories are aware of briquettes and many of them have started using and experiencing the benefits of briquette usage. In case of briquettes per kg of tea requires only about 700g of briquettes almost half as much as firewood.

Currently briquette manufacturers are in Mysore, Coimbatore, Kerala and the price range is **Rs 5.2-7/kg** based on quality of briquettes. The calorific value of most of the briquettes currently available is in the range of 3500-4000 kcal/kg and given that the calorific value of lantana is 4200kcal/kg (to be validated) there is a definite advantage. Therefore locally made briquettes from lantana could be a good source of livelihood for the community. But it is important that the briquettes have less moisture and the community members are trained to fulfill quality criteria and customer requirements.

Inputs from Tea factories on briquettes (in general)

Briquette disadvantages

1) Easy availability of firewood and at cheap rates of Rs 2.5-3/kg. This makes firewood their primary choice.
2) Firewood is easy to store and can be just kept out in the open. However briquettes need a closed enclosure for storage. This could be a major stumbling block. But some factories have gone in for a special moisture free enclosure just for the storage of briquettes. (Woodbridge)
3) Excessive moisture content in briquettes has resulted in factories snapping ties with some suppliers.
4) Presence of stones and mud in the briquettes which melts in their machines when burnt and spoils it.
5) Soot deposit in the machines due to use of certain briquettes (made of resin extraction waste) so they stopped using it.
6) Smell in certain briquettes (made from chilly waste) which was altering the smell of their tea and therefore they decided to stop using those briquettes.
7) In theory it is said that per kg of tea requires 1.5 kg of firewood whereas there is a requirement of only 700 g briquettes (half). And hence there is also a definite cost saving in using briquettes. However in practice this was not widely accepted by

stakeholders in tea industry. There is a need to study this and put this to rest and demonstrate the benefits of briquette usage.

8) Also some factories like to have big briquettes (90 mm) which are strong, hard and compact which does not break/wither easily. While other factories were going in for smaller briquettes (60 mm). Different specifications would be a challenge to fulfill. It would be not be possible for one machine to supply briquettes of two diameters.
9) Some large estate factories have also opted for in house briquette production

Briquette advantages

1) Tea factories conceded that availability of briquettes was a huge problem. It takes a month of advance booking to actually get briquettes (While lead time for firewood is one day). And availability and escalating prices of raw material is always going to be a challenge for briquetters which in turn get passed on to tea factories.eg Coffee husk in peak season the rate can go to as much as Rs 6/kg especially. It is very difficult for factories to completely move away from firewood as briquettes are in short supply.
2) It definitely has higher calorific value and burns better than firewood.
3) Briquettes can be added in exact quantities while with firewood it gets difficult.
4) The selling point for briquettes is that it is easier to handle, no labor required for splitting wood etc, requires lesser quantity and does not produce any char/ash etc.
5) Apart from the fact that it is much cleaner burning fuel.

Quality criteria for briquettes in tea industry (Lantana briquettes have to be tested for these parameters)

- High calorific value

- Little moisture
- Strong, hard and compact
- No stones/mud/sand mixed
- No smell
- Less ash/smoke and should not leave deposit behind on the machines
- No harmful gases released on burning
- No withering/breaking

Future Sales Revenue of the Project

Since the project is going to be located very close to a protected area, a very large scale project is not feasible as it would have adverse environmental impact. Forest Department and wildlife Conservation agencies are very cautious and vary of large scale industries being set up near Pas. Therefore there will always be a need to restrict the scale of activities. While demand wise there would be no issue, there would be various bottlenecks on the supply side such as

- Close to protected area
- Limited capital for purchase of briquetting machine
- Persistent rainfall
- Erratic power supply
- Human resource constraints

In our above figures, we have indicated the realistic extraction rate to be 120 tons/month in Mudumalai and 40 tons/month in Gadsbrook RF/Buffer Area. Given that is cannot function in the monsoons due to drying limitations, we assume production for 6 months, making the annual production between 240 and 720 tons/year. These figures are on the low side however, and assuming a small machine of one ton/hr (3000 tons/year), we are going to only utilize 8-24% of its potential.

Considering all these factors, the maximum level of production that we assume in our projections would be 360 tons/year. That is in the case of extraction from Mudumalai we cap the volume at 360 tons/year, but in Gadsbrook we leave it at 240 tons/year.

In the costing of the project, we have factored in all hidden costs as well (human resources, working capital, overheads etc.) though many of these will be borne/subsidized by the Forest Department.

Capital Cost of Project

Particulars	**Cost (Lakhs)**
Land	Provided by forest dept.
Shed/Building development (1500 sq feet min.)	Provided by forest dept.
Civil works for machinery	0.8
Machinery	
-Briquetting machine (500 kg/hour)	7.5
-Auxiliary equipment (will not know unless tested out)	2.0 (estimated)
Miscellaneous fixed assets (furniture, computer etc.)	0.5
Total capital cost	**10.8 Lakhs**

Human Resource Cost

Particulars	Salaries	Cost (Rs./Month)
Manager	1*10,000	10,000
Skilled workers/technicians	2*8,000	16,000
Supervisor	1*8,000	8,000
Marketing	1*8,000	8,000
Total		**42,000**

There is a concern on the ability of the community to handle the complex business requirements and handle the machinery associated with this project

Working Capital Requirements

(Assuming 30 tons/month)

Particulars	**Quantity**	**Cost (Rs.)**
One month stock of raw materials	30 tons	30,000
One month's power (Rs 4/unit)	50 units/ton (30 tons/month	6,000(50*30*4)
One month's salaries	5 staff	42,000
2 weeks finished stock	14 tons (14T*1.84)	25,760
2 weeks bill receivables	Assuming 10,000	10,000
Total WC requirements		**1,13,760**

Fixed Overheads

Item	Description	Cost (Rs./Month)
Salary of staff	5 nos.	42000
Rent/lease of building/shed	5000/month	5000
Admin overheads	3000/month	3000
Total		**50,000**

Annual Profit & Loss Projection

Comparison of profit and loss at two sites of extraction.

	Item	Mudumalai	Gadsbrook
1	Production (tons)	3,60,000	2,40,000
2	Sales (Rs.) (Assuming 100% sales @ Rs 5/kg)	18,00,000	12,00,000
3	Cost of production/kg (Rs.)	2.71	5.85
4	Total cost of Production (Rs.)	9,75600	14,04,000
5	Gross margin	8,24,400	-2,04,000
6	Fixed overheads	6,00,000	6,00,000
7	**Net profit**	**2,24,400**	**-8,04,000**

Note: Cost of Capital is not being featured, since it is assumed that it will be offset through grant funds.

Financial Appraisal

Only calculated for the site in Mudumalai, as Gadsbrook site is clearly not feasible.

Pay Back period:

Payback Period =Initial Investment/Cash Inflow per Period

= 10.2 lakhs/2.24 lakhs = **4.54 years**

This is not that relevant though, since capital expenditure is offset by project funds.

Net present value

Calculating NPV assuming a project life of 3 years (equal cash inflows across 3 years)

Rate= 0.05, Cash inflow= 2,24,400 for three years, initial investment=10.2 lakhs

= - 378857 -->NPV<0

However, if considered over a five year period, the NPV= **+48571-->NPV>0**

IRR

Calculating IRR assuming a project life of 3 years (equal cash inflows across 3 years)

= 1%

Other Technical Details

Plant capacity	360 T/annum (1 ton/day)
Equipment size (briquetting machine)	Machine not finalized, but assumed to fit within a 100sqft room.
Storage space required	Large drying yard/Polyshed required- around 2500 sqft. Storage space a further 500sqft.
Auxiliary equipment	Has to be tested whether required
Civil engineering for m/c and shed	
Control and automation engineering	Minimal/included in the scope of work of supplier of machine
Captive power plant	Not required.
Waste heat recovery system	Not applicable

Economic and Environmental Impact

There is potential to clear 12 hectares of Lantana annually (assuming 360 tons per year @ 30 tons per hectare) in MTR, or 24 hectares annually (assuming 240 tons per year @ 10tons per hectare) in the Buffer Area (Gadsbrook RF).

Economic Impact on Community (annually)

Income accruing to community	Benefit - Mudumalai (Rs.)	Benefit - Gadsbrook (Rs.)
Income from lantana extraction (labor charges)	3,60,000	4,80,000
Salaries of 5 people	5,04,000	5,04,000
Net profit annually generated by the project	2,24,400	-8,04,000
Total	**10,88,400/-**	**1,80,000/-**

Conclusion

Based on the techno-economic feasibility it is clear that the project is viable in MTR, but not in the Buffer Area (Gadsbrook RF).The key points are:

- MTR has much higher density of Lantana (30 tons/hectare), uprooting and transportation costs are lower, whereas Gadsbrook has lower density of Lantana (10 tons/hectare), uprooting and transport costs are higher.
- Projected annual profit in MTR is Rs. 2,24,000 compared to loss of Rs. 8,04,000 in Gadsbrook.
- Larger area can be cleared in Gadsbrook RF (24 hectares) than MTR (12 hectares).
- Projected total annual benefit to community in MTR is Rs. 10,88,400 compared to loss of Rs. 1,80,000 in Gadsbrook.

Overall there is still significant scope of the project in other parts where such site specific limitations do not exist. In the private biomass briquette market typically 70% of the cost of briquetting is the raw material cost which is available free of cost to the community in this case. There is higher cost in harvesting the biomass, but this is has significant ecological social benefits, since removal of Lantana is good for the forests, and the money spent in removal benefits the local community. In this project since it is a protected area, there is little scope of competition from private players to inflate raw material prices in future, making it a reasonably secure livelihood option for tribals.

However on the technical feasibility of the project, there are numerous concerns in terms of drying in local conditions, requirement of binders, and suitability of lantana briquettes for industry. Also infrastructure challenges in terms of power supply, additional auxiliary equipment to meet customer standards (not budgeted for), and drying space are additional factors to consider.

Finally in terms of human resources community ownership of such projects has always been a problem and it would be risky to invest in huge machinery.