Firewood value chain and market analysis in the rural area of Lilongwe District

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inter aide

Lancement et suivi de programmes concrets de développement

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Acronyms and abbreviations

C&T	Collector and Traders
DC	District Council
DoF	Department of Forestry
DFR	Dzalanyama Forest Reserve
FW	Firewood
GVH	Group village headmen
ha	hectares
HH	Household
kg	kilogram
km^2	Square kilometer
LA	Local aggregators
m	meter
m^3	cubic meter
RT	Retailers
t	1 tonne = 1 metric ton = 1000 kg
tDM	Metric Tons of dry matter (tDM)
TA	Traditional Authority
VH	Village headmen
W	Wholesalers

Cover photo: Wholesale outlet of indigenous firewood in Lilongwe district, 2022.

1. Background

Malawi's forest reserves are rapidly declining to increasing human pressure from cropland expansion, human settlement, and overreliance on firewood and charcoal, used for cooking and heating as well as tobacco curing and brick making. In the district of Lilongwe, this demand of wood used as fuel is exceptionally high, due to its proximity with the capital.

The woodfuel (firewood and charcoal) sector is an important source of income and employment for many people living in rural areas. This is an informal but organized market, which currently contributes little to state revenues. However, an emerging and increasingly robust legal framework that includes the National Forest Policy and the Forestry Act (amended in 2019) is slowly enforcing operations against illegal and unsustainable woodfuel production and trade. This way forward promotes new and sustainable production and market channels, which are urgently needed to meet the increasing demand for woodfuel. One of the priorities is to boost clean firewood value chains, which can bring multiple livelihood benefits. This would help generate income and provide a secure supply of cooking fuel while minimizing negative environmental impacts.

Agroforestry is documented as an integrated, multifunctional solution to production with conservation, and is an effective form of eco-agriculture (Nair and Garrity 2012). Trees can contribute positively to smallholder farmers by providing timber, wood, fruits, and nuts. They additionally can be sources of additional income, contribute to water conservation and protect against drought and soil erosion, have medicinal properties, and bring wider environmental benefits. Trees are typically used to define land boundaries and to ensure the right of use or ownership of a particular plot.

Since July 2020, Inter Aide has been running a pilot agroforestry project in Lilongwe District. One of the objectives is to increase farmers' firewood autonomy. To better support households entering into firewood production with their marketing strategy, it is essential to understand the structure and functioning of the current firewood sector in and around the rural intervention area of Lilongwe District.

This research aims to identify the main actors involved in the firewood sector and understand the structure of the value chain in the rural areas in southeastern and western Lilongwe District. This in-depth study also analyzes price dynamics and the extent to which practices and participation of men and women differ along the value chain. The results highlight potential commercial strategies for firewood producers in the project areas. The study relies on qualitative and quantitative data provided by the project, interviews conducted with key-value chain actors (see Annex I for detail on research strategies and methods), and on complementary data from secondary sources.

2. Context overview

Malawi is divided into three administrative regions: the Northern, Central, and Southern Regions. Lilongwe is one of the nine districts in the Central Region and the most populous district of the country. In total, 1 637 583 people (384,902 households) reside in rural areas and 989,318 people (230,266 households) live in the city of Lilongwe (Msiska 2017; National Statistical Office 2020).

Lilongwe shares its borders with five other districts of the central region namely Dedza, Salima, Mchinji, Dowa, and Kasungu. To the southwest, a mountain range and the Dzalanyama Forest form a border with Mozambique (See Figure1).

Climate. Lilongwe has a sub-tropical climate with an average annual temperature of 21°C and a rainfall pattern from November to April. A cool dry season begins at the end of May, becoming warmer and wetter from September to November (Abbot 2014; Msiska 2017).

Figure 1. Malawi map. Lilongwe District indicated with black line. Source: Global Forest Watch tree-cover maps, 2021.

Economic activities. At national level, 84.7% of the population lives in rural areas. Rain-fed agriculture is a major source of livelihood and an important economic activity; engaging 92.8% of rural households in Malawi, and generating 28% of the country's gross domestic product and 80% of its exports (FAO 2018; National Statistical Office 2019, 2020). Rural populations also earn income from the sale of farm products and occasional casual labor, when necessary, locally known as *ganyu*. Commerce, trade, and the industrial sectors are also important economic drivers in the district. Most commercial activities, including firewood and charcoal, are concentrated in Lilongwe city and in major trading centers with little presence in rural areas (Msiska 2017).

Governance. At the district level, the District Council (DC) is the highest decision-making body responsible for promoting infrastructure and economic development. The district is then divided into 19 Extension Planning Areas (EPA), which overlap across the areas of influence of the Traditional Authorities (TA) (Msiska 2017; CLGF). The division of EPAs seeks to facilitate the planning of agricultural activities according to differing climatic conditions. Alongside the DC, planning processes are supported at the grassroots level by development committees at village level and under the jurisdiction of 18 TAs leaders. Under the traditional leadership, at the highest level, senior sub-chiefs are responsible for several TAs, and a Senior Chief (Paramount chief) has authority over all sub-Chiefs in the district. The population is represented by a Village Headmen (VH) – representing an average of 15 to 50 households, and a Group Village Headmen (GVH) – overseeing 5 to 20 VHs or more. The VH and GVH are the people who directly supervise the day-to-day affairs of the communities and the channel through which the TA communicates.

Land tenure. In Malawi, there are two types of land tenure, namely public or private leasehold. Private land is all land owned, held, or occupied under a freehold title, leased to individuals or

corporations or a registered customary estate. Public land is held in trust for the people of Malawi and managed by a government authority, or a TA (i.e., schools, hospitals, forest reserves, etc.). Customary land[1] is allocated to the family heads by the VH, in agreement with the GVH and the TA, who hold the land in trust. Being resident on customary land allows the collection of firewood and timber as well as livestock farming on the village commons, *dambo*[2], and agricultural land during the dry season (Msiska 2017).

Forest resources and management. Whether they are customary or public land[3], forests are classified according to their land tenure. Communities or individuals who own customary land forests are responsible for their management. The Department of Forestry (DoF), which is responsible for the public forests, can take over customary land forests if people are not organized enough to manage them (GoM 2010; Msiska 2017).

Forest reserves in Malawi are rapidly declining due to human pressure from cropland expansion, human settlement, overreliance on firewood and charcoal, tobacco curing, and brick making. Other factors explaining this pressure are poverty, population growth, expensive building materials, and lack of access to alternative energy sources (Ngwira and Watanabe 2019). National deforestation rates are estimated (using different methodologies and time frames) at 0.5 to 2.8% per year (Kainja 2000; GoM 2010; Stanturf et al. 2011; Bone et al. 2017; The Ministry of Natural Resources, Energy and Mining 2017a, 2017c). More recent sources estimate Malawi's deforestation rate at 0.63% ± 0.10 per year for intact dense forest areas, protected areas, and forest reserves between 2006 and 2016; and below 1% for all forest areas between 2000 and 2017 (Government of Malawi 2018).

In 2010, Lilongwe District had 32,000 hectares (ha) of natural forest, extending over 5.4% of the district land area. However, 5,050 ha were lost in five years (2015-2020), of which 95% was natural forest. In 2020 alone, 633 ha of natural forest were lost, equivalent to 190kt of CO_2 emissions (Global Forest Watch 2021).

In Lilongwe District, the central government manages four forest reserves: Dzalanyama, Thuma, Nalikule, and Namilombwa. In the case of the latter three reserves, only a few indigenous trees and wildlife remain. The District Council of Lilongwe manages a further five to eight forest reserves. Yet, they are still unsustainable and suffer from fires, illegal harvest of trees, and the construction of infrastructure (Msiska 2017).

Forests' composition. Natural forests in Lilongwe are dry semi-deciduous to deciduous woodland, commonly called "miombo" and are spread across the central African Plateau. Generally found at altitudes of 500 to 1500 meters above sea level, the miombo forest hosts

[1] Customary land tenure refers to as a system that communities use to express ownership, possession, access, and regulation of land use and transfer. The customary law varies from community to community and it is grounded on a set of rules based on tradition (Bae 2021).

[2] *Dambos* are low-lying areas which have residual moisture over the dry season. *Dimbas* are low-lying areas which have water available all year round, like plots next to rivers, shallow wells, etc.

[3] Some Malawi's forests are found on customary lands, especially in the Northern Region. These lands are governed and managed primarily by traditional leaders and communities (dof.gov.mw consulted in 2021). In the central region, traditional leaders manage the forest area around Malingunde (southwest of Lilongwe District).

species of the *Julbernardia* and *Brachystegia* genera (*Leguminosae* family, *Caesalpinioideae* subfamily).

Miombo woodland has a low proportion of commercially valuable timber species but is still very important for communities that depend on the forest to get firewood, poles, and grass for houses; medicine, and non-wooden products including mushrooms and edible fruits like *Upaka kirkana* (Masuku) or *Parinari curatefolia*. These forests are a source of income from the sales of wood and non-wooden products, and can be sustainably developed in the future (Lowore 2006; Abbot 2014; Interviews 2021 - 2022).

Image 1. Village forest area in the study location.

Box 1 **Dzalanyama Forest Reserve**

The Dzalanyama Forest Reserve (DFR) is the biggest forest reserve in the district of Lilongwe and the second biggest in Malawi, covering a total area of 989.35 km² and situated 50 km away from the capital city. The forest area covers three districts, 619 km² in Lilongwe District, 356 km² in Dedza, and 14 km² in Mchinji. (Missanjo and Kamanga-Thole 2015; Munthali and Murayama 2011).

DFR is a miombo woodland that hosts multiple tree species such as *Julbernardia globiflora, Uapaka kirkana* (Masuku), *Clophospermuni mopane* (Tsanya), *Brachystegia bussei*, *Brachystegia spiciformis* (Mvukwe), *Parinari curatellifolia* (Muula), *Julbernadia paniculate*, *Terminalia sericea* (Napini), *Brachystegia floribunda* (Tsamba), *Combretum zeheri* (Mkhute), *Bohemmiaa thoningii* (Msekese), *Sysigium guineense* (Katope). The first five species alone account for more than 25% of the total tree biomass (Abbot 2014; Missanjo and Kamanga-Thole 2015; Msiska 2017).

The DoF manages the miombo forest, the Dzalanyama Timber Plantation of pine trees, as well as the Katete Plantation of *Eucalyptus* trees. The pine plantation was historically not successful, with only 300 hectares (ha) of the initial 1700 ha remaining. Recently, reforestation activities have resumed with the planting of 80 ha. One-third of the 3,000 ha *Eucalyptus* plantation is under concession, and 750 ha have been allocated to the JICA project to produce legal charcoal from this plantation (Msiska 2017; Interviews 2021-2022).

Reports estimate that the DFR had an annual deforestation rate of 1.7% (22,000 hectares) between 1990 and 2010 and that this rate is expected to increase to 3.4% over the following 20 years (2010-2030). In addition, 0.4 mega tonnes of living wood are illegally harvested annually (Munthali 2013, Onaka 2013 in Missanjo and Kamanga-Thole (2015).

With the lack of staff in the DoF, fighting against illegal logging is a particularly difficult challenge; law enforcement actions are insufficient, and more support is needed to engage communities in finding alternative income-generating activities. In Chongoni Forest, for example, campsites of charcoal makers were identified on the side of Dedza, where another DoF station is located, but no staff is available to monitor. According to the Plantation manager, that area supplies Mitundu and Lilongwe city with firewood and charcoal.

Image 2. Man, woman, and girl collecting firewood in DFR.

2.1 Study area

The research focuses on the area that is under the leadership of Chadza Traditional Authority in Lilongwe's southeast and west rural area; more specifically, the village group represented by GVH Kayasera, which is composed of 15 villages, the village group represented by GVH Mkweche formed out of 9 villages, and the village group represented by GVH Chidambaila with 47 villages. The research team only visited few selected villages. The study also included relevant actors operating in TA Chiseka (the neighboring TA), and TA Kalumbu (new project's site) due to their interaction with the villagers in TA Chadza. To understand more comprehensively the flow of firewood consumption and commercialization in the district, the research team visited principal trading centers in the rural area of Lilongwe West and Lilongwe city.

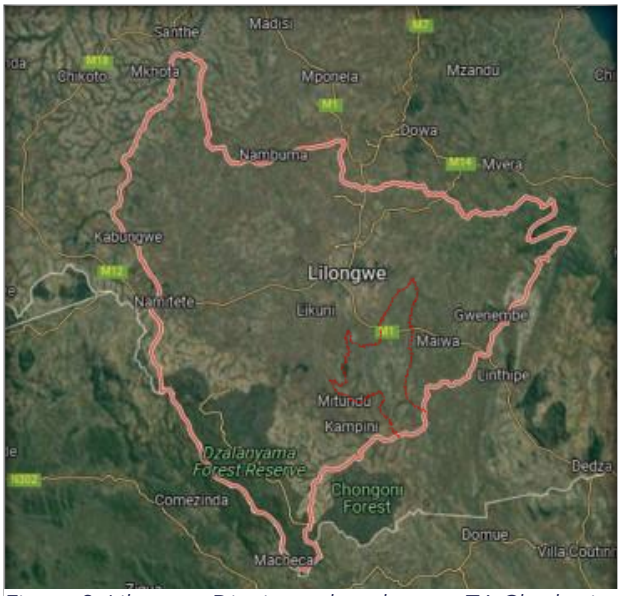


Figure 2. Lilongwe District and study area. TA Chadza is indicated with a red line. Source: Modified based on Google maps 2022.

TA Chadza is bordered by six different TAs of the Central Region, except to the south and southeast, which borders with the Dedza district. TA Chadza comprises four EPAs namely Chitsime, Mkwinda, Mitundu, and Mlomba. With roughly 143,216 people living in TA Chadza (about 32,549 households), smallholder farmers have an average landholding size of 0.62 hectares (Msiska 2017; National Statistical Office 2020, 2019). The main trading centers are Nathenje, Nanjiri, and Katchale. However, Mitundu trading center falls under TA Chiseka and is one of the most important rural marketplaces in the country.

The scarcity of firewood is leading the communities to develop coping strategies into their everyday lives. Scheid et al. (2019) identified that farmers in Tanzania, for example, are using more effective cooking technologies and planting trees for firewood self-sufficiency, but some also adopted more drastic measures like eating fewer meals or walking longer distances to collect firewood, showing that its scarcity is closely linked to food insecurity. Smallholder farmers in this study area are dealing with firewood scarcity by cutting down any tree available in the area, including fruit trees like mangos, using crop residues,

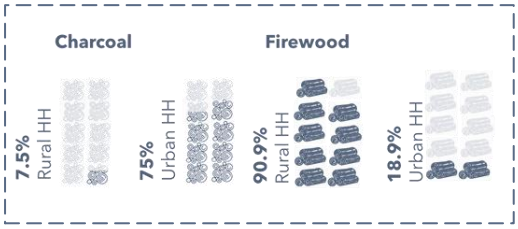
> *"In the past, there were a lot of trees, but in 1988 I noticed fewer trees around. Later, we started to cut down the mango trees, and now, we go to Dzalanyama.*
>
> *Most of us are just starting to plant trees and produce firewood with the project of Inter Aide. Before, we got a small forest and fetched firewood there, but now is almost gone."*
>
> *Man-GVH in TA Chadza, 2021*

walking (or cycling) longer distances to collect firewood, and cooking with small branches or other types of stalks that are not ideal for effective use of wood energy and which cause health issues. In contrast, some farmers are already planting trees through external interventions from non-governmental organizations and government initiatives, such as the national tree planting day.

3. Firewood demand and use

Malawi's population is heavily dependent on forests to get energy supplies since alternatives are not affordable nor fully available to most people. 79.1% of the families have no choice but to rely on firewood as the main source of energy for cooking and heating, while 18.5% depend on charcoal, and only 1.2% of the households use electricity (Stanturf et al. 2011; Yaron et al. 2011; National Statistical Office 2020).

3.1 Firewood demand



There are stark differences in wood fuel used for cooking between urban and rural areas. Charcoal is the main fuel for 75% of the urban homes while, in rural areas, **90.9% of the households keep using firewood as their main fuel for cooking.** Strikingly, only 2% of rural households, who most depend on firewood, planted fuelwood and fertilizer trees (National Statistical Office 2020).

Reliable and updated data regarding the production, trade, and consumption of firewood is scarce and largely underestimated due to the informal nature of the sector and its complexity. Nevertheless, Owen et al. in the Malawi Biomass Energy Strategy (BEST) report considered that **6.7 million tonnes of firewood were consumed by rural households**[4] and 0.68 million tonnes by urban households in 2008. Industrial and services sectors consumed 255,500 and 22,600 tonnes of firewood respectively in the same year. A more recent report estimates that **in 2016, 6.9 million tonnes of firewood were consumed by rural households at the national level (Drigo 2019), giving a rough estimate of 2.3 tonnes per rural household on average.**

Since firewood consumption figures at the household (HH) level in rural Malawi vary among the bibliography available, the Table 1 gives an overview of the data reviewed including author's estimations.

[4] This calculation includes 57,000 t. ('000) wood equivalent for cottage industries (Owen et al. 2009).

Table 1. Compilation of firewood consumption data of rural households (HH) for cooking in Malawi.

Data source	Firewood use per capita/year (kg)	Firewood use per HH/year (kg)	Firewood use per capita/year (m^3)	Firewood use per HH/year (m^3)
Owen et al. 2009*	646.28	NA	*0.97	NA
Abadia 2016**	630 – 750	2,500 – 3,000 1,900 – 2,250 with crop residues	NA	NA
Jumbe et al. in Abadia 2016	841.7	4,545 for 5.4HH members; 3,703 for 4.4HH members	NA	NA
Dringo, 2019	680 ad/ 578 DM	NA	NA	NA
Author's* [Minimum and maximum value]**	708 [506 – 1,053]	3,117 [2,227 – 4,633]	1.30 [0.93 – 1.94]	5.74 [4.10 – 8.53]

Notes: ad=air dry (15% moisture content, wet basis according to BEST, 2009); DM=Dry mater 0% moisture content, equivalent to oven dry).
*The authors consider additional use of crop residues for 45 days coinciding with crop harvest periods (23.13kg) and estimated annual consumption of wood for space and water heating of 28.62 kg per capita, giving a total of 676 kg per capita per year. The authors consider 1.5 m^3 = 1t. (metric tonne =1000kg) air-dry wood **The figure per capita considers crop residues used to satisfy 50% of the needs during the dry season. HH size of 2 adults and 3 children ***This figure is based on information given by five women interviewed considering differences among seasons when applicable (crop residues use). Other considerations: Bundle equivalence used (see Annex). NA=Not available information.

The author's study estimates that, an average rural household of 4.4 members uses about 3,117 kg of firewood annually (708 kg per capita). With a minimum annual consumption per capita of 506 kg and a maximum of 1,053 kg, the firewood household consumption ranges from 2,227 kg to 4,633 kg per year. **Based on this data, rural households in Lilongwe would need about 1.04 million tonnes of firewood per year for cooking and heating water. 101,447 tonnes correspond to TA Chadza, which would be equivalent to a complete coppice fell between 1,244.8 and 3,734.3 hectares of miombo woodland[5] or between 1% and 4% of the DFR.** Given the increasing demand, this figure is not far from Drigo (2019) estimates of a total demand of 816,607 tonnes for rural Lilongwe in 2016.

> "During rainy season, those people who don't have trees fail to cook. But not us."
>
> Woman tree producer, 2021.

It is important to highlight that about 63% (1,979 kg per HH) of the annual consumption of firewood by rural households is used during the five months of the unique rainy season. This happens because a portion of firewood is substituted by crop residues and small branches, mainly to cut expenses during the dry season. The crop residues are available after the harvest, coinciding with the end of the rainy season. By the end of the dry season and during the rainfalls, rural families bear the brunt of the depletion of food reserves and with it, income from crops sales, the crops residues are over, and firewood becomes a key resource for cooking and to generating income. This makes access to quality and affordable firewood critical for food security in communities during the rainy season.

[5] Lowore & Abbot (1994) in Abbot (2014) estimate that old miombo in Malawi yields per hectare approximately 800 poles and 150 stacked cubic meters (m^3) of firewood from a complete coppice fell of all steams above 5 cm diameter at breast height. Celander (1981) in Abbot (2014) also estimates fuelwood yields between 50 and 150 m^3 per hectare for miombo.

The firewood demand in the study area is driven mainly by household needs for heating water and cooking, food-frying businesses like meat and potatoes, tea rooms, scone bakeries, beer brewers, curing tobacco, making bricks, and the production of *chitetezo mbaula* cookstoves, including those made at one production center in TA Chadza. Some activities are seasonal and have specific dynamics that will be explained further in this report. However, to estimate the total demand that a community would need to cover their needs, especially during the critical period of the rainy season, a mini case study was done and presented as follows.

Mini case study

A group of eight villages under the GVH Mkweche was chosen to illustrate the quantity of firewood that a community within the study area would need to satisfy its annual energy needs. **Theoretically, the community would need about 750.23 tonnes of firewood to cover their needs** (see Table 2). The estimation considers the firewood consumption of 191 rural households and the firewood needs for small businesses to operate year-round. It does not consider activities such as burning bricks, brewing beer, curing tobacco, or producing clay cookstoves.

Table 2. Theoretical firewood annual consumption for the selected village group.

	Total households	Inhabitants	Tea rooms	Bakeries	Chips sellers
Number	191	840	5	1	5
Firewood consumption (kg/year)	-	594,720	92,905	34,421	28,178
Percentage of demand		79 %	12 %	5 %	4 %
TOTAL (kg/year)			**750,224**		

Notes: The calculation considered an average HH size of 4.4 members to estimate the inhabitants of the village group. Only one potato chips seller runs the business all the year. The other four sellers work for about three months during the harvesting of potato.

Both families and businesses in the chosen village group get firewood from diverse sources, including standing[6] and planted trees from the area that are sold or used for self-consumption and from the DFR. All these sources are explained in more detail in Section 7 of this report.

In the mini-case study area, four people buy standing trees from farmers or tree producers in the surrounding area, within an approximate sourcing ratio of 5 km, and then, they sell them as firewood in retail. In addition, farmers who have trees also sell them whenever there is a need to get cash, to the local firewood seller, either at the farms' gate, or in an urban trading center. The firewood trade thus is very dynamic, and everyone could get involved at any time of need, making it difficult to calculate the actual local supply of firewood.

[6] Standing trees refer to the mature trees available in the area that can be left untouched or felled for different purposes. These trees can be indigenous or exotic species.

Nevertheless, a way to estimate the share of the firewood demand covered locally was through the firewood sellers, categorized here as local Aggregators/Retailers (LA&RT), because they source and sell trees locally. Two well-known sellers among communities agreed to share their daily sales records for 18 consecutive days during the rainy season. Table 3 summarizes the average sales calculated for different periods, showing that an average local firewood seller alone, could cover between 2.1% and 3.2% of the community's theoretical demand.

Table 3. Average firewood sales and demand locally covered in the study area during the rainy season.

	Average sales (MK)	FW Pieces	Bundles	kg (bundle eq.)	m^3 (bundle eq.)	kg (bicycle eq.)	m^3 (bicycle eq.)
Per week	22,658	906	226.6	492.44	0.91	333.12	1.65
Per month	90,633	3,625	906.3	1,969.76	3.63	1,332.49	6.60
Per year	**1,087,600**	**43,504**	**10,876**	**23,637.17**	**43.50**	**15,989.88**	**79.23**
Firewood demand locally covered				**3.2%**		**2.1%**	

If we assume that there are **four people trading firewood in the community** and have the same business practices as the interviewed sellers (LA&RT), then **the firewood demand of households and businesses covered by local purchases would be between 8.5% to 12.6% of the community's theoretical demand.**

The estimation of Drigo (2019) considers that TA Chadza falls into an area where 20 to 40% of rural HH demand is fulfilled from local resources and 16% is covered by purchased firewood. This study's calculation might be below Drigo's estimations because it considers small businesses' demand and did not consider firewood from other sources, like the firewood from trees and shrubs owned and sold by the farmers themselves.

Image 3. The local firewood aggregator & retailer (LA&RT), and his team with the firewood pieces drying under the sun in the study area.

3.2 Firewood uses in rural households

Traditionally, women in rural areas are responsible for cooking, therefore being the principal users, collectors, and consumers of firewood at the household level. In Malawi, 58% of the households rely on a three-stone fire stove system for cooking, followed by 23.8% of households that use a mobile cooking stove made of clay named *chitetezo mbaula* in Chichewa. It has been shown that women in Malawi face numerous health risks related to the use of low-quality firewood and crop residues associated with cardiopulmonary, respiratory, neurologic, and other symptoms (Das et al. 2017; Borgstein et al. 2019; Embassy of Ireland 2020).

Image 4. Up-left, chitetetzo mbaula cookstove with marginal firewood. Up-right, three-stone cooking with indigenous firewood, and down, three-stone cooking system.

> "As women, we face a lot of challenges. When we come from the field together with our husbands, we are very tired but still, we are expected to do household chores and then cook for the family."

> "After the first delivery of a boy, I was having toothaches and could not cook. At that time, my husband would spend the whole day without eating."
>
> Women tree producers, 2021.

In the study area, about 80% of the participants in the project use improved cooking stoves according to the project's baseline internal report. Women prepare meals three times per day during the rainy season and two times during the dry season. Normally, porridge is cooked for breakfast, while *nsima* (Malawi's staple food based on cooked maize flour) and relish are prepared for lunch and dinner. Usually, after preparing the *nsima* and the relish, pieces of firewood are added to the fire for heating water for tea or bathing.

Due to the perceived scarcity of firewood during the rainy season, people consider that there is no choice regarding the type of firewood to be purchased. However, different characteristics are important when there is a chance for selecting firewood, such as the tree species, piece size, and dryness.

Certain types of firewood are also preferred over others depending on the intended use. For cooking, some of the characteristics considered when choosing firewood include the time available to prepare the meals (quick fire or long-lasting producing charcoal residues), the type of meal to prepare that also determines the cooking system and time required, the cooking system (small or big pieces

that fit the cookstove), the amount of smoke or ashes produced (related to the resulting food quality), and the dryness of the wood at the purchase moment. *"When preparing rice, I use the chitetezo mbaula with firewood to adjust the heat because with charcoal can be overcooked. But today did not use it because the firewood I have is not well dried, and I am afraid it will produce more smoke." Food businesswoman, 2022.*

Image 5. Woman cooking with Senna spectabilis firewood in the study area.

Women who seek a quick fire for cooking prefer firewood from tree species like *Ficus ingens* (Mtawa), *Acacia polyacantha* (Mthete), *Erythrina abyssinic* (Chisale*)*, *Senna spectabili*s (Keshya), *Toona ciliate* (Sendrella), and *Mangifera indica* (Mango). Others, consider that the "good" firewood is from the indigenous miombo wood, such as *Brachystegia spp* (Ludzi*)*, *Upaca kirkiana* (Masuku), *Faurea speciosa* (Chisese), *Pericopsis angolensis* (Mwanga), or *Isoberlinia angole* (Dondo) because those tree species produce more and higher quality charcoal residues. Likewise, *Ficus ingens* (Mtawa) tree produce charcoal residues and together with the miombo species, are commonly used for longer cooking times. However, *Ficus ingens* (Mtawa) trees have a high moisture content and the bark must be removed to dry faster. Tree species producing charcoal residues are often preferred over quick-burning firewood. For example, a woman firewood seller said that out of ten sales, seven are of *Ficus ingens* (Mtawa) and three of *Senna spectabilis* (Keshya).

> *"Since more people are used to natural trees, they prefer them."*
>
> *(Man-Collector & Trader, Mitundu Trading Center, 2021)*

A disadvantage of indigenous species is that they take longer to dry, and some species, such as the *Isoberlinia angole* (Dondo), produce a lot of ash that is not good for the food business, including baking scones but is still bought for this purpose because there is no choice. Species like *Commiphora africana* (Kobo) or *Pine* are less preferred because they produce "a lot of smoke and stain the pots," but pine firewood is sold because it catches fire even when it is wet.

Rural households classify firewood as marketable or for household use according to its physical characteristics. For example, commercial firewood comes from branches of a specific diameter (reported as "arm size") and can be straight or not. All tree branches falling outside these parameters, especially the small and slender ones, are reserved for domestic needs and are often referred to as "marginal" firewood by other studies. Nevertheless, some households use all the wood they produce and sell neither firewood nor other wood products.

By taking percentages of firewood assortments stored and used by rural households estimated by Drigo (2019), **we can assume that TA Chadza falls into a deficit area and about 42% of firewood used is marginal (see Table 4).**

Table 4. Extract of firewood assortments stored and used by rural households in a deficit area estimated by Drigo (2019).

Source	Percentage	Category
Pruning trees and shrubs regularly (small branches)	21 %	Marginal
Whole trees and shrubs cut in farmlands	17 %	Commercial
Purchased conventional firewood	16 %	Commercial
Pruning trees and shrubs from forests (cutting branches from the crown, not main steam)	12 %	½ Marginal / ½ Commercial
Irregular pruning (several years apart) of trees and shrubs from farmland	10 %	½ Marginal / ½ Commercial
Dead wood collected from the forest	8 %	Commercial
Crop residues from the farm	7 %	Non-firewood
Cut whole trees and shrubs from the forest	6 %	Commercial
Uprooted / Tree stump	2%	Marginal

3.3 Other wood products for alternative markets in rural areas

Besides firewood, trees can provide other products for alternative markets in the study area. Each product has different qualities to be considered if the aim is to reach these markets. Table 5 sets out a summary of the diverse features and characteristics identified, and the markets are briefly described as follows.

Most smallholder farmers use and/or sell tree branches as a building material for houses, fences, shades, etc. The demand for poles is higher during the dry season including October and November when people reinforce their house structure. As demand for this purpose is not known in Malawi, (Drigo 2019) gives a tentative per capita value of 12.2 kg of dry matter (DM) per year for the rural population and half (6.1kg DM) for the urban population. This market is mainly related to men as they are seen as the targeted clients. Poles have the potential to be sold at a higher price than branches for firewood if they have the desired characteristics (length, diameter, straightness, and specie). Their price varies from 250 MK to 2,500 MK per unit. A pole from *Eucalyptus* (Blugamu) is more expensive (1,000 MK, 1 USD) than one from *Gmelina arborea* (Malayina) (500 MK, 0.5 USD) in Lilongwe city. At village level, the price per pole ranges from 250 MK to 1,000 MK (0.25 – 1 USD), although farmers selling branches in bulk can receive as low as 100 MK (0.1 USD) for each.

Tobacco producers are the second market identified during the rainy season. In March-April, there is firewood demand for flue-cured tobacco, wood poles for building drying sheds, and barns for burley tobacco. Bigger tobacco producers have their woodlots[7]. Likewise, some tree producers also plant tobacco and use their trees for the curing process. This sector represents about the 9% of the total wood consumed nationally, estimated at 5.3 million trees annually (Stanturf et al. 2011).

[7] The Land Act has a section that requires tobacco producers to grow trees on 10% of their land.

Brickmaking is the third market of wood products identified in TA Chadza. This industry consumes about 4% total wood used in Malawi (Stanturf et al. 2011). Drigo (2019) reports brickmaking as the highest consumption sector for non-residential use, estimated at 452,945 metric Tons of dry matter (tDM) in 2016. In TA Chadza, aggregators reported selling enough firewood to fill a two-Ton[8] vehicle every day from June to September.

A less common but mentioned market was to sell branches as garden stakes for tomato producers. However, a tomato producer reported to use the same stakes for four years before buying new ones.

All these needs, however, could be alternatively sourced from standing trees available in the village and surrounding areas, thus competing with the planted fast-growing tree species.

Table 5. Overview of marketable wood products identified in the study area.

Product / Targeted market	Characteristics	Tree Species	High demand season	Price in Lilongwe District	Estimated demand in Lilongwe District
Firewood	Dry, "arm size diameter". Between 3 - 5 cm, up to 15 cm of basal diameter. Cut in small pieces or not.	Indigenous miombo; *Senna spectabilis* (Keshya), *Ficus ingens* (Mtawa), *Acacia polyacantha* (Mthete), *Albizia lebbeck or versicolor* (Mtangatanga)	Rainy Season (Dec. to April)	10,000-20,000 per oxcart (4.2m^3); 3 or 4 pieces for 100 MK in villages and trading centers, and for 100- 200 MK in the city; full tree between 500 and 7,000 MK (village)	708 kg per capita per year; 1,043,989 tDM for rural areas (author's estimation); 175,180 tDM for urban areas (Drigo, 2019)
Poles / Construction, building materials	Straight and long branches between 5- 15 cm basal diameter (Abbot, 2014)	*Eucalyptus* (Blugamu), *Gmelina arborea* (Malayina), *Senna spectabilis* (Keshya)	Dry season (May to Nov.)	500 – 3,000 MK per tree (all branches); from 250 to 1,000 MK per pole (village level); from 500 to 2,500 MK per pole (trading centers)	18,184 tDM and 6,700 tDM for rural and urban areas respectively (Drigo 2019)
Poles / Drying sheds and barns/ Tobacco curing	Bigger diameter than poles for construction – 4m length	*Eucalyptus* (Blugamu), *Senna spectabilis* (Keshya), *Senna Siamea* (*Cassia or Keshya wa Milimo*)	March-April	From 4,000 to 8,000 MK per oxcart (4.2m^3); or 250-500 MK per pole	9,032 tdM and 437 tDM for rural and urban areas respectively (Drigo, 2019)
Logs / Brickmaking	Big logs or bigger diameter than poles	*Mangifera indica* (Mango), *Acacia polycantha* (Mthete), *Ficus ingens* (Mtawa), *Eucalyptus* (Blugamu), (Msikidzi), *Toona ciliate* (Sendrella), *Erythrina abyssinic* (Chisale)	June to Sept.	From 6,000 to 8,000 MK per oxcart (4.2m^3)	13,804 tDM and 120,522 tDM for rural and urban areas respectively (Drigo, 2019).
Garden stacks	Long branch	*Senna spectabilis* (Keshya)	Unknown	20 MK per stack (3000stacks for 60,000MK)	Unknown

[8] Note for vehicle classifications: Historically, a truck was referred to according to how much weight can carry. For example, a "one-Ton" truck could take one Ton or 2,000 pounds (907.19 kg), but this classification has become very flexible. The vehicle classification in this report helps to give an idea of the truck's size, not the payload capacity.

Other industries have a significant fuelwood consumption in Lilongwe rural areas but are not further explored in this study, including poultry 19,246 tDM, schools (10,436 tDM), fish smoking/drying (435 tDM) (Drigo, 2019).

3.4 Demand in Lilongwe's urban area

According to Drigo (2019), Lilongwe city had a total fuelwood demand of 736,103 tDM for residential use, including construction material, firewood, and charcoal (554,223 tDM) in 2016, and a total of 164,135 tDM for non-residential use, including the commercial, poultry, tobacco, bricks, and school sectors.

4. The firewood sector

Often neglected, the firewood–and charcoal–sectors are a significant generator of self-employment (Owen et al. 2009) but are highly discouraged due to their link to the high deforestation rates and low levels of control over the tree harvest in the forest reserves. The firewood sector in Lilongwe is relatively organized yet informal and predominantly illegal, causing issues with law enforcement. Despite this, some of the most vulnerable participate in this for survival, benefiting from the low investment capital to become involved. In contrast to timber production (exported to neighboring countries), the firewood sector in Lilongwe District seems to remain an internal market.

Image 6. Truck transporting firewood in the study area of TA Chadza in 2021.

The market strategies vary from actor to actor, explained further in the following sections. For some actors, trading firewood is a regular source of income; for others, it is only during certain months. With a seasonal pattern more noticeable in rural areas, the firewood source and its accessibility drive their level of participation. For example, during the rainy season, the road conditions may not be optimal for reaching remote areas, making it more difficult for vehicles and bicycles to transport heavy loads of firewood. **In addition, many trees growing in the farmlands cannot be felled or pruned during the rainy season as they could damage the crops.**

The following sections will present a firewood value chain scheme (Figure 3), then explain briefly the actors involved and the firewood supply organization, including the diverse firewood sources identified in rural and urban areas, the different market channels used relevant to smallholder farmers, and the price structure.

5. Firewood value chain overview

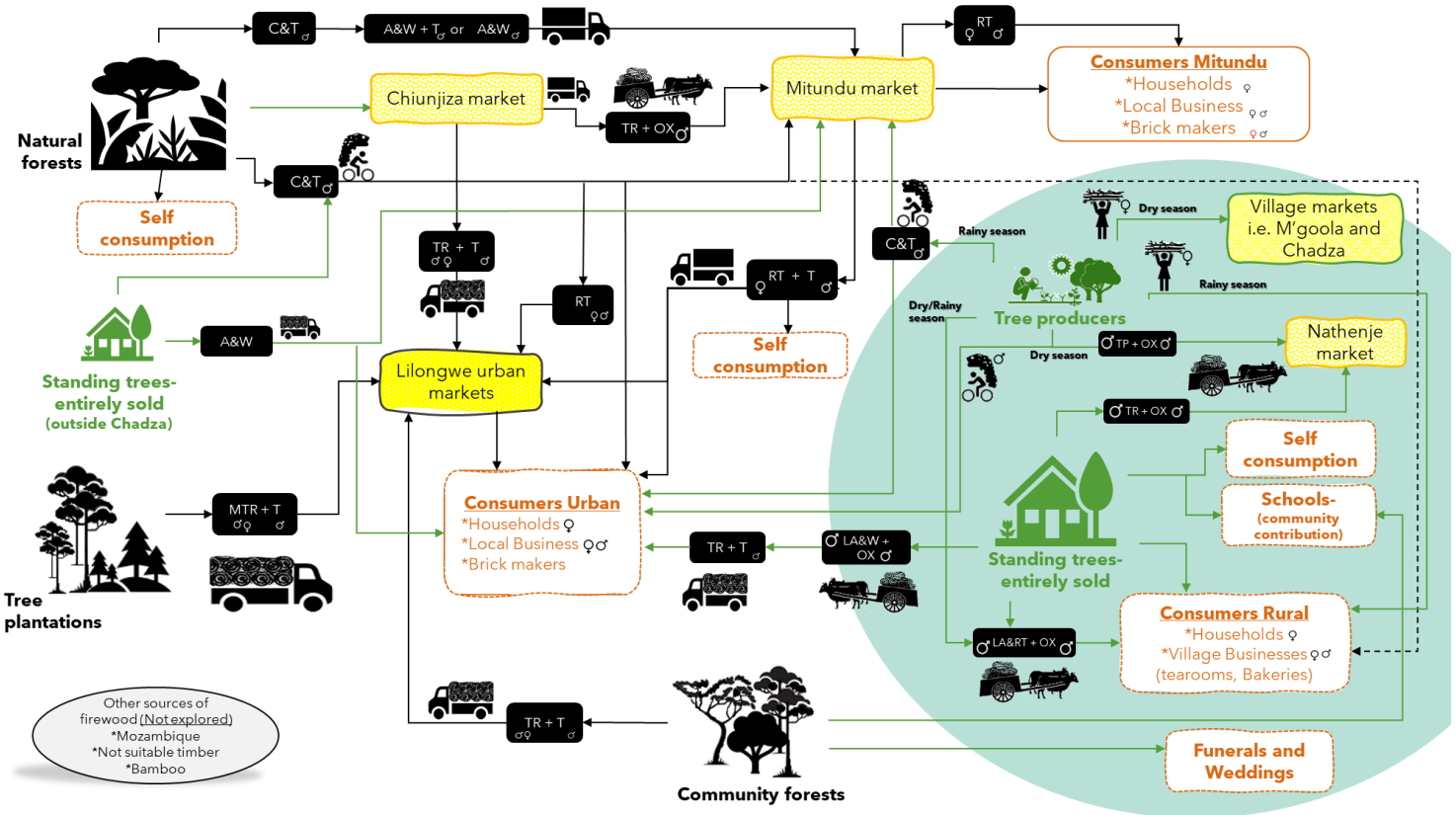


Figure 3. Overview of the firewood value chain in Lilongwe District and TA Chadza.

Figure codes		
C&T Individual firewood trader (by bicycle) **P** Producer **A** Aggregator (1.5, 2, 3-Ton vehicles) **LA** Local Aggregator **W** Wholesaler	**T** Transporter (vehicle) **OX** Transporter (oxcart) **TR** Traders (0.5, 3, or 5-Ton vehicles) **MTR** Major Trader (10 – 20-Ton vehicles) **RT** Retailer	Blue background = Local market, TA Chadza ---- Opportunistic sales along the way — Green flow = Firewood sourced from farmers Men ♂ Women ♀ Big logs Small wood pieces

6. Actors involved

Table 6 gives a brief explanation of the main actors in the firewood value chain of Lilongwe District, including producers; collectors; transporters (bicycle, oxcart, and vehicle); traders (bicycle, oxcart, and vehicle); retailers; and consumers (households and businesses). This table categorizes actors according to their business practices, further described (included challenges faced) in Annex II.

Table 6. Main actors involved in the firewood value chain of Lilongwe, their functions, and their basic profile.

Actor category	Who is involved?	What do they do?	Profile	Margins in United States Dollars (USD); Note: different firewood sources
Producers 	Women and men	Plant & grow trees; often process them (prune, cut, or fell).	Smallholder farmers with average landholding of 0.6 hectares (1.5 acres).	See Section 9
Collectors & Traders (C&T) 	Men	Collect dead wood from forest by bicycle, sell in trading centers. Seldom purchase planted trees.	Mostly farmers; young men without land; primary education; bicycle as main asset (0.5m^3 firewood capacity).	≈ 2.5 USD per trip (bicycle load, indigenous miombo)
Transporters 	Men	Own transport means and offer transport service. Transport any tree species.	Oxcart owners from/to rural areas; vehicle owners from/to urban areas	Vehicle (trading center – urban) ≈18.8 USD per trip Oxcart (rural- trading center) ≈ 5.8 USD per trip Oxcart (rural-rural) ≈1.66 USD per trip
Traders **Aggregators fall into this category, gathering firewood from several sources into one batch.**	Women and men	Buy and sell firewood wholesale or retail. Trade indigenous or exotic tree species. Purchase standing trees in villages and plantations.	Have own transport (men) or hire transporters (men and women); Move larger volumes of firewood (5m^3 to 32m^3) to the urban areas.	Locally sourced aggregators selling to urban traders ≈ 71 USD per month (7-9 USD per two-Ton vehicle) Locally sourced aggregators selling retail in the village ≈ 44 USD per month Aggregators – trading centers ≈ 30 – 75 USD per trip (indigenous miombo wood) Urban traders ≈ 195 – 391 USD per trip (20-Ton vehicle, plantations)

Retailers	Mostly women	Buy at wholesale price and sells in smaller quantities (bundles) to end-users (consumers).	Women living in Lilongwe city; groceries shops in trading centers (men and women).	≈ 4.8 – 7.8 USD per trip (indigenous miombo trees)
Consumers	Women and men	Select and purchase firewood according to their needs.	Households: women; Food businesses (bakeries, tearooms): women & men.	-

Some value chain participants have overlapping functions, as illustrated in Figure 4. For example, Collectors and Traders (C&T), in grey color, may fall into the categories of collectors, transporters, traders, and even retailers when they opt to sell door by door.

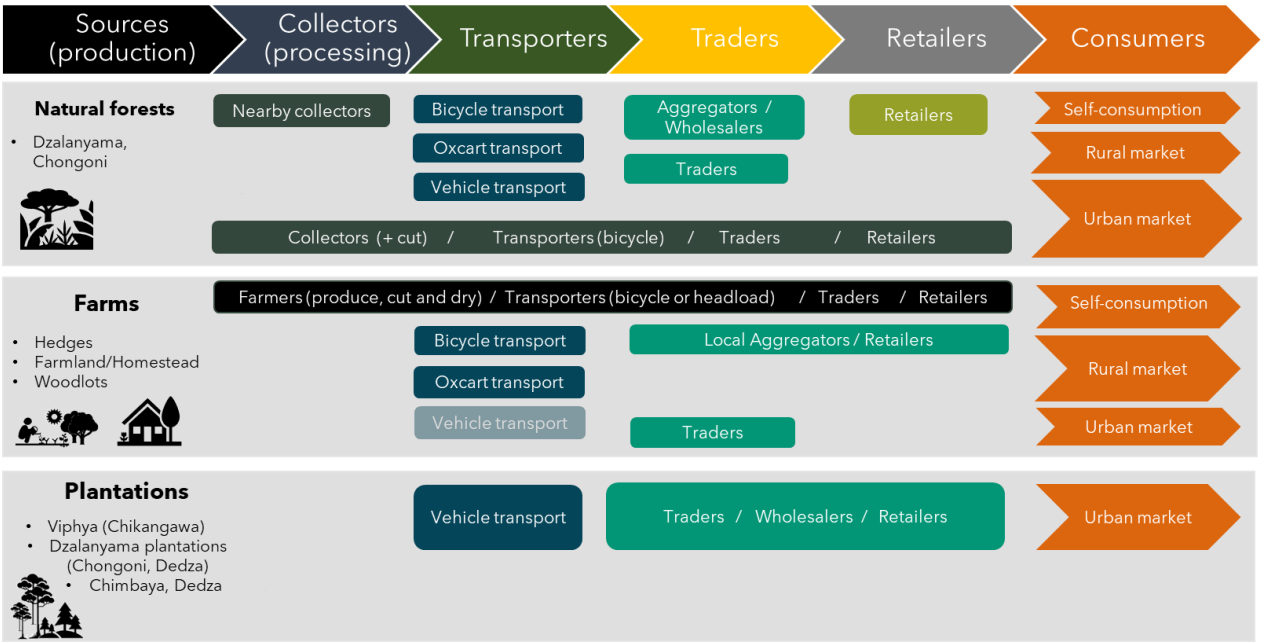


Figure 4. Summary of actors involved in the firewood sector of Lilongwe District.

7. Firewood supply

The firewood value chain starts at the source, where the tree grows. Harvested trees or collected firewood then go through a process of cutting, drying, and transporting before reaching households and businesses in Lilongwe trading centers and village markets. Consequently, actors participating in the firewood value chain follow diverse market channels, which can be short or long chains involving one or more intermediaries. Market channels vary going from rural to urban and rural to rural, including self-consumption, depending on several factors, including the tree source, transport means, access to demand, and market information.

Although several flows exist, this study will only focus on those channels relevant to smallholder farmers.

In Malawi, a significant part of the firewood traded is illegally sourced from forest reserves and surrounding areas (Drigo 2019; The Ministry of Natural Resources, Energy and Mining 2017b). According to Jumbe and Angelsen (2011) in Kachale Mchakulu et al. (2019), 26% of the country's total energy consumption came from forest reserves. Likewise, the IHD5 2019-2020 report, estimates that most enterprises selling forest-based products in the central region source their products from private individuals (43.3%), forest/wild park reserves (34.4%), and communal land (14.8%).

7.1 Firewood sources for rural areas

The forest or park reserve is the essential source of wood for 39.8% of enterprises engaged in forest-based products in the rural areas, followed by the communal land with 16.4%, and lastly, the own land or other sources with 4.2% and 2.2% respectively (National Statistical Office 2020). These figures indicate that commercial firewood is mainly extracted from the forests, but it does not mean that all firewood consumed in rural areas is sourced from there, as discussed in Section 3. In the study area, there are four primary sources of firewood described as follows:

The Dzalanyama Forest Reserve, described as **Natural forests** in Figure 3, provides firewood which is brought to the villages by fellow men villagers whose main livelihood is Collecting & Trading firewood by bicycle.

Standing trees – entirely sold in Figure 3, are a primary source of firewood derived from indigenous and exotic tree species growing in the villages, including *Rauvolfia caffra* (Mwimbi), *Erythrina abyssinica/Albizia antunesiana* (Chisale), *Acacia polyacantha* (Mthethe), *Ficus ingens* (Mtawa), *Albizia lebbeck* (Mtangatanga), *Mangifera indica* (Mango), *Toona ciliate* (Sendrella), *Khaya nyasica* (Mbawa), *Trichila emetic* (Msikidzi), and *Melia azedarach* (Indya), among others. Village businesses like bakeries and tearooms or local firewood Aggregators/Retailers (LA&RT) are the main actors buying these trees, who will cut, dry, transport, and sell the trees as firewood in the area.

Categorized as **Tree producers** in Figure 3, smallholder farmers supply rural areas with firewood during the rainy season. Trees species produced in the study area include *Senna spectabilis* (Keshya), *Acacia polyacantha (*Mthethe*), Albizia lebbeck (*Mtangatanga*), Senna siamea (*Cassia*), Ficus ingens (*Mtawa*), Rauvolfia caffra (*Mwimbi*), Gmelina arborea (*Malayina*), and Faidherbia albida (*Msangu*).*

With more control over their use and natural regeneration management, the last source of firewood in rural areas is the **Community forests** including graveyards (see Figure 3). The use of trees is managed by the VH and GVH following by-laws, and it is not possible to access them without previous authorization as they serve for community welfare[9]. Access to the trees is granted for funerals, to build tree nurseries, bridges, and a football frame for the youth, or even if an elder's house is destroyed, relatives can access trees for remodeling his or her house. Village forests are taken care of by the community and some chiefs also give access to them for weddings, church events, or to cover other social needs. For example, schools engaged in the House-Grown School Meals Program cook porridge for their students twice a week. For those schools to get the firewood needed for cooking, students provide a piece of wood once a week as a contribution, either from the families' plots or from community forests and graveyards, with the VH's previous agreement.

7.2 Firewood sources for urban areas

For the purpose of this study, this section presents five of the main firewood sources identified. Other sources of firewood are not further explored in this study, including wood from Mozambique, unsuitable timber, and bamboo.

As in rural areas, **Natural forests** are one of the main sources of firewood for the urban markets, if not the major one. Traders bring firewood to the marketplaces using bicycles or vehicles, mainly sourced from_Dzalanyama Forest Reserve, particularly from the Dedza district's side. A minor proportion, of traders sell firewood from Nkhotakota and Zomba forest reserves (Interviews, 2021).

Big logs and poles are legally purchased from **Tree plantations** by major traders (MTR in Figure 3) who hire vehicles of a minimum two-Ton capacity to transport the wood. Tree plantations identified include Chikangawa (Viphya Plantations) in Mzimba district; Dzalanyama Timber Plantation of *Pine* trees and the Katete Plantation of *Eucalyptus* trees in Lilongwe District; Chongoni, Dzalanyama Forest Reserve in Dedza district; Kachawa Farms in Lilongwe District; and an unknown plantation in Zomba district.

During the dry season, mostly men smallholder farmers (**Tree producers**) take the firewood by bicycle to trading centers like Nathenje, Nanjiri, Kalenga, and Lilongwe city.

[9] Some villages with a community forest in the study area are SGVH Chidambaiyla and VH Santhe within the same village group, SGVH Mwandzungu, and GVH Mphone. Abadia 2016 also identified woodlots in GVH Mkhanga and GVH Mbangom'be.

Image 7. Standing tree purchased in TA Chadza by LA&W for brick makers, 2021.

The rural areas of TA Chadza also supply firewood to urban areas from **Standing trees – entirely sold** of indigenous and exotic species. These trees are locally gathered by a Local aggregator/Wholesaler (LA&W in Figure 3) and then sold to a trader who hires a vehicle to transport the firewood from Chadza to the trading centers in Lilongwe city. However, **this source mainly supplies brick makers and is only active during the dry season.**

Even though it does not seem to be a common practice, **Community forests are an additional source of firewood reserved for exceptional occasions.** For example, in the area around Malingunde within TA Masula in Lilongwe District, during the construction of a dam, trees from a community forest were sold per cubic meter and a written document was issued to endorse the transaction.

7.3 Collection of firewood from the forest reserve

Any person can legally collect firewood from forest reserves, including DFR, when the person entering the forest area pays an entrance fee to the DoF. The entrance fee, known as "General Receipt" (GR), is 500 Malawi Kwacha (MK) per bicycle load or 200 MK per headload. The GR allows collecting firewood from fallen trees or dried branches from a particular area and carrying it outside the forest reserve. Vehicle entry permits have been banned since the end of 2020. During an interview, one plantation manager of DFR estimated that over 200 people collect firewood or produce charcoal every day, but only 50 or 60 of them (25-30%) pay the GR. Sometimes, the person collecting the firewood needs to cut the fallen tree into smaller pieces

Image 8. Logged tree in DFR, C&T in the DFR, C&T on their way home or trading centers (down, from left to right).

to be able to pack in a bicycle and transport it outside the reserve. Others might cut live standing trees. Most people entering DFR by bicycle are men involved in firewood collection and trade. Women collect dead wood and branches, which are easier to gather and carry by headload. These women often go with their children, who also take their headload of firewood (Bone et al. 2017; Interviews 7/24/2021). There is another alarming portion of men entering the forest reserve for harvesting trees to produce charcoal, but this study only focuses on the firewood sector.

7.3.1 Collectors and traders

Men dominate the collection and trading of firewood from forest reserves, mainly due to the physical effort required to move the heavy firewood loads and the personal risk of spending several hours on remote roads and markets. The main asset of firewood Collectors & Traders (C&T) is the bicycle they use to transport the firewood, which has a value between 60,000MK and 80,000MK. Using a bicycle also includes having high maintenance and repair costs throughout the year.

Most of the men undertaking this activity are farmers with primary education, and some have been doing this for more than ten years. During the interviews, the research team noticed that some young men without land or facing poverty find this activity their livelihood. *"I started last year because I have no farm and no money to feed myself and my family, and I force myself to start a business. To me, it is not that profitable, only for survival." Man - Firewood C&T, Urban Trading Center, 2021.*

Firewood C&T consider trade the only feasible alternative to get cash fast and make ends meet with little initial investments. Therefore, firewood trading by bicycle from DFR is rarely considered a profitable activity. Yet, it remains a self-employment option, which generates approximately 2.5 USD per trip. On average, men C&T go twice a week to DFR, but the number of trips decreases while the person ages. *"In the beginning, I went regularly, thrice weekly. But now, I go once per week or twice a month. I am not strong anymore." Man, Farmer and Firewood C&T, TA Chadza, 2021.*

> *"The main challenge is that the profit is so small to be used for other businesses." Man, Firewood C&T, Urban Trading Center, 2021.*

Bicycle firewood traders spend around 11 hours completing one trip. They usually need between three to five hours to reach Dzalanyama Forest; two to four hours to search, cut down the wood and pack it in the bicycle; and about five hours to return home or head directly to a trading center. The firewood is sold the next day or days in Mitundu or in urban trading centers. Most of the interviewed C&T mentioned paying the General Receipt of 500 MK (0.5 USD) to the Forest Reserve authorities. Next, to sell in the marketplace, C&T pay a market fee of 200MK (0.2USD) to the city council collectors. Some traders reported that if sales were not going well in Mitundu, they moved to urban trading centers and sold firewood randomly street by street. Some men prefer to sell in town to get cash immediately rather than selling in their villages, where it can take one up to several days to get the payment.

Since many of the C&T are farmers, they stop the business from December to February, during the planting season. However, for those traders that rely on firewood trade as main livelihood do not stop. *"I am doing this business to survive, but I am also a farmer." Man, Firewood C&T, Wholesale outlet, 2021.*

Image 9. Bicycle firewood loads on sale at Wholesale outlet.

Challenges: Physical effort and long distances affect C&Ts' health. Some C&T are willing to source from planted trees, but this is less profitable since they need time to dry the wood before selling it. Overall, they are more concerned about the risk of having their load and bicycles confiscated by authorities, being beaten, or being asked for money.

7.3.2 Natural forest firewood market channels

The firewood from the forest follows other market channels and often involves more actors. For example, the previous section explained how men C&T, including some farmers from the study area, go by bicycle to collect firewood in the DFR, pack it, and sell it at the wholesale outlet or travel back home. The travel back home is an extra opportunity to sell the firewood along the way or once in their village, mainly to local businesses such as tearooms and bakeries. The following day, they will go either to a wholesale market (see Box 2) or to the trading centers in the city where they sell doo-to-door to households and shops, including groceries stores, which then sell the firewood to their customers.

Image 10. C&T showing his General Receipt, 2021.

If a consumer buys the firewood at the wholesale outlet, then the chain ends there. However, if a trader or a retailer purchases the firewood, it will be transported to Lilongwe city. The retailers are mainly women living in Lilongwe city who buy at wholesale price one or more firewood bicycle loads or several wood pieces (sold by aggregators in the same trading center) to sell on later. These women must hire transport services from the trading center to the city, usually offered on the spot.

7.4 Trading centers and wholesale outlets

Major trading centers for firewood trade in Lilongwe city include Area 21 (Chilende), Area 22 (Nchesi), Area 23 (Kaliyeka), Area 24 (Ngwenya) known in particular for its offer of large logs, Area 25, and Area 36. Altogether, these areas host over one-third of the city's population (about 366,000 persons), which may explain the high firewood demand.

Image 11. Major Firewood Trader, selling Pine and Eucalyptus species from legally sourced plantations.

Box. 2 Wholesale outlets

A large proportion of the firewood traded in Lilongwe passes through one or both main wholesale markets of the district (Chiunjiza and Mitundu). These wholesale outlets are vibrant and well-known for firewood traders. The first, Chiunjiza Trading Center, is the nearest wholesale point from DFR. The second, Mitundu Trading Center in TA Chiseka, is only about 30 km away from Lilongwe city's trading centers. The firewood sold in these points is mainly from indigenous miombo trees from DFR, and it is rare to see any other tree species such as Senna spectabilis (Msiska 2017; Interviews 2021-2022).

Image 12. Mitundu firewood trading center (wholesale outlet).

7.5 Smallholder farmers | Tree producers

Men and women venturing in tree production require access to secure land, seeds/planting material, polytubes (for species sown in nurseries), water, and labor. Tree producers interviewed in the study area have a landholding size between 0.5 to 3.0 acres with trees of different ages. The eldest trees are about 15-20 years old, while young trees are one or two years old planted in 2020 or 2021.

Depending on the tree species, farmers plant their trees in the field, at field boundaries, in woodlots, or in their homesteads. For example, an interviewed farmer said that tree species like *Faidherbia albida* (Msangu) and *Acacia polyacantha* (Mthethe) are not good in the homestead because they have thorns and are not safe for children. Other species are more versatile, like *Senna spectabilis* (Keshya) planted at the field or homestead.

Image 13. Senna spectabilis planted as windbreak at the homestead.

Farmers participating in the firewood business have between 20 and 300 trees, and only a few have a more considerable amount to become self-sufficient in terms of firewood or enable them to sell firewood the whole year. Nevertheless, farmers' largest challenge is the absence of a management plan for harvesting trees or branches and the few productive trees available. As a result, sales primarily follow household's cash needs without a fixed marketing strategy and families continue using crop residues during the dry season.

Farmers did not report having any major challenges in producing trees. However, to increase their performance, some farmers consider tree management, after planting, the most crucial step for succeeding, including weeding around the tree. Therefore, tree management knowledge and tools are also key for tree producers to benefit fully from agroforestry activities. Some farmers reported struggling to find seeds to diversify tree production or having issues with specific species. For example, *Ficus ingens* (Mtawa) is one of the most preferred species and is suitable for vegetable propagation, but its production is threatened because termites attack the cuttings. Farmers would need further support to find solutions to this issue. Another challenge relates to trees planted within boundaries, which can be uprooted by neighbors or branches can be stolen. By laws are important for decreasing the incidence of the latter.

In marketing, some farmers fear they may need to sell their wood products at a lower price because people do not have enough money to pay for them. New tree producers struggle to set a reasonable selling price for branches or the entire tree, often asking for lower prices.

Nonetheless, they seek information from other farmers or base their decision on the nearby markets' prices.

Image 14. Man, farmer harvesting branches from a Senna spectabilis (Keshya) tree.

7.5.1 Transforming trees into firewood

Harvested trees or pruned branches go through a cutting and drying process before they are sold as firewood. These are two critical steps as they determine the quality customers seek and, in part, define the price. Men farmers who cut their trees do all the labor, but their wives may help to carry the firewood to the homestead. Women farmers also cut their trees or branches but often receive help from teenage boys or hire casual laborers. Local aggregators/retailers and consumers such as tearoom owners hire casual laborers to cut the tree (from 500 to 5,000 MK per tree), split it into smaller pieces, and transport the firewood to their premises (by headload, bicycle, or oxcart).

Image 15. Women harvesting standing tree - entire.

The time spent cutting the tree and splitting it into smaller pieces depends on the number of people involved, the tree size, and whether it is the entire tree or only branches. For branches for example, pruning can take from three to five hours for five trees, plus five to eight hours to cut in smaller pieces. If the farmer is bringing the wood to their homestead to dry, it may need an additional five hours to transport from the farmland to the homestead. The firewood is sun-dried, needing from one to two weeks in the dry season and up to one month during the rainy season depending on the tree's species.

Some species dry faster when removing the bark with a *panga* knife (machete) or a hoe. For the *Senna spectabilis* (Keshya) or *Trichilia emetica* (Msikidzi), the process allows to use the firewood immediately in the dry season and after one or two days in the rainy season. *Ficus ingens* (Mtawa) needs three full days to dry in the rainy season.

Image 16. Bark from Ficus ingens (Mtawa) tree branches for household use (left) and Senna spectabilis (Keshya) pieces without bark for sale (right).

7.5.2 Planted trees market channels used by smallholder farmers in the study area

Smallholder farmers (**Tree producers**) producing trees often play several roles in the value chain depending on how, where, and when they sell firewood. **For example, they primarily deal with direct sales and network marketing, following distinguished seasonal strategies.**

During the dry season (May to November), **the demand for firewood in the villages is low, so producers must sell their firewood in other markets**. Men prune their trees (either branches or fall them entire), cut them into small pieces, dry them (depending on the species), and pack the small pieces of wood onto a bicycle or an oxcart to sell in trading centers in Nathenje, Nanjiri, and as far as Lilongwe city. They sell the firewood as wholesale (bicycle load) or retail (bundle of three or four pieces).

In contrast, women often hire casual laborers (*ganyu*) to prune the trees and cut them into small pieces. After dying, women bring the firewood by headload to nearby village markets or sell retail at their homes (see Figure 5).

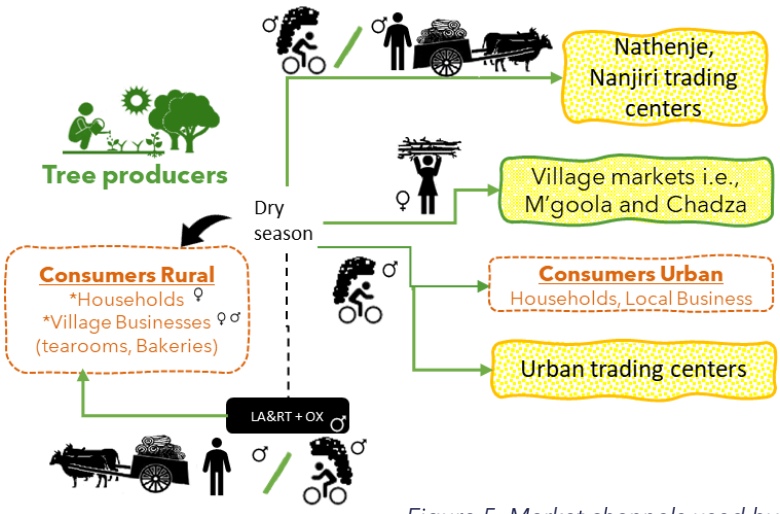


Figure 5. Market channels used by smallholder farmers to sell firewood during the dry season in the study area.

During the rainy season, the demand for firewood increases but conditions to reach markets worsen, and the planting season starts, increasing the farm labor demand. As a result, men and women shift from targeting trading centers and village markets to selling firewood to fellow households and businesses (bakeries, tearooms) in surrounding areas, as shown in Figure 6.

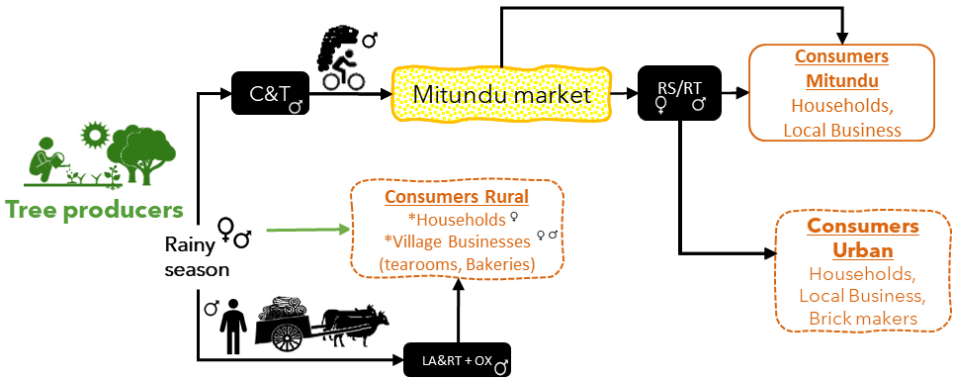


Figure 6. Market channels used by smallholder farmers to sell firewood during the rainy season in the study area.

Farmers display the small pieces of dried firewood in front of their houses and sometimes take them to their customers. Farmers can also sell to collectors & traders who typically source from DFR but who shift to purchasing firewood bicycle loads from farmers during the rains. This option is not a common practice as it requires more capital and time to cut and dry the wood before selling, *"If Keshya branches would be dry, it would be better for doing business daily." Men, collector & trader (by bicycle), Mitundu TC, 2021.*

Image 17. Firewood on sale displayed at tree producer's house.

Besides these channels and throughout the year, smallholder farmers can still sell firewood through their network to customers that cut and transport the firewood at their costs, like tobacco producers, tearooms, and bakeries.

An alternative market channel involves the actor categorized as **local Aggregator/Retailer** (LA&RT in Figures 3, 5, and 7). This channel operates at the village level during the dry and rainy seasons, with higher or lower participation depending on the accessibility and availability of trees. This person buys **Standing trees – entirely sold** or branches from trees of one or several **Tree producers**, transports the fallen trees or branches with a bicycle or an oxcart (hired), hires casual labor to cut the logs into small pieces, dries them, and sells them retail in the village.

7.5.3 Trading centers offering tree planted species.

Image 18. Traders selling Keshya, Cassia, and Malayina firewood from planted tree species in Nanjiri market.

Firewood trading centers characteristically have a wide range of products from diverse sources and different presentations. In rural areas, some smaller trading centers are well-known for their firewood offers like Nathenje, Nanjiri, and Kalenga. For example, traders (in bicycles) targeting these markets may have firewood from planted exotic species like *Senna Siamea* (Cassia), *Senna spectabilis* (Keshya), and *Gmelina arborea* (Malayina).

8. Price structure

Firewood prices vary according to the season, presentation, source, and tree species. For example, Table 7 compares the prices of small pieces sold in bundles at wholesale outlets, villages, and urban trading centers.

Table 7. Prices of firewood bundles during the dry and rainy season in different locations regardless the specie.

	**Bundles price, near forest (Rural areas)**	**Bundles retail price, village (Rural areas)**	**Bundles wholesale price (Rural areas)**	**Bundles retail price (Urban trading centers)**
Dry Season	3 pieces @ 30MK (0.03 USD)	3 -4 pieces @ 50 MK (0.05 USD)	3 pieces @ 50 MK (0.05 USD)	3 pieces @ 100 MK (0.1 USD)
Rainy Season		3-4 pieces @ 100MK (0.1 USD)	3 pieces @ 60 MK (0.05 USD)	3 - 4 pieces @ 100MK – 200MK (0.1 – 0.2 USD)

Table 8 presents the approximate price of *Senna spectabilis* firewood sold in pieces per kilogram of dry matter (DM). It is important to highlight that mass and volume calculations vary per tree species. Thus, to calculate the equivalence between kilograms and cubic meters it is necessary to know the wood's density or to do direct measurements.

Table 8. Approximate price per kilogram of dry matter (DM) of Senna spectabilis sold as firewood.

	Tree producers (Farm gate)	**Village markets**	**Wholesale outlet**	**Urban trading centers**
Price per kilogram DM (Dry season)	89 MK (0.09 USD)	111- 148 MK (0.11 - 0.14 USD)	148 MK (0.14 USD)	296 MK (0.29 USD)
Price per kilogram DM (Rainy season)	89 MK (0.09 USD)	222 – 296 MK (0.22 – 29 USD)	178 MK (0.17 USD)	296 – 444 MK (0.29– 0.43 USD)

The price of the firewood sold by bicycle depends on the load size and the distance traveled by the C&T. Each bicycle load brought to the market has a slightly different size with an estimated average weight of 100 kg and a volume of 0.5 m^3 (Interviews and weighing exercise 2021-2022). The price of the full bicycle load of miombo wood is lower near the forest and increases as you move away from it. The Table 9 shows that bicycle loads sold in villages have a higher value than those sold in Lilongwe city, which makes sense when comparing the distance between the forest and Lilongwe town and the forest and the villages in the study area of TA Chadza, which are more remote and have roads in poor conditions.

Table 9. Price structure according to the estimated distance between selling points and firewood source (Dzalanyama Forest Reserve). Source: Author's elaboration based on approximate information gathered during the interviews and distance measurements in Google Maps.

Sales location	Km between Dzalanyama Forest and sales spot by road	Average selling price for 1 bicycle load (eq. ≈100kg firewood)
Surrounding area of DFR	30 km	3 000 – 3 500 MK
Wholesale outlet*	53 km	3 800 – 5 000 MK
Urban trading centers	62 km	4 000 - 5 000 MK
Villages in TA Chadza	65 - 75 km	5 000 – 7 000 MK

*Note: C&T reported that on a bad business day during the dry season, they are willing to decrease the price of the full load as low as 2,500 MK in Mitundu Trading Center (wholesale outlet).

The price of the firewood from other identified sources also varies according to the tree species and presentation.

In the study area, **standing trees – entirely sold** range from 1,000 MK (1.0 USD) to 10,000 MK (10 USD). The species sometimes play an important role when determining the price; the *Kahya nyasica* (*Mbawa*), known in English as red mahogany and included in the list of protected species, one of the most expensive trees reaching 30,000 MK (29.3 USD). In the villages, species like *Albizia lebbeck* (Mtangatanga), *Mangifera indica* (Mango), and *Senna spectabilis* (Keshya) have about the same value of approximately 1,000 - 1,500 MK (1.0 – 1.5 USD) for the entire tree, depending on the tree size. If only branches are sold, then the price depends on the size of the branches, farmers can sell one branch between 100 MK and 500 MK (0.1 – 0.5 USD). On average, trees like *Senna spectabilis* (Keshya) can have 6 - 20 branches each sold between 500 MK to 3,000 MK (0.5 - 2.9 USD) depending on their size (Abadia, 2016, Interviews and observations 2021-2022).

The commercial plantations sell trees per m^3, and the price depends on the species. The Forestry (Amended) Rules 2010 include guideline prices for indigenous and exotic trees, poles, firewood, bamboo, and non-wood forest products. Among the species cited in the document are indigenous species like *Cholophora excelsa* (Mvule) and *Khaya nyasica* (Mbawa), sold at 15,000 MK (15 USD) per m^3; *Bruttdavya nyasica* (Mbule) and *Rauvolfia caffra* (Mwimbi), sold at 8,000 MK (8 USD) per m^3; and exotic species like *Eucalyptus* (Blugamu) and *Gmelina* arborea (Malayina) sold at 10,000 MK (10 USD) per m^3. A bundle of 7-8 pieces of firewood from these sources in urban trading centers costs 1,000 MK (1.0 USD). Logs of one meter long are sold according to their diameter, ranging from 500 MK (0.5 USD) ≈10-15cm diameter to 3,000 MK (3.0 USD) ≈55cm diameter. An *Acacia polyacantha* (Mthethe) sold in August 2021 as *<indigenous fuelwood, cut, and stacked by the purchaser for industrial use>* was purchased by a trader for 2,500 MK (2.5 USD) per m^3 in the Chongoni plantation. In contrast, **firewood from exotic species is valued at 1,000 MK (1.0 USD) per m^3**.

9. Smallholder farmers' current and potential strategies

Based on the identified price structure, it was possible to estimate a margin for each of the current market channels followed by smallholder farmers. **The estimations presented below assume a model farm of 50 *Senna spectabilis* (Keshya) trees that farmers can use for commercial purposes only, and that the farmers have enough trees to cover their firewood needs for household consumption.** Tables 10 and 11 present the potential margins following the current strategies of smallholder farmers *during* the rainy and dry seasons.

All estimations rely on interview information, observations, and Abadia's (2016) report. The model also assumes that trees are at least three years old and produce an average of 12 branches, with a price per tree of 1,200 MK (1.2 USD), and that one well-pruned tree grows an average of 13.5 kg of dry wood every year (Abadia, 2016). Except for laborers hired to prune trees by women farmers (cost: 500 MK, 0.5 USD for pruning five trees), all the other activities are considered family labor, or the client assumes the expenses. If the farmers do all the labor, they must invest approximately 18 days of eight working hours to transform all 50 trees into commercial firewood during the dry season, and 22 days and five hours in the rainy season.

Table 10. Dry season strategies comparison, 50 trees model.

Market channel	Activities involved	Who is involved?	Total Margin	Time needed to sell 50 trees
Selling to households at village level	Prune tree, cut branches into small pieces, dry, make bundles, transport, and trade.	Women and men	100,000 MK (97.6 USD) With hired labor 92,917 MK (90.7 USD)	28.6 weeks + 18 days of transformation activities -transport to other villages is not considered
Selling by bicycle in urban trading centers ***Assumes selling wholesale bicycle at 7,200 MK (7 USD)**	Prune tree, cut branches into small pieces, dry, pack, transport, and trade.	Men selling; women and men buying	57,600 MK (56.3 USD) *50 trees produce 8.3 bicycle loads, 3.4 branches remain for household use.	2 weeks (Four times per week) + 18 days of transformation activities + 2 hours to load each bicycle
Selling bicycle per pieces in Nanjiri trading center ***Assumes 300 pieces per bicycle (as DFR bicycles) and 3 pieces for 100 MK**	Prune tree, cut branches into small pieces, dry, pack, transport, and trade.	Men (selling) + Men transporters (oxcart); women and men buying	80,000 MK (78 USD) *50 trees produce 8.3 bicycle loads, 3.4 branches remain for household use.	4 weeks (Twice per week) + 18 days of transformation activities + 2 hours to load each bicycle

Selling by oxcart to Nathenje trading centers *** Considers market price of oxcart, not the real value. Remain 8 branches for HH use).**	Prune tree, cut branches into small pieces, dry, load oxcart, transport, and trade.	Men selling + transporting (oxcart); women and men buying	20,000MK (19.53 USD)	1 month + 18 days of transformation activities
Selling by headload in village markets ***Assuming one headload equals all branches form one tree (13.5 kg)**	Prune tree, cut branches into small pieces, dry, make bundles, transport, and trade.	Women selling and buying	60,000 MK (58.6 USD) With hired labor 52,917 MK (51.7 USD)	175 days (25 weeks) – [dry season lasts 151 days approximately] + 18 days of transformation activities
Selling to consumers in rural areas (bakeries, tearooms, food businesses)	Find the customer who prune trees and transport them. *If taken to the customer, add cost and time of transformation and transport	Men and women selling and buying	60,000 MK (58.6 USD)	Bakeries between 6 and 12 days; one small tearoom ≈19 days, big tearoom 10 days *No transformation
Selling to local aggregators/retailers	Find the aggregator/retailer, who prune trees and transport them.	Men and women (selling), Men buying	60,000 (58.6 USD)	2.1 weeks *No transformation

Table 11. Rainy season strategies comparison, 50 trees model.

Market channel	Activities involved	Who is involved?	Margin	Time to sell 50 trees
Selling to households at village level	Prune tree, cut branches into small pieces, dry, make bundles, transport, and trade.	Women and men	150,000 MK (146.5 USD) With hired labor 142,917 MK (139.6 USD)	10.7 weeks + 22 days and five hours of transformation activities - transport to other villages is not considered
Selling to consumers in rural areas, i.e., tearoom, bakery	Find the customer who prune trees and transport branches. *If taken to the customer, add cost and time of transformation and transport	Men and women selling and buying	60,000 MK (58.6 USD)	Bakeries between 6 and 12 days; one small tearoom ≈19 days, big tearoom 10 days *No transformation

Selling to local aggregators/retailers	Find the local aggregator/retailer, who prune trees and transport branches.	Men and women (selling), Men buying	60,000 MK (58.6 USD)	1.4 weeks *No transformation
Selling to collectors and traders	Find the collector & trader, who prune trees, cut into small pieces, and transport them.	Men and women (selling), Men buying	57,600 MK (56.3 USD) *50 trees produce 8.3 bicycle loads, 3.4 branches remain for household use.	8 weeks (assuming once per week) *No transformation

Since farmers follow diverse strategies based on their immediate needs, comparing, or retrieving one model that works best is not easy. Some channels seem to work better when selling retail in markets like Nanjiri or directly selling to consumers who prune the trees and transport the branches. Tables show that women carrying and vending firewood in the village markets during the dry season have a less profitable strategy as it takes longer to sell all the firewood. The worst plan appears to be dealing per oxcart as it does not reflect the actual value of the firewood.

It is possible to analyze individual cases of current business practices, which can be used by the project to develop punctual and effective strategies to support farmers in reaching markets with the best benefits.

Case 1: Selling branches for tobacco barns construction

Gerald has 106 seven-year-old trees planted in hedges with 1-meter spacing. Last year, he sold four oxcarts with tree branches to tobacco producers for building barns during the rainy season (March-April). The customers cut the branches and brought their oxcart to transport them, but Gerald monitored the pruning of trees to ensure they did it correctly. As a result, each oxcart sold at 6,000 MK (6.0 USD) and gave him earnings of 24,000 MK (24 USD). However, Gerald said he afterward realized that by selling the branches as firewood in urban trading centers with a bicycle, he would have gained about three times what he earned with the oxcarts, besides having access to small branches for use in his household. Furthermore, since one and a half oxcarts are equivalent to four bicycles worth load, he would have sold around ten bikes, each at 7,000 MK (7.0 USD).

Even if the bicycle firewood load prices were lower (5,000 MK, 5.0 USD), Gerald could have at least doubled his income (53,333 MK = 52 USD).

Choosing one strategy over another comes with trade-offs, with market information being key to making a wise decision on which strategy to follow. In Gerald's case, the oxcart may have been sold at a higher price, as other farmers reported to sell it at 8,000MK (8 USD). Besides, shifting to sell the tree branches as firewood per bicycle would at least double his income but require more physical effort, extra cost for maintaining the bicycle, and might take longer to prepare and sell all the ten bikes, compared to the four oxcarts. Hypothetically, he could go to town three to four times per week, requiring at least two weeks to sell all firewood plus the time

needed to cut the branches into smaller pieces and dry them before selling (about one week with bark).

The time needed to transform (cut and dry) the tree into firewood, is a barrier for some actors, like the C&T, to shift from firewood collected in the natural forests to purchase firewood from planted trees.

Case 2: Collectors + Traders, sourcing from natural forests or planted trees?

Estimations found that if a man C&T shifts to purchasing firewood from planted trees instead of sourcing from natural forests, he would increase his income by 40% per trip (see Table 12). However, due to the time needed to cut and dry the trees, traders can only sell once per week, compared to the current average sales of firewood from natural forests done twice a week. Therefore, C&T would need to sell planted trees at least twice weekly to prefer sourcing from farmlands over natural forests. Additionally, road conditions are challenging to reach farms in TA Chadza during the rainy season, making it difficult to access trees planted by farmers.

On average, a bicycle load of firewood from natural forests is sold at retail for 4,900 MK (4.8 USD), assuming the load carries 300 pieces. On the other hand, a bicycle load of firewood purchased from tree producers has a higher price (≈7,000MK) for the same amount of pieces for them to get a profit, compared to the firewood from forest that is almost free of charge. This price difference may influence the customer's decision to prefer trees from the forest over planted species until the latter has a significant competitive advantage. Farmers may equal the price to 4,900 MK (4.8 USD) per bicycle load to remain competitive, but a C&T would not be able to do so.

Table 12. Collectors & Traders margin comparison using different firewood sources based on market prices in 2021.

C&T →	**Source: Natural Forest (average price)**	**Source: Planted Trees (sold in urban areas)**
Total costs per trip	2,332 MK (2.3 USD)	7,411 MK (7.2 USD)
Average sales revenue per trip	4,900 MK (4.8 USD)	11,000 MK (10.7 USD)
Net profit per trip	2,568 MK (2.5 USD)	3,589 MK (3.5 USD)
Net profit per week (two trips)	5,618 MK (5.5 USD)	7,177 MK (7 USD)

10. Legal framework

The Department of Forestry (DoF) is the lead governmental agency working under the Ministry of Forestry and Natural Resources responsible for ensuring sustainable development, conservation and utilization of forestry resources for socio-economic growth and development of Malawi.. Malawi has several legal instruments relevant to the firewood production and marketing, including the Forestry Act 2017, the Forestry Rules 2010 (amended) – under review, the National Forest Policy 2016, the National Forest Landscape Restoration Strategy, and the National Charcoal Strategy.

Undoubtedly, one of the biggest challenges of the forestry sector is the illicit trade enabled partly by corruption. Most actors involved in the firewood value chain trading indigenous species mentioned that paying at roadblocks is a common practice for transporting their firewood load to urban trading centers. Traders with bicycle loads reported getting their firewood confiscated, even if presenting a General Receipt; it is also reported that some drop a few pieces of firewood at the roadblock as a fee to get through. Others said authorities had beaten them or damaged their bicycles.

For smallholder farmers producing trees, transporting firewood to urban trading centers has implications, particularly for the current practices at roadblocks. Nevertheless, it is essential to highlight that the Forestry Act 2017 states in **article 37 *the right to plant forest produce***: *Any person who plants any tree species on any land which that person is entitled to use for that purpose shall acquire and retain the right to harvest the resulting produce and to dispose of it freely.* Therefore, rural tree producers such as those supported by Inter Aide, have the right to produce tree species such as *Senna spectabilis* or *Acacia polyacantha*, process the wood into marketable products like firewood and poles, and sell them in rural areas, trading centers, and cities.

However, there remains a lack of knowledge (and frequent abuse) of the Forestry laws by certain police officers alongside poor enforcement practices, as Forestry officers are outnumbered at roadblocks and so remain powerless compared to the police. If a tree producer has the right legally to market firewood produced on his or her farm, the traceability of those products is complex. The police and forestry officers on the roads cannot verify it, especially regarding indigenous species produced on the farmland, like *Acacia polyacantha* or *Khaya nyasica* species. Forest Act 2017, article ***83*** refers to the ***utilization of and trafficking in indigenous timber from private land:*** *(1) No indigenous wood shall be moved from any private land to any place outside the private land without a permit issued by the Director of Forestry. Any revenue realized from the removal of the indigenous wood from leasehold land shall all accrue to the village natural resources management committee in the area. (2) No indigenous endangered tree species shall be cut down without the written permission of the Director of Forestry. (3) Indigenous wood may be used on a sustainable basis for any purpose within the demised area without the written permission of the Director of Forestry.*

Farmers selling tree products locally in rural areas without documents encounter a more accessible pathway. It becomes more difficult if farmers want to transport and sell firewood or other products to urban trading centers, mainly when using motorized transport (especially cars) if their wood is from indigenous species and if traveling to urban trading centers, as they would need a document validating the species' origin to transit freely. This document may be issued by the chief VH and validated by the community's representative of the Department of Forestry. In TA Chadza, the forest assistant or the forest guards based in the Mitundu trading center would be issuing this.

Image 19. News portal of DoF website published on 24 May 2021, retrieved in July 2022.

11. Conclusion and recommendations

The reliance on firewood—and charcoal—for cooking and heating needs puts excessive pressure on the already shrinking forests. Rural areas are transforming into eroded soils, degraded land, and trees are becoming scarce in villages.

Much attention and effort has been made to tackle the illegal charcoal sector in Malawi, as it is the leading cause of deforestation and forest degradation. With significant gains in law enforcement and the emergence of a more robust legal framework, the groundwork has been laid to develop a legal market for sustainable produced woodfuel (firewood and charcoal). Rural areas in the Lilongwe District require more than one million tDM of firewood per year and about 40 tDM for other uses (mostly bricks and poles). However, since charcoal mainly covers the needs of the urban market, somehow, these rural areas have been, if not forgotten, at least not given sufficient attention despite being largely targeted with interventions related to cooking technologies. More effective and accessible ways to produce durable and quality bricks are also highly needed[10].

A holistic approach is required to release the pressure on Malawi's forests and facilitate opportunities for rural families to reach self-sufficiency in woodfuel, whilst other energy sources and alternatives become more readily available. Since efforts need to be made from all fronts, agroforestry offers a pathway to produce clean and sustainable firewood, benefiting the environment and actors involved in the chain, particularly smallholder farmers. **Experiences**

[10] Traditional brickmaking relies on mostly sizeable tree trunks that continuously burn for more than twenty hours, leading to the clear-cutting of indigenous species such as *Acacia polyacantha* (Mthethe) and fruit trees like Mango.

gained in previous firewood production projects found it hard to compete with the "free" wood sources from indigenous woodlands. However, the prices of indigenous trees are rising. If this situation is effectively linked to actions at policy levels, there could be a competitive advantage for firewood from planted trees over natural trees in a few years.

Aside from the urban market, **smallholder farmers venturing into agroforestry already have an active and available market for firewood at the village level, particularly during the rainy season,** since the village firewood demand is currently not fulfilled with the existing local resources.

One identified challenge for smallholder farmers is the need to diversify their opportunities to generate income from different tree products. Choosing market channels according to the demand and seasonality needs information and planning. Nevertheless, if the project or any other intervention aims to boost one strategy over the other, it is paramount to remember that **not all current channels benefit women and men equally.** Table 13 summarizes the seasonality of available firewood (Fw) markets that smallholder farmers could target.

Color code: no demand, low demand, high demand.

Table 13. Identified markets available and their seasonality in the study area.

Market	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fw–Village households												
Fw–Food businesses												
Local aggregators												
Fw–Urban households												
Tobacco producers (barns)												
Bricksmakers (logs)												
Construction (poles)												

Diversification of products during the dry season is particularly difficult for women, who rely on selling in village markets and depending on the local business demand. Thus, the access to cash is achieved only in small amounts and/or over a more extended period. On the contrary, men typically have more alternatives to access money faster by selling by bicycle in the Nanjiri market and urban trading centers.

Women's reduced mobility due to household responsibilities and the enormous physical effort required to transport firewood loads by bicycle limits their market strategies. Hence, women seek alternatives to reach local markets that give them significant benefits, such as selling to local businesses or nearby village markets. **New approaches that benefit women would enable further economic empowerment, particularly during the dry season.**

Even though indigenous species currently dominate the firewood market, other species, such as *Senna spectabilis* (Keshya), have market potential in spite their current low availability. The Senna spectabilis tree species has the advantage of producing versatile wood, growing fast, and processing into commercial firewood takes less time. Besides, its functionality and benefits as a firewood source are well-known in villages. Therefore, this differentiation could be used as an option to activate its demand and promote its use through marketing strategies, in the later stages of the project.

One component of the strategy to boost the firewood trade from planted trees should focus on the legal instruments that can backstop it and ensure its legality. For example, by-laws made by village forest management committees shall be recognized by the Minister. **Considering the legal aspects before producers enter the production phase is crucial to defining the strategy and requirements for trading. It is not the same to trade exotic species as it is to trade an indigenous tree planted on private land.** Hence, the project or any intervention must work hand-by-hand with chiefs and the government to ensure that smallholder farmers are protected under statutory and customary law.

Some men and women farmers struggle to determine a price of a tree or branches during interviews as they mostly set the price according to what they need, selling the trees at a cheaper price if necessary. **Farmers need reliable access to market information, including market prices of different tree products (firewood, poles, etc.).** With access to market information, farmer would not only be able to calculate more accurately the economic value of their trees and tree products but would also be better informed to increase their negotiation skills, which is particularly important for women who typically face more difficulties to negotiate better prices compared to men.

Developing solutions facilitating access to tools is essential for tree producers to accelerate the transformation process from live trees to firewood, allowing them to save time and gain more benefits through retail sales.

It is recommended also to **conduct further research on the technical recommendations (species and size of the poles required for market) and market strategies for producing poles for construction.**

Designing a management plan will be critical to defining the best strategies for farmers to sell their wood products. The next step is to work alongside farmers on a tree management model that can fit their interests, capacities, and needs. This management model must assess any labor constraints within family and farm responsibilities and be compatible with their agricultural calendar.

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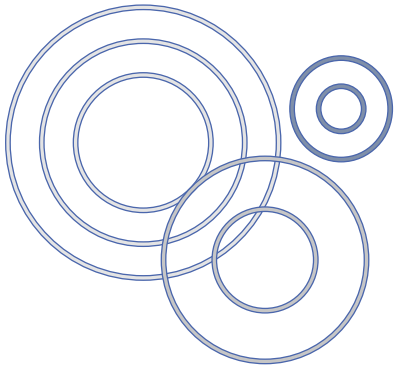

Annex I

Research methods and strategies

The research was undertaken from May 2021 to May 2022 with approximately 5-6 weeks of field work organized to gather data during both dry and rainy seasons.

Data collection included desktop review of published literature on the sector, project documents, and key informant interviews. Tailored semi-structured interviews were conducted with women and men involved in the firewood sector in Lilongwe District, including producers, traders, transporters, and consumers. Mussa Kamanula was hired as English ↔ Chichewa interpreter and received training on the interviewing material to ensure the collection of quality information and to minimize distortion during the translation. Observation and visual research were crucial to support the information gathered through the interviews and focus group discussions. Comparable data obtained from all interviews was cross-checked internally and with literature where available.

All information was recorded, organized, and analyzed systematically according to relevant categories identified before and during the study. Written notes and voice recordings were taken with the respondent's agreement during the interviews and group discussions. The interviews were reviewed within the first 24 hours to avoid missing any detail. Afterwards, each interview was transcript or indexed. The results present quotes of the actual words of the respondents to preserve the original discourses as much as possible.

Summary of techniques used and its practical application:

Techniques used	Practical application
Semi-structured interviews	70 individual semi-structured interviews with key informants
	1 group semi-structured interview with 5 women and 5 men
Focus group discussions	2 focus group discussions. One with 10 women and other with 10 men involved in agroforestry activities
Secondary data sources	National statistics and reports, project documents, unpublished reports, research papers, publications, websites, and news portals.

Estimations notes and assumptions

When interviewees did not specify, the calculations considered a household size of 4.4 members based on the Malawi 2018 census. Calculations considered 151 days for the rainy season (December to April) and 214 days for the dry season (May to November). Equivalences were used to calculate firewood volume and mass. In this report there are two equivalences considered depending on the commercial presentation of the firewood, namely bundle pieces and bicycle pieces.

Equivalences

1 tonne = 1 metric Ton = 1000 kg

1 bicycle load = 110kg = 300 pieces = 6 trees' branches (pollarded)

1 oxcart = 4.2 m^3 = 4 - 5 bicycle loads = 24 trees (pollarded)

Bundle equivalent	Bicycle equivalent
1 m^3 = 543.3 kg	**1m^3 = 201kg**

The discrepancy on equivalences is because of the gap left when stocking the firewood depending on the type of presentation sold. Firewood sold from natural forests, collected by traders and packed in bicycle have more irregular shape than the firewood sold per bundle which is cut in smaller pieces.

1 tree Senna spectabilis = 13.5 kg DM = 12 branches = 120 pieces of firewood

Note for vehicle classifications: a one-Ton truck has a capacity of at least 2000 pounds (907.185 kg), which is equivalent to a Ton, while 1000kg is a tonne (or metric Ton).

Complementarily information for governance structure in Section 2:

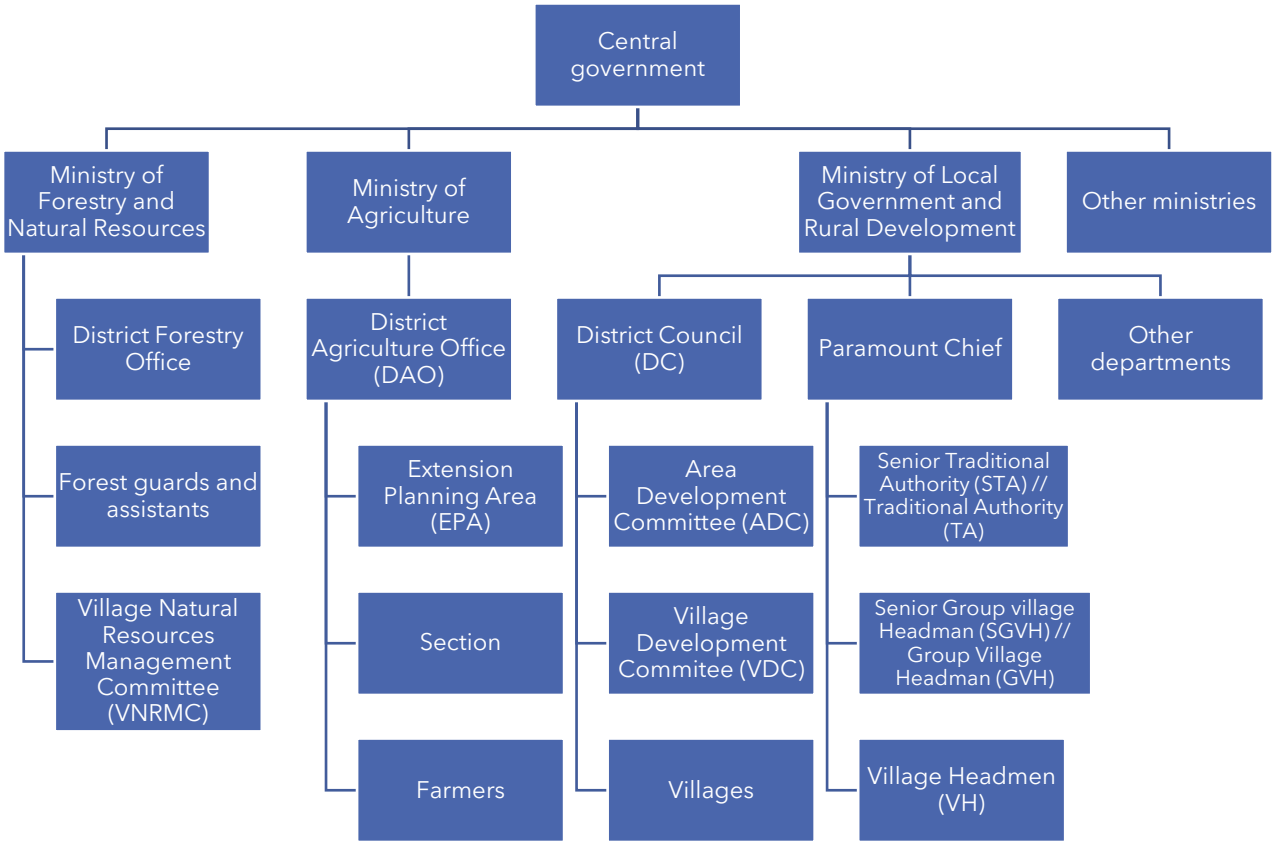

Figure 7. Graphic representation of the governance structure. Source: Author's elaboration.

Annex II

Detailed description of actors involved in the firewood value chain.

Village oxcart aggregators and traders

These aggregators operate at the local level. Their presence in rural areas demonstrates that there are existing business structures in place, albeit informal ones, to supply local firewood to people living within c. 5 km ratius. For example, one aggregator is based in TA Kalumba, providing services to Mkweche Village in TA Chadza; a second aggregator is also a tearoom, located in TA Chiseka and providing services in the area bordering TA Chadza. The aggregator identified based in TA Chadza is an elder farmer. Contrary to the other aggregators identified, he does not always use an oxcart to transport the wood, instead, he transports it by foot.

Business practices: Local aggregators invested capital gained through casual laborers (*ganyu)* to start their firewood business. **They source raw materials by buying full trees or branches from standing trees available in their village and/or surrounding area.** Villagers are also used to offering their trees directly to the aggregators when they need cash.

Aggregators' functions include cutting down the trees or branches, transporting the wood to their business place using an oxcart or bicycle, cutting it into smaller pieces, and drying the wood to be sold as firewood. It takes one or two days to cut down the trees or branches at the source location, load the oxcart, and bring the wood to their home to further cut in smaller pieces. Drying the wood pieces takes one week during the dry season and up to 2-3 weeks during the rainy season. Therefore, local aggregators need around two weeks from tree sourcing to the time the firewood is ready to be sold. The time for drying changes according to the tree species.

Trees are bought directly from their owners at prices ranging from 1,500 MK to 10,000 MK for a full tree depending on their size and regardless of the species. When buying only the branches, the price ranges between 800 MK and 3000 MK depending on the size of the branches. Even though the tree species does not directly change the price, it influences the buyer´s choice. Preferred tree species identified by the local aggregators are Albizia lebbeck (*Mtangatanga*), Acacia polyacantha (*Mthethe*) or Senna spectabilis (*Keshya*), and *Mangifera indica* (Mango).

Oxcarts are not owned by the aggregators, but rather hired, which is considered as an expensive service. The hiring cost of an oxcart ranges from 2,500 MK to 5,000 MK (2.5 – 5 USD) per travel. The cost depends on the distance and accessibility conditions, with an estimation of 1-hour travel for the furthest travel point and 30 minutes the shortest travel. Other expenses include hiring casual laborers for cutting down the trees and loading the oxcart. The rate ranges between 3,000 MK and 3,500 MK for small trees; and 5,000 MK for bigger trees. For work such as off-loading the oxcart or cutting down a tree into smaller pieces, an extra 1,000 MK is paid per day. If wood is transported by bicycle, hiring one costs for 1,200 MK (1.2USD).

These local aggregators offer their product in on the spot, either from their home or business, as is the case of the tearooms selling firewood. They sell a bundle of three pieces of firewood for 50 MK, and in the rainy season, a bundle of four pieces for 100 MK. The most important clients are the women villagers who buy firewood daily, and the tearooms and bakeries of scones of the surrounding area; albeit aggregators are not the only suppliers of the latter businesses.

According to the interviews, one aggregator supplies the village and surrounding area with one oxcart of firewood every week during the dry season, and with two oxcarts per month during the rainy season.

Wholesale aggregators and traders of indigenous trees

These aggregators are mostly men purchasing firewood from villages surrounding the Dzalanyama forest. The main characteristic of these actors is that they have access to a vehicle and can take larger quantities of firewood at once. These aggregators target a wholesale outlet like Mitundu or Chiunjiza. The individuals interviewed are relatively new in the firewood business. They started either in early 2021 or in 2020, motivated by friends and acquaintances who were already involved in the business. *"I am a driver, and I was hired by someone to transport firewood. At that time, I saw that you could get something out of the firewood business." Man, Firewood aggregator and trader, Mitundu trading center, 2021.*

Business practices: These aggregators source their wood from households near the forest and from those selling firewood collected from Dzalanyama. They have a good relationship with some firewood collectors who keep the product until aggregators are ready to collect. The trust is such that firewood collectors in Dzalanyama call aggregators when firewood is ready for collection or to advise them not to travel when soldiers are around the forest confiscating firewood.

The quantity of firewood aggregators buy depends on the vehicle's capacity. A truck of about four-Ton capacity is supposed to be filled with about 25 to 35 bicycle loads, (it was not possible to see the truck to verify the capacity). According to this aggregator, it can take up to one month to collect enough quantity of firewood to fill his truck of about two-three Ton capacity, even though we consider one week is a more accurate time frame. Aggregators can also buy three-piece bundles, for 30MK. Their focus for offering quality firewood is the dryness of the wood and the pieces without bark. *"If it is wet, is hardly sold" [Man-Firewood trader, Mitundu Trading Center]*

Aggregators bring the firewood to Mitundu TC to be sold on market days (Wednesday and Saturday). To ensure that, they arrive one day before to unload, and they overnight on the spot to keep an eye on the firewood. Aggregators´ costs include hiring the vehicle, purchasing the firewood, paying casual laborers for loading, the market fee of 5,000 MK - 6,000 MK to the city council, and fees incurred at roadblocks.

Challenges: These aggregators buy from anyone, whether enter the forest legally or illegally to collect firewood or cut trees. One challenge they face is the long time required to gather the

enough quantity of firewood to fill the truck. Due to the illicit origin of the wood, similar to their counterparts in bicycle and transporters, aggregators are also at risk of losing their assets, being involved in situations of extortion and authority abuse. *"...last time I encountered officers. The officers threated me with confiscating the firewood if I did not pay. I needed to pay 6,000 MK." [Man-Firewood Trader, Mitundu TC]*

Seasonality: From observations at the wholesale market, these aggregators are active year-round. The only difference is that during the rainy season they finish selling firewood earlier in the day than in the dry season due to the high demand.

Transporters

Men dominate the transport sector and own oxcarts or vehicles.

Oxcarts are hired per round trip and are not often going to Lilongwe city but from/to other trading centers, i.e., study area– Nathenje (3 hours travel one way, ≈18 km by road) or Chiunjiza-Mitundu (6 hours travel one way, ≈24 km by road); both with a cost of 10,000MK ≈ 10 USD per trip and an average net profit of about 5, 823MK (5.7 USD) per trip.

The oxcart service also operates at the village level, charging between 2,000MK – 2,500MK (2 - 2.5USD) for transport within the village and increasing the price according to the distance. For example, an oxcart in Kambuera village, TA Kalumbu, charges 3,000MK (3 USD) to go to Kakwera village and 5,000MK (5 USD) to Chikanga. In terms of time, less than 30 minutes of travel would cost between 800 – 1,000MK (≈1 USD) and about 3,000 MK – 4,000 MK (3 to 4 USD) for one hour. These transport services generate approximately 1696MK (1.66 USD) per trip.

The major challenge for oxcart transporters is maintaining the cart and the two cows. Transport costs are composed of paying a transfer certificate of 1200MK (1.2 USD) issued by the forestry department to allow them to transport the firewood, and the market fee of 200MK per day. Some oxcart transporters depend on the firewood traders to complete the sales, which required a high time investment, adding an additional trip, or overnight at the marketplace. One oxcart can fit from four to five full packed bicycles of firewood and has a capacity of 4.2 m^3.

Cars typically go to town and are one-way; these transporters offer their services per volume, using firewood "lines". A line refers to the firewood placed horizontally aligned with the direction of the truck and packed c.1 m heigh. Each "line" costs between 5,000 MK and 6,000 MK (5 - 6 USD), and fits between two to four bicycle firewood loads depending on the vehicle's capacity. One truck of two Ton capacity can fit up to six lines of firewood (equivalent to ≈6.6m^3), carrying a firwood market value between 75,000 MK to 90,000 MK (75 – 90 USD).

The clients, who are mostly women retailers, choose the transport service on the spot, and the vehicle leaves the market once it is completely loaded. The transporter may go to different trading centers from Monday to Saturday, coinciding with the market days. The transporters´

costs include car maintenance, fuel, the casual laborers to load the vehicle, and fees incurred at roadblocks.

Their biggest challenge are the risks taken by transporting illicit sourced firewood. Together with the traders, transporters are subjected to law enforcement actions, risking getting arrested, losing their car, and paying a fine of several million Malawi kwachas. *"The good side of planted trees as transporters is that we could be transporting the firewood without a problem." Man, Firewood transport service, 2022.* However, they spend about 4,000 MK – 12,000 MK (4 - 12 USD) to pass through three roadblocks on their way to town. *"I would prefer to be employed because we are spending a lot of money, and for me, the profit is little". Man-Firewood transport service owner, 2021.*

Traders in urban areas

Traders moving bigger volumes of wood target Lilongwe Town market, including the trading centers in Area 23, Ngwenya in Area 24, and Area 36, which were visited as part of this study. Out of the seven traders we interviewed at these markets in Lilongwe Town, two were doing the business for the first time. The rest of the traders had at least three years´ experience in the business.

Business practices: Most traders of this category legally source big logs and poles from different forests including Chikangawa (Viphya Plantations) in Mzimba district; the Chongoni side of Dzalanyama Forest in Dedza District; Kachawa Farms in Lilongwe District. However, indigenous wood extracted illegally is also sold in the same trading centers. This indigenous wood is brought from Dedza District, Mitundu Trading Center, Chiunjiza forest, as well as Mozambique and the bordering areas (assumed to be nearby Dzalanyama).

Most of these traders use a vehicle with a capacity of either 3, 5, 10 or 20 Ton to move the wood from the source to the trading centers. Depending on the capacity, the wood source, and the distance, the cost ranges from 100,000 MK to 950,000 MK per trip, including purchasing, loading, and transport. Traders with some years of experience and well-established businesses go between three to five times a month to purchase wood at the Viphya Plantations or to the Kachawa Farms (with a vehicle capacity of 10 or 20-Ton). However, by the end of this study, Kachawa Farms did not have trees anymore according to an informant who had consequently shifted to sourcing wood from Nkhotakota district.

Diverse tree species are marketed in the visited trading centers such as pine, *Acacia polyacantha* (Mthete), and *Eucalyptus* (Blugamu), among other tree species. Sales can be done per log with prices ranging from 500 MK to 5,000 MK or per bundle. Surprisingly, prices per bundle vary greatly from one seller to another. For example, in Ngwenya, we found two sellers selling 4-5 pieces of indigenous wood at 1,000 MK, another seller offering about 15 pieces of the same type of wood at 500 MK, and one more selling a bundle of 8-10 bigger pine pieces at 1,000 MK.

Some of the traders offer bundles of three smaller pieces for 100 MK to 200 MK. These offers targets those who cannot afford to invest much in firewood per day. These bundles are also sold by town resellers and local retailers such as grocery stores.

Challenges: Include thieves taking logs at night, the long distance needed to travel to purchase firewood, and when selling indigenous wood, the risk of having the product confiscated. New traders also fear having their product confiscated or being asked for money even though they hold a general receipt. Keeping a stock is another challenge, along with the access to capital or loan credit, which would enable them to supply firewood in rainy season. This access is limited as they do not have warranties available to put against the loan.

In the rainy season, another challenge is the accessibility of the roads. It was reported that trucks could stay stocked at the plantations for weeks before the road was in a condition to be used again. In TA Chadza, an informant told us about two large lorries passing along the road twice a week. They are of about 18-Ton capacity and pass even during evening hours. This situation shows that transit of firewood is not restricted to daylight and suggests that they are loaded with firewood from natural forests.

Retailers

Retail sales of firewood are dominated by women living in Lilongwe city, although his does not exclude men to participate. There are some retailers who target other markets and resell for example in the same Mitundu trading center. *"As a man you don't feel interested in doing this[business], you send your wife. It would be like finding a man cooking." Man-transporter, Wholesale outlet, 2022.*

Business practices: Retailers who go to a wholesale outlet such as Mitundu trading center buy firewood and hire transport services to bring the product to town. Women retailers purchase once or twice a week between 10,000 MK – 30,000 MK of firewood per trip. However, there are women who have the purchasing power to buy a full vehicle´s worth. This quantity needs one to three lines of firewood in the transporting vehicle respectively. The purchase price is set at three pieces for 50 MK. The resale price is usually three pieces for 100 MK, but it can vary depending on the size, and four or even five smaller wood pieces can be sold also at 100 MK or 200 MK.

Grocery stores located along the roads next to the trading centers are also considered retailers. These retailers offer the firewood purchased from bicycle firewood traders as it is also considered as a fast-moving product. Retailers can buy for about 10,000 MK. The price varies depending on the size and the sales area; four or even five smaller wood pieces can be sold also at 100 MK, and up to 200 MK in a location further from the trading center. The most important clients for the retailers are women that use firewood for household use and fried chips sellers who purchase firewood every day. Higher quantities of firewood are sold during the during dry season.

Challenges: Resellers have reported that earlier in the year, like in May/June they could sell the load within three days. During the rainy season, it could take one week because there are a lot of people selling firewood. However, a retailer expressed that in the rainy season, due to a scarcity of firewood, when he gets one bicycle load to sell in the morning, by midday all the product is already sold and sometimes he can even sell two loads.

The major challenge also involves authorities, particularly confiscation whilst transporting the firewood, or even at the market. When bicycle traders are the ones losing the product, then they must stop business and do casual labor (ganyu) to build up initial capital once more. Transport services can also be scarce at the wholesale outlet, sometimes requiring women retailers to stay overnight with their firewood until transport is available. Access to capital remains another limitation to improving their business, where interviewers suggested the need for a larger quantity, or larger logs for better market.

Consumers

According to the different actors, clients buying firewood include women and men in the same proportion. Identified and interviewed consumers of firewood within the study area are owners of tearooms, bakeries, and restaurants, fried meat and fried chips sellers, and brick makers.

The owners of these businesses purchase firewood every day, supplementing with small quantities of charcoal. They purchase firewood from people who sell within their area, either bicycle firewood traders or local aggregators. However, if the business needs a bigger quantity of firewood (tearooms and brick makers), and the owner has the means, they will several standing trees, which they cut and transport with oxcart to their business location, as the local aggregators do.

Fried meat and chips sellers buy between 10,500 MK and 21,000 MK of firewood per week. However, the restaurants and tearooms have different needs depending on their location, but they can buy 5,000 MK per week, one full bicycle load per day, or one oxcart per month.

Challenges: They mainly complain about the scarcity and the price increases during the rainy season. They find it difficult to source well-dried firewood, which constraints their business activities as they end up drying the firewood themselves. For those who buy standing trees, they expressed that there are no trees available in the area anymore, and so they buy leftovers from timber producers. There are high levels of trust among actors, as reflected in the fact that clients can pay hours or days after getting the product from bicycle traders. However, some gender issues were identified for this process as women may find more difficult to negotiate with male bicycle traders. For improving their firewood supply, consumers were proposing to have a warehouse with sufficient storage to keep firewood for the rainy season.