FEASIBILITY STUDY OF DOMESTIC CHARCOAL PRODUCTION IN BHUTAN

(NOVEMBER 2021)

Forest Resources Management Division
Department of Forests and Park Services
Ministry of Agriculture and Forests

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ABBREVIATIONS

AAC	Annual allowable cut
ABSD	Accelerating Bhutan's Socio Economic Development
AWBI	Association of Wood Based Industry
BCCL	Bhutan Carbide and Chemicals Limited
BFAL	Bhutan Ferro Alloys Limited
BTS	Bhutan Trade Statistics
CF	Community Forest/Community Forestry
CFMG	Community Forest Management Group
CFMP	Community Forest Management Plan
cft	Cubic foot/feet
DoFPS	Department of Forests and Park Services
DoI	Department of Industry
FAO	Food and Agriculture Organization
FMCB	Forest Management Code of Bhutan
FMP	Forest Management Plan
FMU	Forest Management Unit
FNCA	Forest and Nature Conservation Act, 1995
FNCRR	Forest and Nature Conservation Rules & Regulations, 2017
FRMD	Forest Resources Management Division
FRPA	Forest Resources Potential Assessment
Ha	Hectare
HWC	Human Wildlife Conflict
MoF	Ministry of Finance
SFED	Social Forestry and Extension Division
tCO_2	Ton of Carbon dioxide

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ABSTRACT

The annual charcoal import of approximately 112,000 tons from India contributes to about annual revenue loss of approximately Nu. 2 billion which adversely impacts our trade balance. Therefore, it is crucially important to substitute such imports with our local production either through promotion and expansion of the existing production units or establishment of new production units. Import substitution will not only offset the revenue loss and foster the local economy but also provide employment opportunities to our aspiring youths. However, substituting the import with domestic production is constraints by several factors like inadequate raw materials available from existing timber harvesting areas, high raw materials cost caused by high extraction and transportation cost due to rugged and inaccessible terrain, limited potential forest areas which could be brought under additional commercial management, depleting timber resources in the existing timber production areas like forest management units and high risk of associated environmental and social impacts.

Of the many factors that contributes to viable domestic charcoal production, technology, sustained supply of adequate raw material and its cost plays a crucial role. As of today there is only one charcoal production unit located at Lingmithang which is functional with additional six on the pipeline for establishment while one production unit established in Gelephu is already closed. If all of these existing units are functional at full capacity, the combined production would be able to offset around 13% of the total charcoal import. However, there is already an existing raw material shortages with a gap of about 14,570 m^3 on a monthly basis required to run these production units at full capacity. Deployment of improved technology in this production units is likely to substantially narrow the raw material requirement gap as well as increase the profit margin to a large extent.

In order to offset the entire annual 112000 tons of charcoal import from India approximately 1050000 m^3 of raw material is required on an annual basis. Against this requirement the raw materials in the form of wood residues available from existing timber harvesting areas is approximately 99000 m^3 on an annual basis which will be able to offset only about 9.43% of the total imports. However, inadequate raw materials could be substantiated by carrying out energy plantations in about 1537.58 ha of barren and degraded SRF land along the southern belt, exploring unharnessed bamboo resources found in southern Dzongkhags like Samtse, Samdrup Jongkhar, Tsirang and Samtse as a potential raw materials for charcoal production, exploring other forms of biomass such as saw dust briquettes as raw materials and by bringing about 12.31 % of additional forest areas under commercial management. However, all of these additional means are constraints by several factors and risk.

One of the eminent risk foreseen is the clear felling of forested private registered land as empowered by the Land Act. This in long run may lead to unchecked deforestation and subsequent change in the land-use increasing vulnerability to loss of associated ecosystem services, climate change impacts and increased CO_2 emissions. Every hectare of forest land converted to non-forest land releases about 624 tCO_2 into the atmosphere. This will also have an impact on forest cover of our nation as a whole.

Though bringing additional forest areas under sustainable commercial management would be able to offset about 31.57% of the total charcoal imports (9.43% by raw materials sourced from existing harvesting areas and 22.14% by raw materials sourced from additional potential commercial management areas), it is severely constrained by high cost of extraction due to rugged and inaccessible terrain besides imposing several adverse environmental impacts by virtue of these areas being located in steep and erosion prone topography with high rainfall and biodiversity. Operation of these areas also pose risk of downstream hydro power dam siltation and damages to infrastructures besides triggering transboundary issues of flooding and other collateral damages across the border. Further, failure to successfully restock these harvested areas will have significant impact on our commitment to remain carbon neutral and maintain 60% forest cover for all times to come. Every cubic foot (cft) of timber harvested releases 0.04 tCO_2 into the atmosphere while it will take at least 183 years to store the same amount.

Taking into account the strength, weakness, opportunities and probable threats pertaining to domestic charcoal production and import substitution, some of the viable way forward are to explore establishment of bigger production units with consortium of parties considering the economics of scale and long term resilience of the production units. Further, introduction of improved and advanced charcoal production technologies is crucial in reducing the environmental impacts as well as to enhance the production. It is also important to explore use of other forms of biomass such as bamboo and sawdust briquettes as raw materials for charcoal production. NRDCL must also explore supplying existing undisposed lops and tops in Forest Management Units and other timber extraction sites at cheaper rates than the current rates and do aggressive marketing for sale and disposal. Bringing additional forest areas under commercial harvesting needs to be further reviewed and analyzed both in terms of its economic benefits vis a vis associated environmental, social and political impacts prior to initiation of timber extraction activities from these areas.

1. BACKGROUND

With over 71% of the total land of Bhutan under forest cover, forests form an important and indispensable national asset. The Constitution of Bhutan mandates the Government to maintain a minimum of 60% of the country's total land under forest cover for all times to come. Although Bhutan has a rich forest resource base, the country imports huge volume of wood-based produce from the neighboring country, India. One such commodity is charcoal which is in high demand in metallurgical industries, as it is used as a chemical reducing agent for the production of ferro-alloys and calcium carbide. Charcoal is solid residue remaining when wood is "carbonised" or "pyrolysed" under controlled conditions in a closed space such as a charcoal kiln. Control is exercised over the entry of air during the pyrolysis or carbonisation process so that the wood does not merely burn away to ashes, as in a conventional fire, but decomposes chemically to form charcoal. The charcoal, due to its lower greenhouse gas emission profile, is a more environmentally friendly alternative to other sources of carbon like coke. The Bhutan Trade Statistics data show that a huge volume of charcoal is imported annually with an average approximate import value of Nu. 2,066.34 million.

2. RATIONALE

Substituting charcoal imports with local production will be beneficial not only in offsetting huge annual revenue loss and fostering the local economy of the country but also in providing employment opportunities especially for the aspiring youths. In view of the enormous quantity of Charcoal imported and the subsequent Rupee outflow, it is felt crucially important to substitute such imports with our local production either through promotion and expansion of the existing production units for mass scale production or establishment of new production units.

A recent study also concluded that charcoal production would be profitable in 11 of the 20 districts offsetting up to 61 percent of charcoal imports, provided the share of commercially managed forest area increases from 7.3 percent to 15 percent of the total forest area. However, the study also emphasizes on importance of introducing improved harvesting technologies to further increase in the commercially managed forest area (Feuerbacher et al. 2016). Enhancing charcoal production following strict sustainability criteria for the supply of needed raw materials and making smart use of wood waste—for example, using waste from sawmills and other residues—could also help reduce imports and create jobs (Bhutan Forest Note, World Bank, 2019).

Therefore, a study regarding availability of adequate raw materials like wood residues, other wood products, etc. from existing timber extraction areas as well as possibilities of increasing the commercially managed forest area to increase the raw materials resource base needs to be carried out to ensure sustainability of Charcoal production in the country. Crucially, cost benefit analysis of charcoal production within the country both in terms of economic as well as environmental aspects needs to be worked out to arrive at a conclusion of the feasibility.

In this study we carried out an assessment of the domestic charcoal production potential, economic opportunities as well as other associated risks and constraints. Further we also assessed the availability of raw materials within the country in terms of using residual woods generated out of logging activities within State Reserve Forest Lands and also exploring other potential raw material sources like bringing additional forest area under commercial timber production, creation of energy plantations and Bamboo charcoal substitutions (MoEA, 2015) considering the long-term sustainability of domestic charcoal production in the country.

3. METHODOLOGY

In order to carry out the domestic charcoal production feasibility study, a number of approaches were used.

i. To access the current available resources base in the already existing forest management regimes, primary data were collected through field visits.

ii. To understand the current trend of charcoal import, demand and utilization, secondary data were collected from available national statistics (Bhutan Trade Statistics) and records maintained with respective government agencies.

iii. Literature reviews regarding the production capacity and charcoal production technologies were carried out.

iv. A case study on the actual production process and raw material requirements was carried out by collecting information through a structured interview with the proprietor of the only charcoal production unit in Bhutan located at Lingmithang under Mongar Dzongkhag.

v. The validation of the study was done through a consultation meeting with relevant stakeholders to integrate their concerns and opinions.

4. CURRENT CHARCOAL DEMAND TREND AND IMPORT STATISTICS

Wood charcoal has been extensively preferred for numerous applications that include industrial fuels, medicine, and cooking fuels. Charcoal is also used as raw materials in many industries. Charcoal in Bhutan is mostly used in metallurgical industries as one of the raw materials. Ferro Silicon factories like Bhutan Carbide and Chemicals Limited (BCCL), Bhutan Ferro Alloys Limited (BFAL) and SD Ferro Silicon Industries Limited use huge quantities of charcoal annually, most of which is imported from India.

Charcoal is one of the top ten commodities of import in Bhutan with an annual import value of Nu. 2,226.24 million in 2018 alone (BTS,2018). The total import value constitutes around 3.12% of the total import for the country. Such huge quantities of charcoal import are mainly due to limited domestic production within the country. Although there has been a slight decrease in the quantity of charcoal being imported in 2019 and 2020 compared to that of 2018, the difference is insignificant and basically shows a close to steady demand scenario. On an average (as per the data from 2018-2020), approximately 0.112 million metric tons of Charcoal is imported worth 2,066.34 million Ngultrum (Table 1) annually. The statistics also shows that the import of bamboo charcoal has substantially increased in the year 2020 compared to previous years.

Table 1: Charcoal Import Statistics (2018-2020)

Year	Wood Charcoal	Quantity (in metric ton)	Value (in million Ngulturm)
2018	Of Bamboo	8.16	0.073
	Others	125,672.586	2,226.24
2019	Of Bamboo	16.670	0.246
	Others	109,921.358	1,882.58
2020	Of Bamboo	1,181.540	19.49
	Others	99,893.424	2,070.51
Average	**Of Bamboo**	**402.123**	**6.57**
	Others	**111,829.122**	**2,059.77**
Average Total	**Bamboo and Others**	**112,231.245**	**2,066.34**

Charcoal imports from India experienced more than tenfold increase between 2005 to 2019, growing from approximately 9,400 to 100,000 tons during that period (Figure. 1) (MoF, 2013-2019). Currently, most of the charcoal is imported from Karanataka and Gujarat in India. Charcoal is made from Bamboos, Acacia nilotica and Prosopis juliflora by small scale farmers in India.

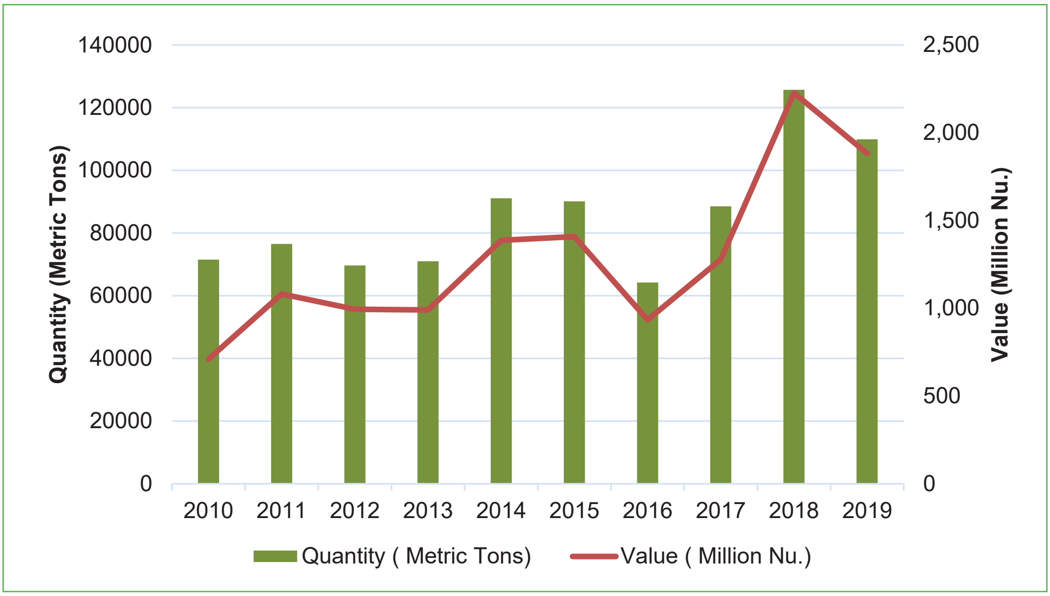

Figure 1: Charcoal Import Statistics (2010-2019)

5. CURRENT STATUS OF CHARCOAL FACTORIES IN BHUTAN

Despite the high demand for charcoal within the country there is only one physically established and operational domestic charcoal production unit in the country today. The production unit was established in 2018 and is located at Menchhugang, Lingmethang under Mongar Dzongkhag. The production unit has a capacity of producing around 20 tons of charcoal in a month utilizing approximately 560 m^3 of raw materials. However, the unit is temporarily closed for now due to increase in transportation charges caused by covid-19 pandemic. The charcoal produced in the production unit is supplied to SD Ferro-Silicon industry located at Samdrup Jongkhar.

The Green Druk Venture (Biochar Cottage Unit) established in 2012 at Gelephu was closed in 2017 after being operational for about five years. One of the main reasons attributed for its closure was inadequate as well as high cost of raw materials and labour shortages. The proprietor claimed that local Bhutanese laborers are generally reluctant to work in charcoal factories. These factors resulted in making the operation economically not feasible. Further, the Department of Forest and Park Services has also issued Forestry Clearance for the establishment of additional five (5) other charcoal production units which are not yet physically established and operational.

The details of the additional charcoal production units issued with the Forestry Clearance by the Department for establishment are as detailed in the table below:

Table 2: Current status of Charcoal Factories in Bhutan

Sl. No	Name /Location of Charcoal Factory	Year of Establishment	Capacity (Tons/ Month)	Current Status	Technologies used/ proposed
Operational Units					
1	Eastern Bhutan Wood Charcoal Production Unit, Menchhugang, Saleng Gewog, Monggar	2018 (Establishment)	40 tons	Operational	Metal Kiln (manual)
Non-Operational Unit					
1	Green Druk Venture (Biochar Cottage Unit), Pelrithang, Gelephu	2012 (Establishment)	60 tons	Non-Operational, Since 2017	Metal Kiln (manual)
Establishment Proposals with Approved Forestry Clearance					
1	Kathup Charcoal Industry, Nyinshingborang, Norbugang, Pema Gatshel	-	125 tons	Not established (clearance Issued May, 2019)	
2	Jigme Yonten & Partners, Olakha, Gyeling Gewog, Chhukha Dzongkhag	2021 (Approval)	416 tons	Not established (clearance Issued July, 2021)	Lifting Carbonization Furnace (Improved)
3	Bhutan Charcoal (Mr. Jigme Tshewang), Jigmeling, Sarpang Dzongkhag	2021 (Approval)	40 tons	Not established (clearance Issued April, 2021)	EKKO Kiln (Improved)
4	Bhutan Eco-Charcoal (Mr. Karma & Rinzin Wangchuk), Motanga Industrial Park, Deothang, Samdrup Jongkhar	2020 (Approval)	600 tons	Not established (clearance Issued December, 2020)	Horizontal Air-flow Carbonization Furnace (Improved)
5	Mr. Tashi Tobgay & Mr. Namgay Phuentsho, Jawogna, Naja, Paro	2020 (Approval)		Not established (clearance Issued October, 2020)	

5.1. Raw material requirement, import substitution and resource gaps for the existing Charcoal production units

Given that all the Production Units mentioned above are operational at their full capacity, a total of 11,452.98 m^3 of raw materials will be required on a monthly basis if the units deploy improved charcoal production technologies. If the traditional metal kiln fueled by firewood is used for the production of charcoal, a total of 34,188 m^3 of raw materials will be required on a monthly basis. The approved production units upon becoming fully operational will be able to produce 14,652 metric tons of charcoal annually. In terms of import, these units will be able to offset approximately 13% of charcoal import in the country.

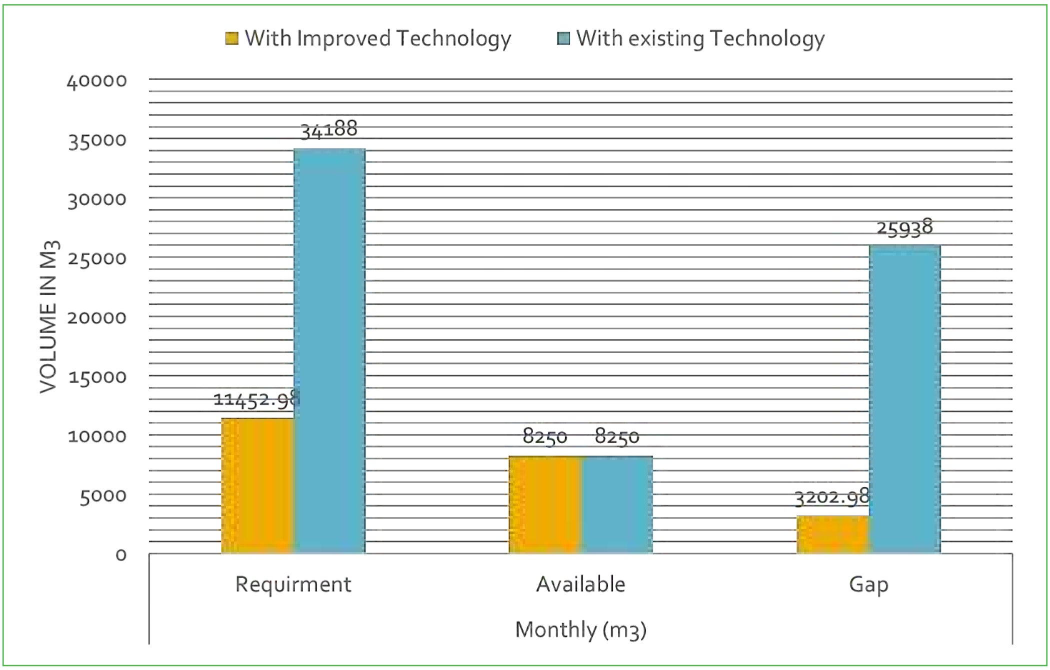

Figure 2: Graph showing monthly raw material requirement and gaps for existing charcoal production units

Despite the capacity of existing production units to offset around 13% of the annual charcoal import, there is an existing raw material resource gaps of around 3202.98 m^3 if improved technologies are deployed and 25938 m^3 with the use of traditional metal kiln on a monthly basis (Fig 2). The resource gap is significant with the use of traditional metal kiln due to very low turnover ratio.

Assumption: *9.38 m^3 of wood is required to produce 1 metric ton of charcoal (Logistics of Charcoal Production, FAO) with the use of improved technology and 28 m^3 of wood is required to produce 1 metric ton of charcoal with the use of traditional metal kiln (Lingmithang Charcoal Production Unit).*

6. CHARCOAL PRODUCTION PROCESSES

The charcoal production process involves several stages of operation and it starts with growing fuel wood for use as raw materials. The growing of fuel wood is the best alternative to direct harvesting of natural forest as it will ensure sustained supply of raw materials without having to depend on the existing primary forest. This is followed by wood harvesting and transportation to the factory site. The wood thus harvested is dried, chipped and prepared for carbonization. The wood is then carbonized under controlled conditions in a closed space (kiln) to charcoal.

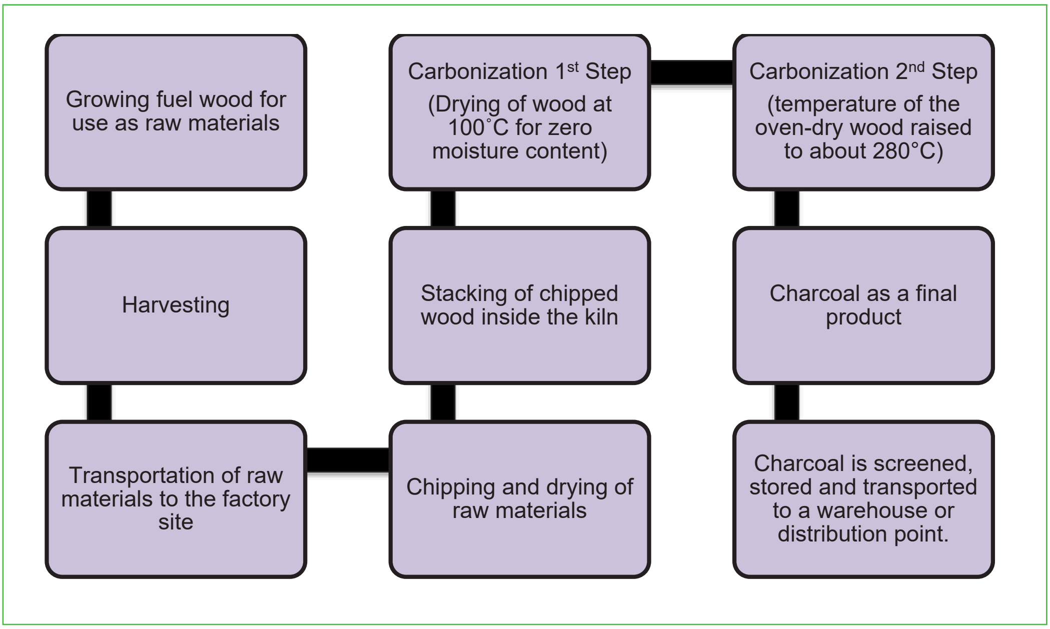

Figure 3: Charcoal Production Processes

Carbonization is a very important stage in the charcoal production as it is the main factor that determines the efficiency and yield of charcoal. This will directly impact the cost of resources involved. Before carbonization, the wood is dried so that the water in the wood is driven off. The remaining water in the wood to be carbonized is again dried in the kiln or pit by using the energy provided by burning some of the wood itself.

The first step in carbonization in the kiln is drying out of the wood at 100°C or below to zero moisture content. The temperature of the oven-dry wood is then raised to about 280°C. The energy for these steps comes from partial combustion of some of the wood charged to the kiln or pit and it is an energy absorbing or endothermic reaction.

When the wood is dry and heated to around 280°C, it begins to spontaneously break down to produce charcoal plus water vapour, methanol, acetic acid and more complex chemicals, chiefly in the form of tars and non-condensable gas consisting mainly of hydrogen, carbon monoxide and carbon dioxide. Air is admitted to the carbonizing kiln or pit to allow some wood to be burned and the nitrogen from this air will also be present in the gas. The oxygen of the air is used up in burning parts of the wood. The spontaneous breakdown or carbonization of the wood above a temperature of 280°C liberates energy and hence this reaction is said to be exothermic. This process of spontaneous breakdown or carbonization continues until only the carbonized residue called charcoal remains. After the carbonization process, the charcoal is screened, stored and transported to a warehouse or distribution point.

7. A CASE STUDY ON EASTERN BHUTAN WOOD CHARCOAL PRODUCTION UNIT

7.1. Background

The Eastern Bhutan Wood Charcoal Production Unit is situated in Lingmithang under Mongar Dzongkhag. The Production Unit was established in 2018 with the main aim to supply charcoal to Ferro-Silicon Industries at Samdrup Jongkhar Dzongkhag. The Unit is the only operational Charcoal Production Unit in Bhutan with an actual production capacity of 240 metric tons of charcoal annually (i.e. 20 metric tons per month). However, the unit is temporarily closed for now due to increase in transportation charges (as a result of trans-shipment requirement) caused by covid-19 pandemic.

7.2. Raw Material Sources

The charcoal production unit in Lingmithang uses only wood as raw material for the production of charcoal. Both soft wood and hard wood are used for the production of charcoal in the Unit. The Unit sources its raw materials from areas near its establishment, mainly from Lingmithang FMU, ad-hoc extraction areas and drift wood from Kurichhu. Raw material collection is being outsourced to local private firewood contractors. The contractor delivers the raw materials to the production unit at Nu. 4,000 per 16 m^3. At this rate, the raw materials are collected only from areas nearby the production unit especially from private registered land, community forests and other rural timber allotment areas. However, it was also mentioned that sourcing of raw materials from far flung areas and areas outside Mongar Dzongkhag is not feasible due to high transportation cost. The proprietor also mentioned that the firewood cost above 4,000 per 16 m^3 will not be profitable for the business.

On the other hand, the minimum existing firewood rate of NRDCL in the region is Nu. 590 per m^3 of firewood which amounts to a total of Nu. 9,440/- for 16 m^3 which is not profitable as per the Proprietor. Therefore, the production unit prefers sourcing raw materials from sources other than NRDCL. In order to operate the production unit in its full capacity, a total of 560 m^3 of wood is required every month.

Table 3: Firewood rates of Zhongar Region, NRDCL for 2021

Sl. No.	FMU/Sources	Rate Nu/m^3
		Approved Rate of 2021
1	Lingmethang FMU	785
2	Rongmanchu FMU	775
3	Korila FMU	590
	Lingmethang to Korila FMU	750
4	Dongdechu FMU	899
5	Khaling-Kharungla FMU	888
6	Samdrupjongkhar	735
7	Samdrrupcholing	750
8	Khengzor FMU, PemaGatshel	699
9	Nanglam	900
10	Jomotshangkha	999
11	Panbang	1055.5

7.3. Production Capacity and Processes

The production capacity of the Eastern Bhutan Wood Charcoal Production Unit is 20 metric tons per month (240 metric tons per year) if it operates on its full potential. With the current technology in use, it takes approximately 28 m^3 of wood to produce one metric ton of charcoal. Therefore, the ratio of charcoal production to raw material requirement is approximately 1:28. Out of the 28 m^3, 16 m^3 of wood is burned to fuel the furnace and the remaining 12 m^3 of wood is converted into actual charcoal. When compared to other advanced technology, the efficiency of the technology currently in use is relatively low.

It takes around three days to complete one cycle of production which starts with wood collection to production and packing of charcoal. One day is required for transportation of wood to the production unit and stacking of wood in the furnace. The next day, the actual production starts whereby the carbonization takes around 24 hours. On the third day, the carbonized wood, i.e. the charcoal, is left in the furnace for cooling and later on packed for shipment.


Figure 4: Firewood chipped into appropriate sizes for use as raw material


Figure 5: Charcoal (finished produce)

7.4. Production Technology

The Production Unit uses manual metal furnace technology to produce charcoal from wood. The wood is burned to fuel the furnace. Here, wood is used both as a raw material for charcoal production as well as to fuel the entire process. Although this technology is comparatively more efficient than the traditional used earth kiln and brick kiln technology, it is not as efficient as the semi-automated or automated metal kiln technology powered by electricity when it comes to the charcoal turnover per cycle and production efficiency (productivity). There are two metal furnace set-ups in the unit with each furnace capable of producing one metric ton of charcoal per cycle. The entire process is carried out manually.


Figure 6: Metal Kiln for Charcoal Production fuelled by firewood

7.5. Cost Benefit Analysis

Based on a study carried out by FAO, in terms of cost for producing charcoal, the maximum expenses are incurred in purchasing/harvesting of raw materials (approximately 60% of the total cost) and transportation of the charcoal (approximately 26% of the total cost). Together, they amount to around 86% of the total costs. In order to get a realistic cost benefit analysis, data on the cost components associated with the production and revenue generated through the sale of the produce was calculated as illustrated in Table 4. Two broad scenarios were considered for cost-benefit analysis taking into account the existing charcoal production technologies and more advanced semi or fully automated technologies. These two scenarios were further segregated based on the mode of raw material sourcing. The scenario A takes into account the existing technology with raw material being sourced from NRDCL at existing minimum firewood rate (Nu. 590 per m^3) while scenario B takes into account the existing technology with raw materials sourced by the factory owner themselves (at Nu. 250 per m^3). Scenario C takes into account the use of improved technologies with raw materials being sourced from NRDCL and scenario D takes into account the use of improved technologies with the raw materials collected by the factory owners themselves.

Improved technology here will mean deploying metal kiln technology which will basically use electricity to fuel the charcoal production process instead of conventional use of firewood as a primary source of energy.

Box 1: Estimates used for cost benefit analysis

- Cost of 2 steel furnaces = Nu. 600,000
- Cost of shed construction = Nu. 150,000
- Life of steel furnace & shed made of steel frame = 15 years
- Labour payment = 12500/labour/month (there are 6 labourers)
- Total qty of charcoal production = 20-25 tons per month - but kept at 20 tons /month for the calculation
- Cost of firewood/TL (16 m^3) when supplied by NRDCL = Nu. 10,000/TL @ Nu. 625/m^3
- Cost of firewood/TL (16 m^3) when collected by factories themselves, using their own labourers/contractors = Nu. 4,000/TL
- Loan interest repayment =Nu. 40,000/month
- Land lease rent = Nu. 1,100/annum
- Cost of 1 bag = Nu.5.0. They need 100 bags/TL
- Total production of charcoal = 20 tons/month
- Total firewood required to produce 20 tons of charcoal = 560 m^3
- Cost of firewood = Nu 625/m^3
- Selling price of charcoal/tons = Nu. 20,000
- Each T/L carries 6 tons of charcoal

As illustrated under scenario A, domestic charcoal production is not profitable with the use of existing technology along with raw materials being sourced from NRDCL at their existing firewood rate. It is profitable (with less profit margin) only if the raw materials are collected by the factory owner themselves as presented under scenario B. However, the profit margin increases significantly with the use of improved technologies irrespective of the raw material source as presented under scenario C and D.

Therefore, one of the potential improvements that can be made is in the technology used for the production of charcoal. The third and fourth scenario gives us the clear picture of using improved production technology which will have the potential to increase the profit margin by a larger extent. If improved technology is used, the productivity of the entire production unit takes a leap essentially due to the increase in charcoal turnover per cubic meter of firewood used.

Through this cost benefit analysis, it can be concluded that there are essentially two primary factors that will determine the profitability of the business and they are:

a. The deployment of improved charcoal production technologies.
b. The cost of raw materials (firewood) per cubic meter.

Table 4: Cost Benefit Analysis

Mode of Raw Materials sourcing with existing technology				**Mode of Raw Materials sourcing with improved technology**			
Scenario A:When firewood is supplied by contractor (NRDCL)		**Scenario B: When firewood is collected by factory owners**		**Scenario C:When firewood is supplied by contractor (NRDCL)**		**Scenario D: When firewood is collected by factory owners**	
I Direct costs	**Amount (Nu.)**	**I Direct costs**	**Amount (Nu.)**	**I Direct costs**	**Amount (Nu.)**	**I Direct costs**	**Amount (Nu.)**
Total cost for two steel furnaces (Nu.)	600,000.00	Total cost for two steel furnaces (Nu.)	600,000.00	Total cost for two semi-auto steel furnaces (Nu.)	1,200,000	Total cost for two semi-auto steel furnaces (Nu.)	1,200,000
Depreciation cost/ month for 2 furnaces (Nu. 0.6 mil)/month	3,333.33	Depreciation cost for 2 furnaces (Nu. 0.6 mil)/month	3,333.33	Depreciation cost for 2 furnaces (Nu. 0.6 mil)/month	6,666.66	Depreciation cost for 2 furnaces (Nu. 0.6 mil)/month	6,666.66
Land lease rent/month	91.66	Land lease rent/ month	91.66	Land lease rent/ month	91.66	Land lease rent/ month	91.66
loan interest/month	40,000.00	loan interest/ month	40,000.00	loan interest/month	80,000	loan interest/month	80,000
Cost of shed construction (steel frame)	150,000.00	Cost of shed construction (steel frame)	150,000.00	Cost of shed construction (steel frame)	150,000	Cost of shed construction (steel frame)	150,000
Depreciation cost of shed for furnace/ month	833.33	Depreciation cost of shed for furnace/ month	833.33	Depreciation cost of shed for furnace/ month	833.33	Depreciation cost of shed for furnace/ month	833.33
Total direct cost	**44,258.32**	**Total direct cost**	**44,258.32**	**Total direct cost**	***87591.65***	**Total direct cost**	***87591.65***
II Variable costs		**II Variable costs**		**II Variable costs**		**II Variable costs**	
Total labour cost/ month (Nu.)	75,000.00	Total labour cost/ month (Nu.)	75,000.00	Total labour cost/ month (Nu.)	75,000	Total labour cost/ month (Nu.)	75,000

Total firewood cost (Nu. 590/m^3) for 560 m^3/month	330,400.00	Total firewood cost (Nu. 250/m^3) for 560 m^3	140,000.00	Total firewood cost (Nu. 590/m^3) for 393 m^3	231,870	Total firewood cost (Nu. 250/m^3) for 393 m^3	98,250
No. of packing bags/TL (100 bags, cost = Nu. 5/bag)	1,500.00	No. of packing bags/TL (100 bags, cost = Nu. 5/bag)	1,500.00	No. of packing bags/TL (100 bags, cost = Nu. 5/bag)	3000	No. of packing bags/TL (100 bags, cost = Nu. 5/bag)	3,000
total transportation cost/month (for approx. 3 TL till Ferro silicon factory at SJ)	40,500.00	total transportation cost for approx. 3 TL till Ferro silicon factory at SJ	40,500.00	total transportation cost for approx. 6 TL till Ferro silicon factory at SJ	81000	total transportation cost for approx. 6 TL till Ferro silicon factory at SJ	81000
Total variable cost	447,400.00	Total variable cost	257,000.00	Total variable cost	*390,870*	Total variable cost	*257,250*
Total production cost	**491,658.32**	Total production cost	**301,258.32**	Total production cost	**478461.65**	Total production cost	**344,841.65**
Total sale price/month for 20 tons (@ Nu. 20,000/ton)	400,000.00	Total sale price/month for 20 tons (@ Nu. 20,000/tons)	400,000.00	Total sale price/month for 40 tons (@ Nu. 20,000/tons)	800000	Total sale price/month for 40 tons (@ Nu. 20,000/tons)	800000
Profit/Loss per month	**-91,658.32**	**Profit/Loss per month**	**+98,741.68**	**Profit/Loss per month**	**+321,538.35**	**Profit/Loss per month**	**+455,158.35**

7.6. Risk Factor

Although the raw materials sourced through sources other than NRDCL is comparatively cheaper, the sustained supply of the raw materials cannot be assured as it is available only on an ad-hoc basis. These includes wood residues mostly extracted from private registered lands, community forest and rural timber extraction sites. In order to run a mass charcoal production unit, it is essential to ensure a sustained supply of raw materials so that the production is not disrupted due to inadequate quantity of raw materials during the process.

7.7. Issues and Challenges

Relatively high raw materials cost when sourced through NRDCL

The minimum fire wood rate for Zhongar region is Nu.590/m^3 which is around Nu.9440 for 16 m^3 which is inclusive of labour cost, the cost of the raw materials as well as the transportation cost. At this rate and with the use of existing technology, the charcoal production is not at all profitable.

Higher transportation cost

The high transportation cost due to trans-shipping is an interim issue triggered by COVID-19 pandemic which is expected to normalize once the pandemic is over.

Low Productivity of the technology used

Regarding the charcoal production technology being used in the charcoal production unit at Lingmithang, Mongar, the turnover ratio is approximately 1: 28 (1 ton of wood charcoal is produced from 28 m^3 of wood). The turnover is very low as about 60% of wood is burned to power the furnace and only the remaining 40% is converted into charcoal. This results in low efficiency and higher raw material requirements leading to low profitability of the business.

8. RAW MATERIALS REQUIREMENT FOR DOMESTIC PRODUCTION

Based on the charcoal import statistics, the average annual charcoal demand in Bhutan is approximately 0.112 million metric tons of imported charcoal which are consumed by the Ferro Silicon factories like Bhutan Carbide and Chemicals Limited (BCCL), Bhutan Ferro Alloys Limited (BFAL) and SD Ferro Silicon Industries Ltd. If the charcoal demand is to be met through domestic production, adequate availability of wood raw materials within the country to sustain the domestic production is also inevitable.

As per the study carried out by FAO, approximately 9.38 m^3 of raw materials (wood/wood residues) is required to produce 1 ton of Wood Charcoal. By weight, about five tons of wood produces one ton of charcoal (Logistics of Charcoal Production, FAO). However, this assumption is based on the use of semi-automated and fully automated charcoal furnaces powered by electricity. With this assumption the total raw materials required to offset the charcoal import of 112,000 metric tons is approximately 1.05 million m^3/year. The table below shows the raw materials requirements per year to offset charcoal imports on a varying scale.

Table 5: Annual quantity of raw material required on varying scale of production

% Import / year	Import / year (tons)	Quantity of raw materials required (in million m^3) to meet various import %
100%	112,000	1.05
50%	56,000	0.525
40%	44,800	0.42
30%	33,600	0.315
20%	22,400	0.21
10%	11,200	0.105

9. RAW MATERIALS AVAILABILITY FOR DOMESTIC PRODUCTION

Against the requirement of raw materials, it is also equally important to assess the availability of raw materials on a sustainable basis for production of domestic charcoal. Raw materials for the production of charcoal can be broadly sourced from two potential sources. Firstly, wood residues as raw materials available from existing and planned timber harvesting areas and secondly, additional raw materials that can be made available by bringing in more forest areas under harvesting, through energy plantations and exploring other biomass (eg.saw dust, bamboo..etc) as alternative raw material for charcoal production.

9.1. Wood Residues from current harvesting areas as potential raw materials

9.1.1. Current Situation

Bhutan has 71% forest cover[1], which consists about 2,717,161.64 ha of the total country area out of which Broadleaved forests constitutes 46% (1,763,899.46 ha) while conifer forest constitutes 25% (953,262.18 ha) of the total forest area .Out of the total

[1]FRMD, 2016 & LULC 2016

forest area (2,717,161.64 ha) about 33.29% (904,423.78 ha) falls within National Parks, Wildlife Sanctuaries and Strict Nature Reserve where commercial harvesting/logging is restricted and about 19.96% (542,346.32 ha) is managed as FMUs, CFs and LFMAs (Table 4).

Table 6: Managed forest area outside Protected Area Network

Sl. No.	Management Type	Total Area (ha)	% of Forest Area
1	Forest Management Unit	198,406.84	7.30
2	Community Forest	89,745.05	3.30
3	Local forest management areas	189,670.50	6.98
4	Private registered land	64,523.93	2.37
	Total	**542,346.32**	**19.96**

Annually timber is extracted from FMUs, LFMAs, CFs, ad hoc areas, PA and private registered lands as commercial and rural timbers. Commercial timber extraction is mainly restricted to FMUs and other ad-hoc extraction areas outside FMUs while rural timber is extracted from Local Forest Management Areas, Community Forests as well as Protected Areas.

Approximately, 50% of the standing volume extracted from these management regimes is converted into residual wood, most of which are utilized as firewood and wood chips. The wood residues generated within FMUs are mostly extracted by NRDCL to cater to the commercial firewood demands of urban areas and government institutions. Additionally, some of these wood residues are also supplied as raw materials to wood based industries like BBPL and as wood chips to ferro-silicon industries within the country. However, a considerable quantity of these residual woods remains un-utilized in the forest areas.

9.1.2. Production Potential

Annually around 45000 m^3 of wood residues generated out of commercial timber extraction are left un-utilized in FMUs. Further, approximately 30000 million m^3 of wood residues is also generated through rural allotment annually. Additionally, an approximate of 70000 million m^3 and 30000 million m^3 of lops and tops are produced from Community Forest and Private Registered Land respectively. Although some portion of these wood residues are used as firewood and woodchips for rural and urban consumptions, most of these residues remain unutilized in the forest. Therefore, these residues can also be potential raw materials for the charcoal factories. Considering all of these raw materials are collected for use as raw materials in the charcoal factories, approximately 99000 m^3 of raw materials in the form of wood residues is available annually. This can cater to only 9.43% of annual domestic charcoal demand equivalent to 10554.37 metric tons as analyzed in Box 2 below. Therefore, the raw materials sourced only from already harvested areas alone will not be adequate to meet the raw material demand for the Charcoal factories.

Further, the Forest Management Units from which most of the lops and tops are generated are scattered throughout the country with about 70% located within the temperate forest. Only about 30% of the Forest Management Units are located in the Broadleaved Forest. On the contrary almost all the industries utilizing charcoal as raw materials are located along the southern belt of the country the major ones being silicon factories at Pasakha industrial area in Phunstholing and Samdrup Jongkhar Dzongkhag (Fig 6). Therefore, the cost incurred for extraction and transportation of raw materials from these FMUs to the production units and transportation of charcoal to the factory sites considerably determines the selling price of domestically produced charcoal and the profitability of the production units.

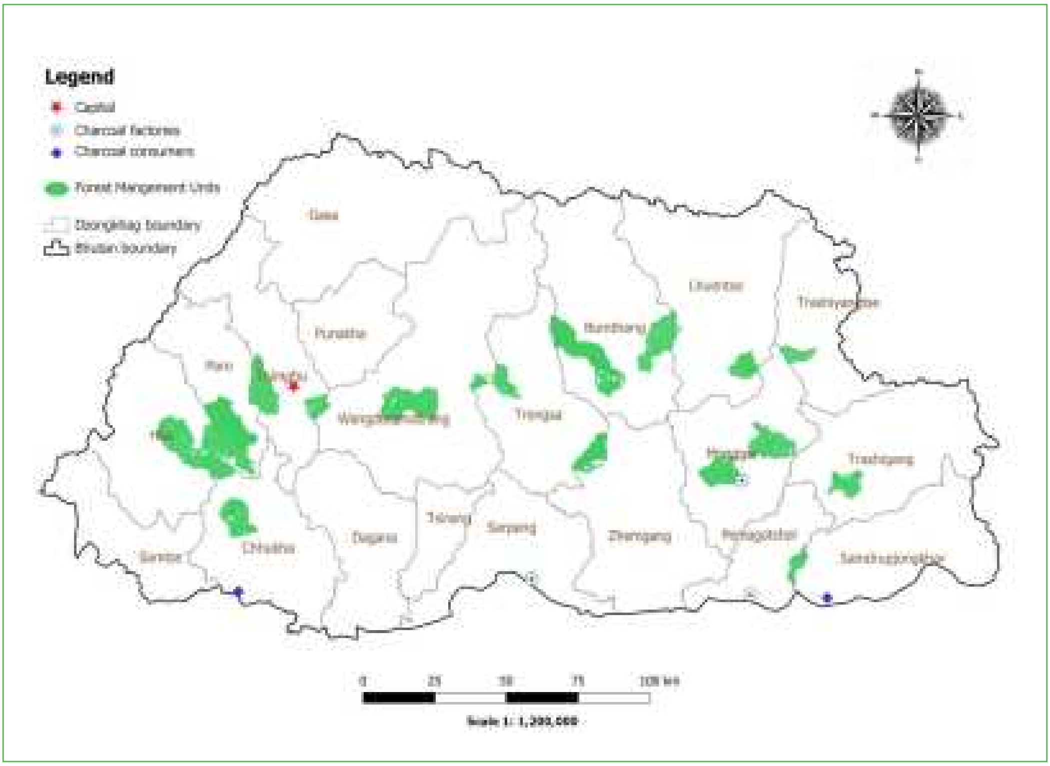

Figure 7: Map showing Forest Management Units, Charcoal factories and consumers

Table 7: Production of Lops and Tops from FMUs

Sl. No.	Name of the FMU/ Extraction Sites	Standing vol (m^3)	Log volume cft	Log recovery %	Lops & Tops %	Lops and Tops (m^3)
1	Karshong FMU	4,352.7	107,585.69	70.00	30.00	1305.81
2	Dawathang FMU	8,348.84	147,398.77	50.00	50.00	4174.42
3	Rodungla FMU	15,310.154	324,360.92	60.00	40.00	6124.06
4	Chendebji FMU	6,571.84	139,231.00	60.00	40.00	268.74
5	Khotokha FMU	7,522.12	164,675.76	62.00	38.00	2858.41
6	Gogona FMU	7,225.27	140,318.36	55.00	45.00	3251.37
7	Dongdechu FMU	7,667.42	73,098.88	27.00	73.00	5597.22
8	Khaling-Kharungla FMU	1,760.36	24,863.32	40.00	60.00	1,056.22
9	Khengzore FMU	1,874.21	26,471.34	40.00	60.00	1,124.53
10	Zonglela FMU	6,038.99	127,942.04	60.00	40.00	2,415.60
11	Haa-East FMU	0	0.00	60.00	40.00	0.00
12	Selela FMU	10,546.5	253,229.90	68.00	32.00	3,374.88
13	Lonchu FMU	4,562.37	109,546.15	68.00	32.00	1,459.96
14	Bitekha FMU	8,946.16	189,533.35	60.00	40.00	3,578.46
15	Gidakom FMU	4,429.55	101,664.82	65.00	35.00	1,550.34
16	Chamgang FMU	0	0.00	0.00	100.00	0.00
17	Metapchhu FMU	2,303.39	32,533.08	40.00	60.00	1,382.03
18	Lingmithang FMU	1,489.982	21,044.51	40.00	60.00	893.99
19	Korilla FMU	0	0.00	0.00	0.00	0.00
20	Rongmanchu FMU	0	0.00	0.00	0.00	0.00
21	Wangdigang FMU	0	0.00	0.00	0.00	0.00
22	Kikhar Timber Extraction Site	5,259.68	74,287.72	40.00	60.00	3155.81
	Total (A)	**104,209.536**	**2057,785.61**			**45,931.84**

Box 2: Raw materials sourced from already harvested areas

- Raw materials available from FMUs (annually)= 45000 m^3
- Raw materials available from ad-hoc areas (annually)= 24000 m^3
- Raw materials available from Rural Timber Marking Areas (annually)= 30000 m^3
- Total raw materials from all above sources= 99000 m^3
- Percentage of domestic charcoal demand met from existing available raw materials
  = (99000 / 1050000) × 100
  = 9.43 % (eq. 10554.37 metric ton)

9.1.3. Limitations

Cost of lops and tops from FMUs and NRDCL operated areas

Extraction of lops and tops from FMUs is carried out by NRDCL through private contractors. The extraction activities are tendered out through competitive bidding within the Regional jurisdiction of NRDCL and awarded to the lowest bidders. The average rate of firewood for Zhongar region is 818.79 per m^3 while for Jakar Region is Nu. 1110.49 per m^3. The average rate of firewood for the entire country is Nu. 980.84 per m^3 for the year 2021. As per the cost benefit analysis carried out, one of the challenges which make it difficult to run the charcoal business with higher profit margin is the high cost of raw material.

High Transportation Cost

The current operational FMUs in Bhutan are scattered throughout the country, except in the south. On the contrary, the industries utilizing the charcoal are all situated in the southern districts. This will lead to high transportation cost thus making the domestically produced charcoal cost relatively expensive. This increase in the cost of domestically produced charcoal compared to that of imported charcoal will definitely

Higher extraction cost of wood residues from rural timber extraction area

It will be logistically challenging and difficult to collect all the lops and tops resulting from rural timber extraction areas. Further, it will also incur high extraction cost as most of the rural timber extraction areas are scattered with limited accessibility. The high cost of extraction will certainly lead to higher cost of domestically produced charcoal as compared to imported charcoal. Practically, it may be possible and economically viable to collect wood residues only from those rural timber extraction areas which are located within the proximity of motorable roads.

9.2. Wood Residues from existing identified thinning areas

9.2.1. Current Situation

Scientific thinning as one of the important tools in sustainable forest management has been emphasized by the Department of Forest and Park Services for a long time but has not taken pace as desired, especially with regards to implementation in the field. The importance of scientific thinning had also been emphasized as one of the milestones under Accelerating Bhutan's Socio-Economic Development (ABSD) initiatives under which around 4000 hectares of Blue Pine and Mixed Conifer forest had been identified for thinning under different Dzongkhags. However, though some thinning activities had been carried out sporadically in the field, scientific thinning has not been carried out proactively despite its benefits in improving the forest condition of existing forest stands, especially in Blue Pine and Mixed Conifer Forest and also in meeting the demand for smaller round woods.

9.2.2. Production Potential

Scientific thinning areas are one of the potential sites for production of raw materials for the charcoal production units. The Department has identified a total of 2,382.70 ha of areas in both conifer and broadleaved forest for thinning purposes. Out of the 2,382.70 ha, 2023.16 ha of Conifer forest has been identified for thinning under Bumthang, Wangdue, Thimphu, Dagana, Trashigang, Zhemgang, Paro and Gedu Divisions including 1217.19 ha under Jigme Dorji National Park. The total volume of timber that has been estimated for extraction from the identified areas is 622,715.46 cft in standing volume. Similarly, a total of 359.54 ha of Broadleaved forest has been identified for thinning under Gedu, Zhemgang, Dagana , Sarpang Divisions including 187.73 ha under Royal Manas National Park and Jigme Dorji National Park. The total volume of timber that has been estimated for extraction from the identified areas is 359.54 cft in standing volume. However, most of the timber extracted from these sites will be pole-sized timber.

Although the prime timber extracted from these thinning areas will not be used as raw materials (as justified in Box 5), the lops and tops can be used as raw materials. Considering the 40:60 log to lops/tops conversion ratio in broadleaved forest and 60:40 log to lops/tops conversion ratio in conifer forest, the total available lops and tops that can be sourced as raw materials from existing identified thinning areas is 7,060.37 m^3.

9.2.3. Limitations

Sustainability

The availability of raw materials from thinning activities is subject to variation and uncertainty as it is carried out on need basis unlike operations in managed regimes. Therefore, availability of raw materials from thinning activities will be adhoc which may not be available at all times.

High raw material cost due to high cost of extraction

By virtue of most of the thinning sites being inaccessible and located in remote areas, the extraction of timbers from these thinning sites will incur significant cost. The high extraction cost is attributed to the need for construction of forest roads and installation of cable cranes wherever required. As per the existing rate of NRDCL, the construction of a kilometer of road cost around Nu. 2.5 million while a new cable crane cost around Nu. 10 million. All these cost will add up to the cost of the raw materials extracted which in turn will determine the profitability of the charcoal production units.

High transportation cost due to scattered operation

Since the thinning operations are scattered throughout the country, the transportation of raw materials from the thinning sites to the production units will incur significant cost as well. The actual cost of transportation will be determined by the location of the production unit and the thinning sites.

Issues related to marketing of Pole-sized Timber

Proper and efficient utilization of pole-sized timbers is one of the major issues affecting timber marketing currently. Therefore, there is a risk of under-utilization and wastage of the prime pole-sized timbers thus extracted from these identified areas.

10. REVIEW OF TECHNOLOGIES

10.1. General Account on Charcoal Production Technologies

There are generally three most common charcoal production methods/technologies: earth kilns, brick kilns and metal kilns.

Earth Kilns


Figure 8: Earth Kiln

Earth pit kilns are the traditional and the simplest technology for charcoal production. The wood is usually stacked in a pit and then sealed with a layer of grass and soil. The wood is ignited at one end, thus starting the carbonization process. The earth kilns can vary in size based on the objective of production. As the ventilation system of this type of kiln is difficult to control, the carbonization process is incomplete, resulting in production of low quality charcoal. However, in some parts of the world, the earth kilns are improvised by fitting a chimney to allow better control of air flow and reduce heat loss during carbonization, producing higher quality charcoal. The earth kiln must be completely rebuilt after each cycle and the production cycle lasts around 24 hours which is too long.

Brick Kilns


Figure 9: Brick Kiln

Brick kilns are an effective method of charcoal production with up to 30% efficiency. The kilns are usually built using bricks but concrete is also used. It is suitable for semi-industrial production of charcoal. There are many types of brick kilns in the world and most of them give good results. The most notable designs are the Argentine half orange kiln and the Brazilian beehive kiln. The first Kiln is made entirely from brick and mud. It is important to know that easy drainage of water away from the kiln is the main requirement of setting the kiln. The Brazilian beehive kiln is internally heated, fixed, batch type. They are circular, have a domed roof and are made of ordinary bricks. The circular wall of the kiln is in contact with the outside air. The carbonization cycle lasts 9 days with a production of 5t/cycle. It has a high efficiency of up to 62% when properly operated. The life span of the kiln is up to 6 years on the same site.

Metal/Steel Kilns

Figure 10: Metal Kiln

Metal/Steel kilns are considered as one basis of modern charcoal production. Many different types of steel kilns have been developed throughout the world. The main difference of steel kilns is in their capability to carbonize even poor quality wood. What is more, it can easily be transported. However, still kilns are not suitable for high-volume production as their annual output is only about 100 – 150 t of charcoal, wherein their efficiency is high (27–35 %) and the process of carbonization is quick (from 16 to 24 hours). Steel drum kilns facilitate access to sustainably made charcoal as the kilns are low cost, portable and easy to use. Moreover, the conversion efficiency obtained in oil drum kilns is around 23%. However, the main disadvantage of the kiln is that the raw material must be less than 30 cm long and the diameter must be 5 cm, which requires a considerable amount of labour in the preparation of the raw material.

10.2. Improved Charcoal Production Technologies

Introduction of improved charcoal production technologies is one of the two important factors that will determine the economic feasibility of the business. The improved technology will have advantages over the existing technology in terms of production efficiency and efficient use of raw materials. Besides this, the improved technologies are also known to have environmental benefits in terms of reducing pollution as it is mostly powered by electricity and maximizing the use of available raw materials thus, reducing deforestation.

Figure 11: Semi-automated Charcoal Production Kiln

The conventional charcoal production technology is constrained with type and size of raw materials, mostly being wood residues, for the production of charcoal. However, with the improved charcoal production technologies, charcoal can be produced from a number of raw materials and not limited to wood only. This creates an opportunity to use other biomass for the production of charcoal which otherwise would go waste. The improved technologies are efficient with minimal environmental pollution and heat energy required for carbonization. The carbonized material has the advantages of high calorific value, no smoke during combustion, no explosion, and environmental protection. These technologies also have the advantages of reasonable structure, energy saving, fast cooling speed, good charcoal quality, and a short production cycle compared to the conventional technologies.

11. ENVIRONMENTAL IMPACTS

11.1. Contribution to forest degradation and deforestation

With high demand for charcoal in the country, the production of charcoal will certainly increase pressure on our limited forest resources due to higher raw material requirements. This may contribute to forest degradation and its negative impacts on forest resources in the long run. Further, forested private registered land will be one of the potential sources of raw materials for charcoal production. As empowered by the Land Act, most of the land owners may resort to clear felling of their forested registered land for income generation. This practice in the long run may lead to deforestation and subsequent change in the land-use increasing vulnerability to loss of associated ecosystem services , climate change impacts and increased CO_2 emissions as every hectare of forest land converted to non-forest land release about 624 tCO_2 into the atmosphere. This will also have an impact on forest cover of our nation as a whole.

11.2. Air Pollution (due to dust and smoke)

During the carbonization of the raw material, a variety of combustible gases such as carbon monoxide, methane, and oxygen are produced. If these gases are directly released to the atmosphere, it will be a source of air pollution. However, adoption of improved technology is likely to reduce such air pollution substantially.

11.3. Noise Pollution due to machineries and trucks

The machineries used to produce charcoal may produce noise during its operation and may cause noise pollution in the areas located at the vicinity of the production units. However, these impacts are negligible due to the improved technologies. The transportation of raw materials and the end produce requires deployment of trucks which may also contribute to the noise pollution.

11.4. Pollution of Water Resources

The debris generated from the production process may pollute the water resources nearby the production units, especially the perennial streams and rivers. The pollutants produced during the process, if channeled to the rivers and other water bodies, will have adverse impact on the aquatic biodiversity and the people who may use the water for drinking, agriculture or other purposes.

11.5. Impact on aesthetics

The construction of charcoal production unit and its associated establishment may impact the aesthetics of the place as lot of structures will possibly come up in and around the production unit. It will also affect the aesthetics of the natural landscape due to construction of ancillary facilities like road, stock yard, etc.

11.6. Increase in Solid Waste

One of the pollutants generated from charcoal production process is tar which if not handled properly may become the source of pollution to land and water bodies. Therefore, proper management of these solid waste generated from the process should be ensured.

12. SUSTAINABILITY

Based on the outcome of this study, one of the most essential components that need to be addressed in order to make the domestic charcoal production feasible is to ensure adequate availability of raw materials on a sustained basis. The raw materials currently available for charcoal production in the country are not adequate to sustain even the existing charcoal production establishments. Further, the existing production units if operated in its full capacity will be able to offset only about 13% of the annual charcoal demand. Therefore, if the annual charcoal import has to be offset to a scale which will have a significant impact on our local economy, adequate quantity of raw materials on a sustained basis must be ensured. Currently, natural high forest is the only perceived source of raw materials. Energy plantations as a potential source of raw materials has been not explored so far. There are also other alternatives to ensure adequate quantity of raw materials on sustainable basis few of which are proposed below:

12.1. Afforestation in Barren Lands / Enrichment Plantation

One of the potential sites to carry out energy plantations for supply of raw materials for charcoal production is barren and degraded forest areas in the country. Further, it will be even more appropriate and cost effective to take up such energy plantations close to the industries where charcoal is used as raw materials. Since most of the metallurgical industries are located along the southern belt of our country, it will be suitable to take up such energy plantations in barren and degraded lands along the southern belts to reduce the transportation cost and subsequently the price of the domestically produced charcoal.

As per the survey and mapping of barren and degraded area carried out by Social Forestry and Extension Division, a total of 1,708.42 ha of degraded area has been identified for plantation along the southern belt of which only 1537.58 ha would be suitable for plantation taking into account the topography and site conditions. Taking up energy and bamboo plantation in these area will not only resolve the issue of sustainability and inadequacy of raw materials for charcoal production units, but also reduce the pressure on the natural forest to meet the growing demand for wood. Besides it will also contribute towards increasing the forest cover, reclamation of degraded sites and increasing the carbon sink in the long run.

Table 8: Dzongkhag-wise barren areas available for plantation in the Southern Belt

Sl. No.	Dzongkhag	Total Barren and Degraded Area (ha)	Net Plantation Area (ha)
1	Chhukha	273.83	246.45
2	Mongar	655.74	590.17
3	Pemagatshel	126.77	114.09
4	Samdrup Jongkhar	282.65	254.39
5	Samtse	92.76	83.48
6	Sarpang	268.31	241.48
7	Zhemgang	8.36	7.52
		Total	**1537.58**

12.1.1. Cost Estimation for Plantation

However, successful plantation and its associated benefits comes at a cost and is generally resource intensive. Based on the Plantation Norms and Standards, 2020, on an average under ideal conditions, creation of new plantation costs approximately Nu.190,472 per hectare. Similarly, it would cost approximately Nu. 38,971 per hectare for maintenance of plantations in the subsequent years. Therefore, based on the estimated rates, total plantation cost for carrying out energy plantations in 1537.58 ha of barren and degraded SRF land located within southern belt is approximately Nu, 592.47 million, (Nu. 292.87 million for initial plantation creation and Nu. 299.61 million for maintenance up to 5 subsequent years upon creation). The details cost estimates is as illustrated in table 9 below.

Table 9: Cost estimation of plantation in degraded and barren areas

Sl.No	Dzongkhag Identified for Plantation	A-Plantation Creation costs			B-Plantation maintenance estimate for 5-consecutive years					Total Costs (A-Creation + B-Maint.) Nu in millions
		Plantation area/Net Operable area (ha)	Rate/ hectare	Amount (Nu in millions)	Plantation Area/Net operable area (ha)	Rate/ hectare	Amount (Nu in millions)	Maint. (5-times)	Total maint. costs (Amount X 5-times)	
1	Chhukha	246.45	190472	46.94	246.45	38971	9.60	5	48.02	94.96
2	Mongar	590.17	190472	112.41	590.17	38971	23.00	5	115.00	227.41
3	Pemagatshel	114.09	190472	21.73	114.09	38971	4.45	5	22.23	43.96
4	S/Jongkhar	254.39	190472	48.45	254.39	38971	9.91	5	49.57	98.02
5	Samtse	83.48	190472	15.90	83.48	38971	3.25	5	16.27	32.17
6	Sarpang	241.48	190472	46.00	241.48	38971	9.41	5	47.05	93.05
7	Zhemgang	7.52	190472	1.43	7.52	38971	0.29	5	1.47	2.90
	Total	1,537.58		292.97	1,537.58		59.92		299.61	592.47

1. Total Cost for initial creation of plantation= Nu. 292.97 million
2. Total costs for maintenance of plantation for 5-consecutive years= Nu. 299.61 million
3. Overall costs (Creation and Maintenance) = Nu. 592.47 million

12.1.2. Constraints

High initial investment

Creation of plantation and ensuring its successful establishment is highly resource intensive both in term of human as well as financial resources. Further, ensuring successful establishment of plantations in the subsequent years following its creation against all environmental and biotic adversities is a big challenge often incurring huge costs. Particularly ensuring successful establishment of plantation in broadleaved forest is an existing challenge for the Department of Forest and Park Services mainly due to intensive grazing by domestic as well as wild animals and high infestation of invasive weeds and bamboos in the plantation areas. Currently most of the plantations carried out in harvested areas of Forest Management Units in Broadleaved forest has very low survival percentage.

No immediate returns

Unlike agricultural crops, trees have relatively long rotation age. Trees are long lived and slow growing and the final harvest of plantation forests usually occur several years after establishment. Therefore, the economic returns are often delayed for several years after the creation of plantations. This implies the need for long term thinking. Sustaining production over time will include conservation and improvement of tree genetic resources, sustaining the yield levels of the plantation through optimized silviculture interventions and avoiding land degradation.

Heavy reliance on the state forest for raw materials

The naturally growing high forest is generally perceived as the only source of raw materials for any wood based industries in the country. State Reserve Forest has been the major source of timber to meet the domestic as well as commercial timber demand of the nation. There is a little will in our society to meet our timber needs by taking up our own plantations and planning on long term returns rather than focusing on immediate returns only. Therefore, unless there is a paradigm shift in the societal thinking in taking up plantations to meet our timber resource needs, plantations at an individual level or at a private charcoal production unit level will be a big challenge.

12.2. Using Bamboo as Raw Material for Charcoal Production

High dependency on wood as the only primary raw material will be constrained with resource depletion in the long run due to limited resource availability. Therefore, it is essential to identify alternative raw materials that can produce similar quality of charcoal if the supply of wood as raw materials declines over the years. One of the potential raw materials for charcoal production is Bamboo. Although, Bamboo is used in Bhutan for multiple purposes, the utilization is far from being optimum in terms of product diversification and production scale. As Bhutan grows several different species of bamboo, it can be a sought after raw material after wood. Bamboo has a comparative advantage over wood due to its short rotation and reduced risk of deforestation. Cultivating bamboo as raw material for charcoal production is attractive as it can mature and can be harvested in a short period of time (approximately 2-3 years).

12.2.1. Advantages of Using Bamboo as Raw Material

The following are some of the main advantages of using bamboo as raw material for charcoal production:

- Maximizing the use of bamboo will reduce dependency on wood-timber resources and thus, help environmental conservation and protection.
- Bamboo plantations can effectively help rehabilitate degraded forest and other barren/fellow lands.
- Help generate employment opportunities in cultivating bamboo for supply as raw materials.
- The cost of bamboo is comparatively less than that of wood, thus making it cost effective.
- The un-utilized bamboo in the community forest and other management regimes can be effectively put to use.

12.2.2. Raw Material Sources

Bamboo grows naturally because of the country's largely undisturbed forests and the limited agriculture practiced in areas where bamboo proliferates. Four Dzongkhags have a significant production of bamboo. These are Samtse, Samdrup Jongkhar, Tsirang and Zhemgang. The following table gives the production figures for 2014 per the INBAR Report on Bamboo Construction in Bhutan (February 2015).

Table 10: Dzongkhag-wise Production of Bamboo in Bhutan (2014)

Dzongkhags	Samtse	Samdrup Jongkhar	Tsirang	Zhemgang
Parameters				
Total Bamboo Area (ha)	982.12	101.20	248.54	156.32
Total Volume by Culm (m^3/ha)	96.31	255.70	152.57	9.67
Total Weight of Culms (tons)	37,835.00	10,350.00	15,167.90	604.64

Large areas of bamboo are found in the Community Forests in these four Dzongkhags and its current utilization is limited to production of bamboo furniture, handicrafts and construction which are all in a very small scale. Most of the bamboo in these community forests goes unharnessed due to high transportation cost. In case of construction bamboo, due to its length requirement, transportation via narrow farm roads in the mountainous terrain is a limitation and discourages people from buying it. If these bamboo resources are diverted for the production of charcoal, due to its requirement in small sizes, the transportation huddle is drastically reduced. Harvesting and supplying the bamboo growing in the Community Forests for charcoal production will not only reduce the pressure on wood as the primary raw material but also benefit the communities to increase their alternative income through its sale.

12.3. Bringing additional forest area under production to meet the raw material needs

12.3.1. Background

Forests of Bhutan display a wide range of altitudinal variation, ranging from subtropical in the southern foothills to alpine scrub in the north. According to the latest Land Use and Land cover of Bhutan (FRMD, 2017), forest constitutes around 71% of the total geographical land. Despite high forest cover and huge timber resource base the net area available for sustainable forest management specifically for timber production is restricted and constrained by several factors like steep and rugged terrain, far flung inaccessible areas, critical wildlife habitat and watershed areas, water catchment areas,.. etc. According to the Forest Resources Potential Assessment of Bhutan (FRPA) 2013, only about 334,066.75 ha which is about 12.31 % of the total forest area is estimated to be suitable for sustainable commercial management outside protected areas and major watersheds. Further since potential areas falling within conifer forest area are already managed under existing Forest Management Units, most of the remaining potential areas which could be possibly explored for commercial timber management are located within Broadleaved forest. The potential areas are mostly scattered with limited accessibility and rugged terrain (Fig 9). Therefore, extraction of timber resources from these potential areas will incur high extraction cost and subsequently may lead to high cost of raw materials besides imposing several adverse environmental impacts by virtue of being located in steep and erosion prone terrain with high rainfall and biodiversity.

Additionally, timber harvesting in these potential areas in broadleaved forest also has high risk of causing siltation of hydropower dams and damages to hydro power infrastructures downstream. It may also trigger transboundary issues of flooding and associated collateral damages in the neighboring Indian states. Therefore, operating these potential areas also calls for conscious decision making based on the possible revenue loss due to damages caused to hydropower infrastructures against the anticipated revenue generated through timber harvesting in these broadleaved areas. It is also equally important to consider the political and social implications it may have both within and outside the country.

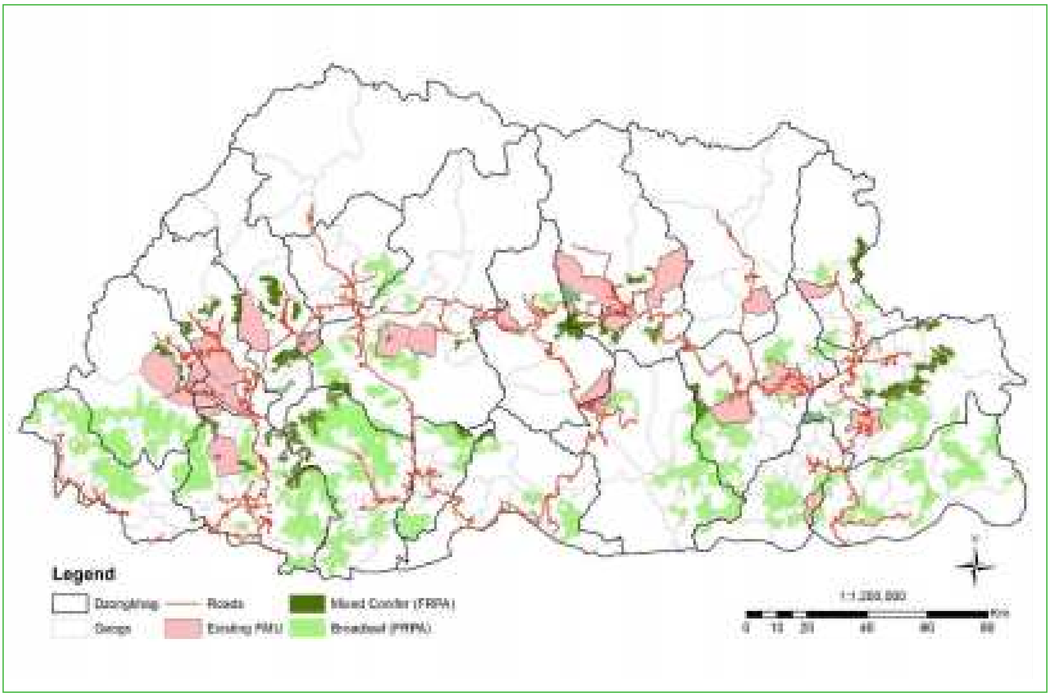

Figure 12 : Map showing potential areas for commercial management

12.3.2. Production Potential

The mapping of potential forest areas during Forest Resources Potential Assessment 2013 was carried out based on spatial criteria that indicate suitability of potential forest lands for sustainable management derived based on the provisions provided in Forest and Nature Conservation Act of Bhutan 1995, Forest Management Code of Bhutan 2004, Forest and Nature Conservation Rules of Bhutan 2006, National Forest Policy of Bhutan 2011 and recommendations by professionals. The Forest Resources Potential Assessment (FRPA) 2013 used following 9 spatial criteria for mapping of potential production area that could be additionally brought under commercial management:

a. Only in forests lands below or equal an elevation of 4000m above mean sea level
b. Not within 200m either sides of roads (highways, feeder roads, farm roads, etc.).
c. Not within 30m from major drainages.
d. Not within 1 km from rural settlements.
e. Not within 1.5 km from towns.
f. Not within RAMSAR wetland sites.
g. Not within existing botanical, recreational parks and heritage forests.
h. Not within existing Forest Management Units and Working Schemes (WS).
i. Not within existing Community Forests (CFs).
j. Not within existing Protected Areas and Major Watersheds

Based on the report, approximately 334,066.75 ha which is about 12.31% of the total forest areas have potential to be brought under commercial management outside Protected Areas and Major watersheds.

12.3.3. Annual Allowable Cut from the potential production areas

In order to estimate the volume of raw materials that will be available from these potential areas, the Annual Allowable Cut of the potential production area was calculated based on the following considerations.

a) A total of 20% of the total potential area was deducted to obtain the net production area considering the terrain and timber extraction feasibility. Thus, the total net production area is approximately 267,253.39 ha.
b) An average standing volume of 261 m^3/ha was considered based on the National Forest Inventory Report.
c) An average rotation of 150 years was considered as the mapped potential production area consist of both broadleaved and conifer forests.

Box 3: Calculation of Annual Allowable Cut from the Potential Production Areas

Total Potential Production Area (as per FRPA) = 334,066.75 ha

Assuming that the 20% of the mapped potential production areas could not be harvested due to terrain conditions and accessibility,

The Net Potential Production Area = 267,253.39 ha

Average Rotation Age: 150 years

Average standing volume (as per NFI Report) = 261 m^3/ha

Therefore, Annual Allowable Cut = (Average standing volume/ha × Net Production Area) / Rotation

= 465,020.912 m^3/year standing volume

Total lops and tops = 232,510.456 m^3/year

The total Annual Allowable Cut of potential commercial management area is estimated to be 465,020.91 m^3 per year. Taking into account the conversion ratio of 50:50 for log and lops/tops, the total estimated lops and tops that could be extracted from the potential areas and which could be potentially used as raw materials for charcoal production is approximately 232,510.45 m^3. It is also anticipated that approximately same volume of primary timber in the form of logs will also be available which shall be used for other economical purposes and not as raw materials for charcoal production as the economic value of the primary timber in log form is relatively higher compared to the value of charcoal produced from same volume of timber as illustrated in Box 5.

Box 4: Raw materials sourced by bringing additional forest area under production

Total raw materials available from potential production areas (annually)

= 232,510.45 m^3

Percentage owwf domestic charcoal demand met:

= (232,510.45 / 1,050,000) × 100

= 22.14 % (eq. 24,787 metric tons)

Box 5: Economic value of primary timber vis a vis charcoal produced

Average selling rate of broadleaved timber in log form
= Nu. 130.24/cft

Economic value of 9.38 m^3 (331.20 cft) of broadleaved timber in log form
= Nu.43,136.50

Economic value of 1 ton of domestically produced charcoal
= Nu.20,000.00

The economic value of 9.38 m^3 of broadleaved timber in log form is almost double the value of 1 ton of charcoal that will be produced from the same volume of broadleaved timber. Therefore, use of primary timber as raw materials for the production of charcoal is not recommended.

Considering all the lops and tops produced from these areas are used as raw materials in the charcoal factories, approximately 22.14% of annual domestic charcoal demand equivalent to 24,787 metric tons can be met through local production. Therefore, the raw materials sourced only from harvesting the potential production forests in the country alone will not be adequate to meet the raw material demand for the Charcoal factories. However, it will be a significant area from where raw materials for charcoal production can be supplied in substantial quantities.

12.3.4. Limitations/Challenges

Since most of the potential forest areas are located in Broadleaved forest with rugged terrain and limited accessibility, some of the major environmental and logistical challenges in extracting timber resources from these areas area as follows:

- ***Road Construction:*** Due to rugged terrain and poor accessibility the extraction of timber resources may incur high cost of extraction due to the need for road constructions. The high cost of extraction may also lead to high cost of raw materials leading to high cost of domestically produced charcoal.

- ***Soil Instability:*** The clear felling of forests in the proposed broadleaved forest areas may pose risk of soil erosion, landslides and flash floods as these areas receive high precipitation, are geologically fragile and generally steep. It may also pose a risk of downstream siltation of hydropower dams both within and outside the country.

- ***Natural Regeneration and Plantation Survival:*** Restocking of the harvested areas through natural regeneration will be a challenge especially in broadleaved forests given the experiences from Forest Management Units located within the broadleaved forest. Currently, the stand dynamics and regeneration processes in sub-tropical and warm broadleaved forest types are poorly studied and documented in Bhutan. Further, only little is known about the plantation techniques that are suitable for these areas. All harvested areas have to be restocked with plantations of suitable species. The restocking through plantation will be very costly and will incur substantial cost. Further, plantations take several years to establish and involve at least 5-10 years of maintenance without any return. Success of the plantation was affected by the livestock grazing and even the barbed wire fencing proved futile in many FMUs. Therefore, management of livestock grazing is very critical and imposition of any restrictions may affect environmental and social safeguards of local communities in the form of their livelihoods.

- ***Biodiversity Loss:*** Commercial operation of the broadleaved forest in the proposed areas may also lead to significant loss of biodiversity.

- ***Social Impacts:*** The rural timber supply for people living in the southern belt of the country could be impacted. Due to limited accessibility, the cost of timber extraction could be high mainly contributed by cost of road construction of roads and procurement of logging machineries like cable cranes. In general, a kilometer of new road construction cost Nu.2.5 million and a cable crane cost around Nu.10.3 million (NRDCL).

- ***Water Source / Watershed Degradation:*** The clear felling activities in watershed areas may also trigger drying of water sources for the local population. Already there are trends of drying water sources in the local communities. The drying up of water sources and dam siltation may subsequently impact the hydropower generation in the country which is one of the main sources of revenue to the Government.

- ***Forest Carbon Loss:*** If clear felled areas are not restocked and reforested, the harvesting of broadleaved forests may not only lead to significant decrease in forest cover of the country posing risk to maintaining 60% forest cover as per constitutional requirements but also result in huge CO_2 emission thereby compromising our commitment to remain carbon neutral. Every cubic foot (cft) of timber harvested releases 0.04 tCO_2 into the atmosphere while it will take at least 183 years to store the same amount.

- ***Issues related to marketing of Prime Broadleaf Timber:*** Proper and efficient utilization of broadleaved timbers is one of the major impeding factors affecting timber supply and demand in the local market currently. There is also a risk of under-utilization of the broadleaved timber thus extracted due to limited demand for broadleaved timber in the country except for few special class timbers like Champ, Walnut, *Morus* spp, Teak, Sal, etc. Even in the current situation, most of the broadleaved timbers extracted from Forest Management Units are left unsold in various depots of NRDCL across the country.

Institutional Capacity: NRDCL as the authorized agency for timber extraction is the sole government firm responsible for extraction and disposal of timber from state reserved forest. Even in the current situation NRDCL has not been able to fully extract timber from allotted sites and FMUs in the country. Therefore, with the existing capacity of NRDCL, it would be a challenge to operate the entire area for timely supply of raw materials.

Increased Human Wildlife Conflict: Human Wildlife conflict is a national issue especially in our rural areas and is attributed for substantial loss of agricultural products and livestock of our famers annually. The Human Wildlife Conflict issue is also attributed for Rural-Urban migration which is a major concern for all of us today. Increasing the timber harvesting areas within broadleaved forest may further aggravate the Human Wildlife Conflict issue.

12.4. Leasing of SRF Land for Plantations

One of the possible means to sustain the raw material supply is through leasing of barren/forested SRF land to carry out plantations. As an experience, the Bhutan Board Private Limited (BBPL) also followed this method to sustain the supply of raw material for their broad processing plant. The Unit leased out certain SRF land and harvested the existing forest as well as carried out the plantation in order to ensure future supply of raw materials. This modality may also be explored. However, it is essential to also learn and understand through the experience of BBBL if such modalities will work in case of charcoal production plant or not.

13. SWOT analysis

STRENGTH

» Strong political will, government priorities and support

» Availability of un-utilized lops and tops in the timber harvesting areas (FMUs, CFs, Rural Timber Extraction Areas and Ad-hoc sites)

» Presence of assured market for domestic charcoal

» Availability of environment friendly charcoal production technologies

» Availability of support through credit facilities under National Credit Guarantee Scheme and Bank (Cottage and small Industries).

» Existance of tax exemptions and fiscal incentives on import of green technologies

» Existing established Institutions/aspiring private individuals to take up the production

WEAKNESS

» High initial investment (plant, machinery and set up)

» High cost of raw materials due to transportation and extraction cost.

» Limited/in adequate raw materials to offset the existing charcoal demand

» Absence of skilled laborer and expertise for improved technologies

» Dependence on imported technologies and high cost of the technologies

» Poor resource accessibility due to rugged terrain

» Underutilization of Bamboo resources

OPPORTUNITIES

» Technology advancement

» Employment generation and enhancement of local economy

» Efficient utilization of wood residues in the harvested areas improving forest health.

» Scope for charcoal business growth

» Enhancement of technical skills, capacity and expertise.

» Reforestation and restoration of barren and degraded areas through energy plantations.

» Possibility of import substitution.

» Use of bamboo to meet future raw material demand for charcoal

» Bringing more forest areas under commercial harvesting

» Opportunity to manage charcoal production through Public Private Partnership model, consortium or private individuals.

THREATS

» Sustainability of the resources

» Competition from imported charcoal

» Frequent changes in government priorities

» Competing use of lops and tops for various purposes (firewood, woodchips, wood based industries)

» Limited domestic use and local market for prime broadleaved timber

» Deforestation and degradation of private registered land and State Reserve Forest

» Forest cover and forest carbon loss

» Increased Human Wildlife Conflicts

14. WAY FORWARD

14.1. Short Term Measures

14.1.1. NRDCL to explore supplying lops and tops/ firewood at a negotiated rate

Since the existing firewood rates of NRDCL is relatively higher, most of the consumers prefer to source raw materials from sources other than NRDCL. On the contrary, most of the timber extraction areas from which lops and tops are generated as a byproduct is operated by NRDCL. Due to high rates most of these lops and tops generated from logging activities remain undisposed which gets deteriorated with time leading to wastage of resources. Further, such undisposed lops and tops on the forest floor also adversely impacts the forest health as it encourages outbreak of pest and diseases due to poor sanitation condition in the forest stands. Therefore, it is crucially important for NRDCL to review the rates and if feasible negotiate with the customers so that customers opt to purchase the firewood from NRDCL rather than looking for alternative sources. NRDCL must also do aggressive marketing for disposal of such lops and tops.

14.1.2. Promote more efficient and environment friendly charcoal production technologies

The existing technology in use consumes nearly two thirds of the wood as fuel in the production process whereas only one third of it is converted into charcoal. Using such inefficient technologies results in wastage of raw materials which otherwise could be used for production of charcoal. Therefore, it is essential to promote more efficient (semi-automated and fully automated) charcoal production technologies which use electricity as a source of energy over fuel wood. This practice is not only cost effective, but also environmentally friendly and efficient.

14.1.3. Ensure selection of site for establishment of charcoal production units taking into account the market and raw material base

The cost of the transportation of raw materials and the finished produce accounts for the second highest proportion of the production cost which is approximately 26%. In order to reduce the transportation cost, the location of the production units plays an important role. The interested parties should be encouraged to establish charcoal production units nearby the factories which use charcoal as raw materials to reduce cost of transportation. Moreover, the availability of raw materials in those selected sites should also be considered prior to its establishment to cut down transportation cost to a significant level.

14.1.4. Encourage and ensure use of un-utilized wood residues from existing harvesting areas

The disposal of wood residues from the existing commercial harvesting areas has always been an issue as the cost of extraction and disposal of these residues incur higher cost than its returns. In order to meet the wood resides demand for charcoal production units, it is essential to encourage the use of un-utilized wood resides from existing harvesting areas instead of opting green felling. This will not only help utilize the wood resides effectively, but also contribute in maintaining the health of the forest through clearing of wood debris resulting from timber extraction. This should be carried out through awareness, advocacy and proper marketing by NRDCL.

14.1.5. Inclusion of criteria for establishment of charcoal production unit in the guidelines for establishment of wood based industries

Since establishment of charcoal production unit entails issuance of Forestry Clearance by the Department of Forest and Park Services like any other wood based industries, criteria specifically with regards to the minimum requirement of the technology as a bench mark to ensure efficiency and productivity must be formulated and included in the existing guidelines for establishment of wood based industries based on which forestry clearance must be issued for any future establishments.

14.1.6. Government to facilitate negotiation on charcoal rates

The factories and industries which use charcoal as raw material in the country reportedly offer a lower rate for the domestically produced charcoal compared to the ones that are imported. For instance, the factories pay around Nu. 22,000/- per metric ton for imported charcoal whereas, the domestically produced charcoal is paid only Nu. 20,000/- per metric ton. Therefore, in order to encourage domestic producers to offset import, it is essential for the government to facilitate negotiation on the rate of charcoal.

14.2. Long Term Measures

14.2.1. Bringing additional forest areas under commercial harvesting

Bringing additional forest areas under commercial harvesting will certainly address the issues of raw material inadequacy for charcoal production which in turn will help in offsetting charcoal imports to certain extent. However, since most of the potential areas are located in the broadleaved forest with rugged and steep terrain with potentially high annual rainfall, both environmental and economic aspects of timber harvesting needs to be analyzed and considered prior to initiation of timber extraction from these areas.

14.2.2. Promote bamboo cultivation/ energy plantation in the barren land within community forests and other potential SRF land

The wood is the only raw material considered for production of charcoal in the country currently. However, in order to sustain and supplement the raw materials requirement for charcoal production, alternative raw materials like bamboo should also be promoted as a potential raw material for the production of charcoal. Many community forests in some of the Dzongkhag in the southern belt have good potential to produce bamboo. Most of the bamboo goes unharnessed from these community forests due to lack of a market currently. If bamboo is promoted as a potential raw material for charcoal production, the communities may even be willing to take up exclusive bamboo cultivation/plantation in the barren land within the community forest as well as other potential barren SRF land. Therefore, it is essential to create awareness to both the charcoal producers as well as communities about the alternative raw materials besides wood for the production of charcoal in the country.

14.2.3. Promote establishment of bigger scale production units

The benefits of setting up numerous smaller scale production units with low turnover is likely to have a negligible impact on the economy as well as to charcoal production units perse in terms of profitability due to the economics of scale. Therefore, it is recommended to promote establishment of few but bigger scale production units instead of many smaller ones.

14.2.4. Explore other forms of biomass as raw material sources including saw dust

As a result of the current availability of wood as a primary raw material for charcoal production, other alternative sources of raw materials are not explored yet. Therefore, exploring other forms of biomass as raw materials for charcoal production will be an important step forward in order to ensure a sustainable supply of raw materials in the future. Therefore, the production units should be encouraged to explore using other forms of biomass such as briquette made out of saw dust, needles..etc as raw materials instead of relying only on wood residues. Import of technologies which can convert other forms of biomass into raw materials suitable for charcoal production should also be explored in order to sustain the supply of raw materials in the future. This will also divert pressure on the forest thus reducing deforestation and degradation.

14.2.5. Build market linkages amongst the charcoal producers and community forest groups

Community forests are one of the potential areas from where bamboo could be harvested in huge quantities for supply to charcoal production units as raw material. However, currently, there are no structured linkages between charcoal producers and community forest groups to explore such opportunities. Therefore, there is a need to form market linkages between community forestry group and the charcoal producers for efficient utilization of Bamboo as raw materials for charcoal production.

14.2.6. Explore possibilities of leasing SRF land for energy plantations

For long term sustainability of charcoal production, it is essential to explore means to make the raw material for charcoal production adequately available on a sustainable basis. Relying only on the natural forest for raw materials may restrain the future expansion of the production units. One of the ways in which the raw material supply can be sustained is by encouraging the charcoal production units to grow their own raw materials. Leasing of SFR land for energy plantations can help reduce the pressure on the natural forest in the future. The Government must formulate enabling policies to support leasing of SRF land for such plantations. However, lesson learnt from the past experiences on leasing SRF land to business entities (for example, BBPL) in the country must be taken into account while initiating such lease.

14.2.7. Manage charcoal production through Public-Private Partnership model, consortium or private individuals.

As stated above, adequate and sustained availability of raw materials for charcoal production is crucial to make the charcoal production business successful. Further, considering the economics of scale it is recommended for establishment of bigger production units with higher turnover. However, since establishment of bigger production units will incur huge initial investments, charcoal production will be more feasible and sustainable if implemented through public-private partnership model or through a consortium of parties. This practice will also ensure that the business is resilient and sustainable in long term.

15. ANNEXURE

I. List of participants of consultation meeting held at Punakha, 30th September to 1st October, 2021

Sl.No	Name of the participants	Designation	Agency
1	Passang Wangchen Norbu	Advisor/ Specialist	DoFPS
2	Sonam Tobgay	Chief Forestry Officer	FRMD, DoFPS
3	Tashi Norbu Waiba	Dy.CFO	FRMD, DoFPS
4	Lhab Tshering	Sr.FO	FRMD, DoFPS
5	Deo Kumar Biswa	General Manager	NRDCL
6	Karma Wangdi	Sr. Analyst	NRDCL
7	Drakpa Gyeltshen	Sr.Industries Officer	DoI, MoEA
8	Tshewang Dorji	Sr. FR	SFED. DoFPS
9	Thinley Yangzom	Executive Member	AWBI
10	Mindu Tshering	Executive Member	AWBI

Forest Resources Management Division
Department of Forests and Park Services
Ministry of Agriculture and Forests