

From transition fuel to viable energy source: improving sustainability in the sub-Saharan charcoal sector

Henry Neufeldt, Kate Langford, Jessica Fuller, Miyuki Iiyama, Philip Dobie



**World
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LIMITED CIRCULATION

Correct citation: Neufeldt H, Langford K, Fuller J, Iiyama M, Dobie P. 2015. From transition fuel to viable energy source: improving sustainability in the sub-Saharan charcoal sector. ICRAF Working Paper No. 196. Nairobi, World Agroforestry Centre. DOI: <http://dx.doi.org/10.5716/WP15011.PDF>

Titles in the Working Paper Series aim to disseminate interim results on agroforestry research and practices and stimulate feedback from the scientific community. Other publication series from the World Agroforestry Centre include: Technical Manuals, Occasional Papers and the Trees for Change Series.

Published by the World Agroforestry Centre
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Nairobi, Kenya
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Working Paper No. 196

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Summary

Charcoal is a vital source of energy for millions of people around the globe and one of the most commercialized resources in sub-Saharan Africa, yet policies to effectively govern the sector are lacking in many countries. Authorities in countries around the world tend to view charcoal production and use as an environmental and health problem. However, if managed properly charcoal can provide a low-cost and locally available energy source that has the potential to become sustainable and contribute significantly to poverty alleviation.

This paper discusses the main obstacles to a sustainable charcoal value chain in sub-Saharan Africa and identifies key areas where interventions are required to improve sustainability while ensuring charcoal continues to provide livelihood benefits. It provides evidence of how a sustainable, transparent and properly regulated and governed charcoal sector could be part of the solution to energy access and economic challenges faced by many developing countries.

The paper has been prepared as background to the workshop on 'Sustainable Tree-derived Bioenergy in sub-Saharan Africa'¹. While it summarises the most up-to-date literature on the issue at this time, with a strong focus on sub-Saharan Africa, some of the recommendations may be equally applicable to other charcoal-dependent developing countries.

Key recommendations

- Improve sustainability in the charcoal sector, and reduce associated degradation, through development of and capacity building for community-based forest management options, growing and nurturing trees on farms and in landscapes, strengthening tenure and property rights and improved charcoal production technologies.
- Improve governance and financial management and reporting across the charcoal value chain to create a regulated, transparent and coordinated sector which formally contributes to national economies.
- Increase participation by disempowered stakeholders in the charcoal sector to encourage greater uptake of more efficient technologies and more sustainable management practices.
- Transform the negative image of charcoal, allow sub-national governments to earn charcoal revenues and tap into internationally recognized mechanisms to create incentives for investment in a sustainable charcoal sector.

Key words: Agroforestry, Bioenergy, Sustainable charcoal, Governance, Wood fuel, Sub-Saharan Africa, Forest degradation

¹ Workshop to develop an agenda for action on Sustainable Tree-derived Bioenergy in sub-Saharan Africa. 26-28 May 2015 in Nairobi

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List of abbreviations & acronyms

AFOLU	Agriculture, Forestry and other Land-use
CBFM	Community-based forest management
CCB	Climate, Community and Biodiversity
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CGIAR	Consultative Group for International Agricultural Research
CSO	Civil Society Organization
ESDA	Energy for Sustainable Development Africa
FAO	Food and Agricultural Organization of the United Nations
FMNR	Farmer-Managed Natural Regeneration
FSC	Forest Stewardship Council
GEF	Global Environment Facility
GHG	Greenhouse Gas
ICRAF	World Agroforestry Centre
IEA	International Energy Agency
IUCN	International Union for Conservation of Nature
KFS	Kenya Forest Service
LPG	Liquefied Petroleum Gas
NAMA	Nationally Appropriate Mitigation Actions
NGO	Non-governmental Organization
NRCO	National REDD+ Coordinating Office
PES	Payments for Ecosystem Services
REDD	Reducing Emissions from Deforestation and Forest Degradation
SE4ALL	Sustainable Energy for All
UNDP	United Nations Development Programme
UNEP	United National Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

US	United States
VCS	Verified Carbon Standard
WSP	Water and Sanitation Programme

Background

In Africa, it is estimated that wood fuel (including firewood and charcoal) constitutes nearly 90 per cent of wood consumed for energy purposes (UNEP 2014). In sub-Saharan Africa, biomass is used by more than 80 per cent of urban households as their main source of cooking energy (GEF 2013).

FAO (FAOSTAT, 2014) estimates official charcoal production for Africa to be 30.6 million tons in 2012 (Figure 1), worth between US\$9.2 billion and US\$24.5 billion annually (UNEP 2014). Fuelled by rapid population growth, urbanization and the increasing cost of alternative fuels, the demand for charcoal is expected to double in Africa by 2030 (Arnold et al. 2006). At the current level of kiln efficiency, the annual demand for charcoal translated into the amount of forest area required would rise from roughly 1.5 million hectares today to nearly 4.5 million hectares in 2050 (Iiyama et al. 2014a).

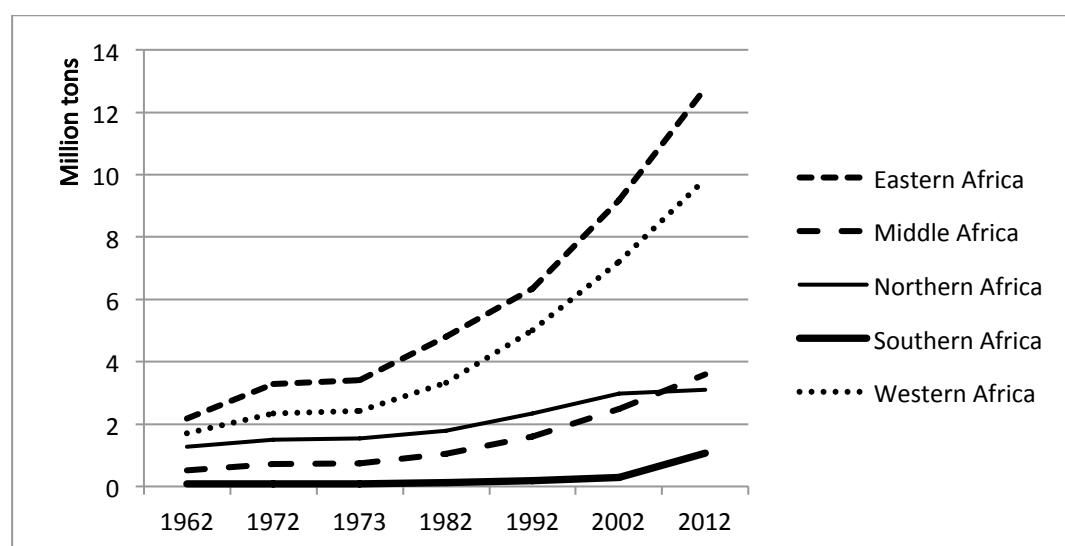


Figure 1: Charcoal production in Africa (FAOSTAT 2014)

There is a commonly held theory that charcoal serves as a 'transition' fuel, i.e. as households and countries grow economically, people's energy preferences transition up an energy ladder from 'inferior' biomass fuels through charcoal to modern alternatives such as LPG, kerosene and electricity. However, charcoal is not primarily used by low-income households; it is consumed across a wide range of income categories without a lot of variation in per capita consumption (Mwapamba 2007). In Ghana a survey of 8,686 households revealed that both charcoal and gas use increased with income, but a greater number of the richer households used charcoal rather than gas (Figure 2).

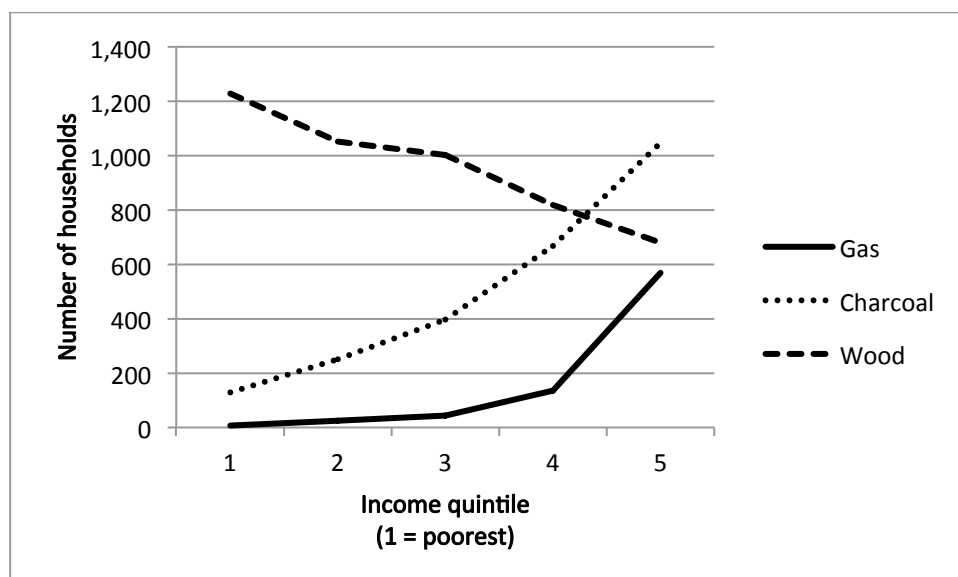


Figure 2: Relationship between household income and the number of households using wood, charcoal and liquefied petroleum gas in Ghana (Adapted from Adam FW et al. 2013)

The IEA (2010) estimates that the number of people in sub-Saharan Africa relying on traditional use of biomass may increase to 918 million by 2030. While at present, charcoal and firewood are used in almost equal proportions, charcoal demand is expected to grow at a higher rate (56 per cent by 2030) than fuel wood demand (GEF 2013). Therefore, the charcoal sector may provide the main source of livelihood in rural and urban areas for ca. 12 million people by 2030, up from the current figure of around 7 million (Mwampamba et al. 2013a).

ICRAF (2002) estimated that charcoal creates 200 to 350 job-days per Terajoule consumed, compared to 80-110 for electricity, 10-20 for LPG and 10 for kerosene. Thus, the charcoal sector has an important role in job creation, and with growing demand, opportunities in the sector are increasing. Large numbers of people are attracted to the commercial production and sale of charcoal as there is stable demand, ease of access to forest resources and low initial investment costs (Arnold et al. 2006). Charcoal provides alternative income generation in rural areas and employment opportunities through small retail businesses in urban areas (Zulu and Richardson 2013). The rural poor benefit through their role in charcoal production or as small transporters, wholesalers or contract labourers involved in loading, repairing or driving trucks (Minten et al. 2013). Farmers who make use of trees felled during land clearing enhance their social and economic security through charcoal production (Zulu and Richardson 2013), supplementing farm income and enabling them to purchase grains and other household commodities when food supplies run low during the off-season. The urban poor benefit from the charcoal sector through employment as charcoal transporters, retailers or producers/retailers of stoves (Minten et al. 2013).

At country level, charcoal has been estimated to contribute annually:²

- US\$650 million to Tanzania's economy; 5.8 times the combined value of coffee and tea production (World Bank 2010)
- US\$450 million in Kenya; comparable to the country's tea industry (ESDA 2005). However, a recent survey suggests that the sector is now worth US\$1.6 billion (KFS 2013)
- US\$77 million in Rwanda (van der Plas 2008).

² These figures do not account for losses from ecosystem services

Charcoal provides urban households with a convenient and reliable source of energy for cooking, heating and small-scale industrial activities at relatively stable prices (Zulu and Richardson 2013); ensuring energy security. It is also considered a 'cleaner' option than firewood as it produces less smoke (Iiyama et al. 2015). Charcoal is widely available in a form that people can readily use and is far more affordable and accessible than LPG, kerosene or electricity (Bailis et al. 2005; Brew-Hammond and Kemausour 2009). In addition, the quantity of charcoal purchased can be adjusted to a household's available cash.

Impacts of charcoal production and use

Unsustainable production and environmental degradation

In Africa, much of charcoal production is unsustainable (Zulu and Richardson 2013). Recently Bailis et al. (2015) assessed that between 27 and 34 per cent of African wood fuel was harvested unsustainably in 2009, while in hotspots in eastern and southern Africa most of the demand was unsustainable. Rapid urbanization and population growth in sub-Saharan Africa means business-as-usual in charcoal production will lead to serious land use changes, especially dryland forest/woodland degradation (Bailis et al. 2005; Iiyama et al. 2014a).

The biomass used in charcoal production in sub-Saharan Africa is sourced predominantly from unreserved natural forests or woodlands on village land or from farmland that is being cleared for agriculture, and may also follow forest clearing for agriculture (Hofsted et al. 2009), except a few outliers such as in Rwanda where most charcoal is derived from trees that have been planted on private tree plantations, on median less than 2 ha (World Bank 2012; Drigo et al. 2013). In Kenya, for example, drylands are reported to provide over 75 per cent of the hardwood used to make charcoal (Iiyama et al. 2014a). Harvested wood is generally converted to charcoal in rudimentary earth kilns with a conversion rate ranging from 8 to 20 per cent (Chidumayo and Gumbo 2014; Tabuti et al. 2003).

While the main driver of tropical deforestation is agricultural expansion (Kissinger et al. 2012; Chidumayo and Gumbo 2014), charcoal production can lead to severe deforestation at local scales and near production sites, and following conversion of land for agricultural purposes. Estimates of annual deforestation range from 5.4km² in Oceania to 29,760km² in Africa, which accounts for nearly 80 per cent of global charcoal-based deforestation (Chidumayo and Gumbo 2013).

Through selective logging, charcoal production more commonly contributes to forest degradation than clear cutting. In addition to biomass-related carbon loss, localized deforestation due to extraction for charcoal around major cities in sub-Saharan Africa has caused associated environmental degradation and reduction of ecosystem services resulting in lower agricultural productivity (Zulu and Richardson 2013).

At national or regional scales, charcoal production mainly contributes to forest degradation rather than deforestation (Chidumayo and Gumbo 2013; Mwampamba et al. 2013a). Degraded forests frequently maintain a closed canopy which makes degradation more difficult to track or to evaluate the damage done to the environment than deforestation. Selective logging of species which are best suited to charcoal production, primarily slow-growing hardwood species (Naughton-Treves et al. 2007; Iiyama et al. 2015), may induce fundamental changes in the composition and physiognomy of forests and woodlands (Okello et al. 2001). Forest degradation attributed to charcoal production also has an impact on forest goods such as fruits, bush meat and medicines, and on forest services, including erosion control, water quality, carbon sequestration and biodiversity. Arnold and Persson (2003) suggest that shifting of charcoal production into drier areas, combined with extensive degradation, is leading to a downgrading of woodland to bush and bush to scrub over very large areas. The environmental costs of degradation for charcoal production are difficult to quantify and

are not reflected in the product price (Luoga et al. 2000). This contributes to resource depletion and threatens sustainability (Chidumayo and Gumbo 2013; Iiyama et al. 2015).

The production and burning of charcoal releases large amounts of greenhouse gases into the atmosphere, mainly carbon dioxide and methane (Kammen and Lew 2005). Globally, Africa is the largest emitter of greenhouse gases from charcoal production, accounting for nearly two-thirds of emissions (Chidumayo and Gumbo 2013).

Illegal trade and deforestation

International demand for charcoal is fueled mainly by the Gulf States, and in Somalia alone generates an estimated US\$360 million to US\$384 million of income per year (Brown 2014). Charcoal from Somalia is exported to Yemen, Saudi Arabia, Kuwait, Egypt and the United Arab Emirates via *dhow*s and small freighters. Militant groups typically control borders and export points along the supply chain for locally produced charcoal, and considerable illegal profit is made from unregulated taxes.

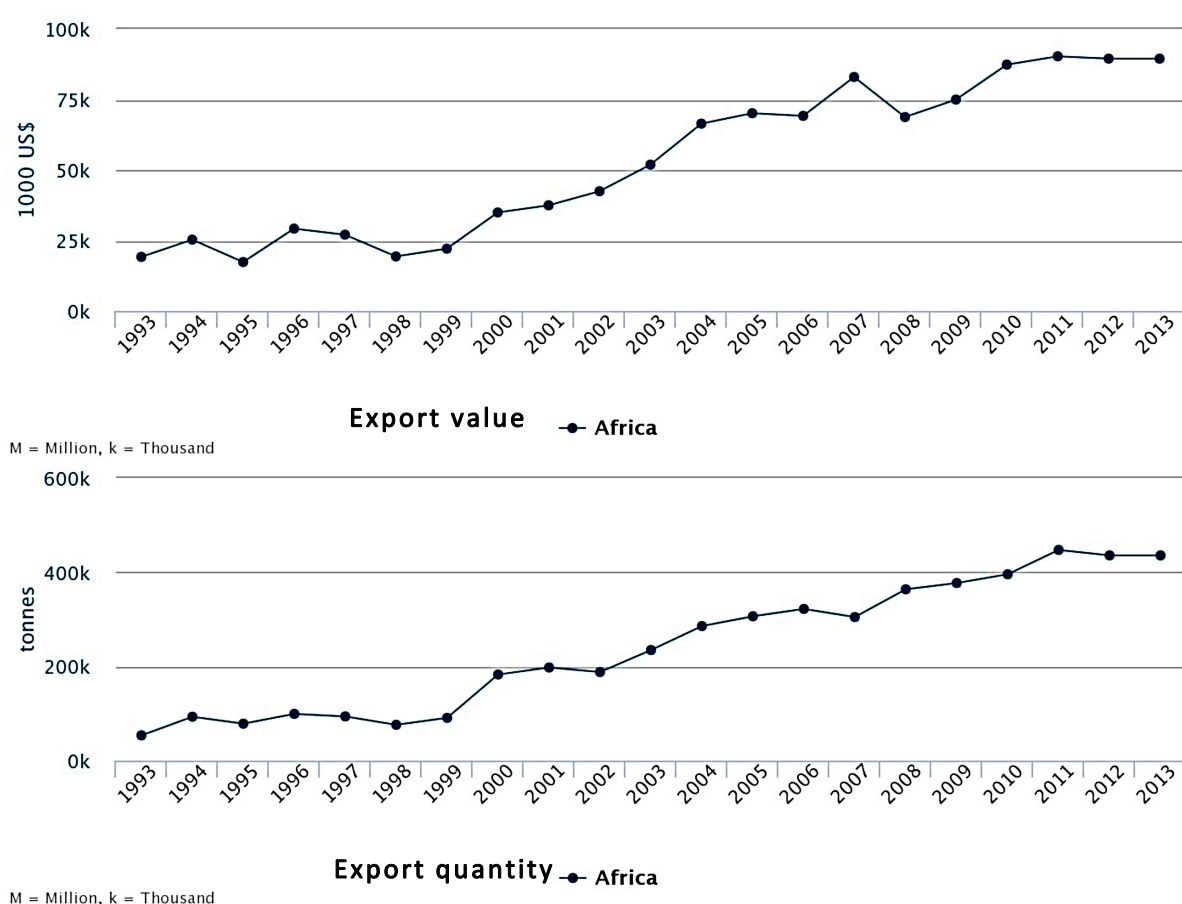


Figure 3: Export value and quantity of wood charcoal in Africa from 1993-2013
(FAOSTAT 2014)

WSP (2001) estimated the charcoal output of north-east Somalia in 1996 at 120,000 to 144,000 tons, 80 per cent of which was exported. Producing this volume required cutting about 2.1 million *Acacia nilotica* trees (favored for charcoal production and export to the Gulf States because of its slow burn rate and scented wood). At an average density of 60 trees per hectare, this translates into a deforestation rate of 35,000 hectares of land per year. Reports indicate that the export demand for charcoal has surpassed supply and the harvest of trees has spread into neighbouring countries such as Ethiopia (IUCN 1997).

With export quantity and value of charcoal increasing steadily since 1993 (Figure 3), there is good reason to believe that the charcoal sector will continue to fund international terrorism.

Social impacts

The nature of the charcoal sector leaves many in the value chain voiceless. Charcoal producers are the most disempowered stakeholders in the sector (World Bank 2010; Schure et al. 2013; Iiyama et al. 2015). They have little negotiating power, are regularly exploited by intermediaries in order to keep prices low and receive very little of the value of the final sale price of charcoal. Charcoal producers in Malawi capture just 20 per cent of the final value of the product and 21 per cent in Mali. Landowners (where the land is formally owned) often receive trivial amounts from the unregulated (or informally regulated) trade in charcoal amounting to 0-3 per cent in Kenya (Mwampamba et al. 2013a).

Women are especially marginalized in the charcoal sector due to unequal gender relations surrounding charcoal production (Zulu and Richardson 2013). Male labour is often diverted away from agriculture to charcoal production, which overburdens women with food growing in an attempt to make up for the labour gap, thus undermining agricultural productivity (Zulu and Richardson 2013).

Health impacts

Charcoal is preferred by many consumers, especially those in urban areas, due to its higher energy density per unit weight, cheaper transport costs and relative cleanness (Iiyama 2014a). Charcoal produces less smoke than firewood, thus causing fewer deaths from respiratory diseases (Bailis et al. 2015). However, traditional charcoal stoves still pose a health threat as they emit larger amounts of carbon monoxide (Maes and Verbist 2012). Overnight carbon monoxide poisoning due to charcoal burning causes thousands of deaths worldwide annually (UNDP 2000).

Obstacles to sustainability in the charcoal sector

Poor governance

In many charcoal-dependent developing countries, comprehensive policies, strategies or legal frameworks governing charcoal are non-existent. Where they do exist, they are often unclear, conflicting, unrealistic and ineffective (Owen et al. 2013; Schure et al. 2013; Iiyama et al. 2015).

Biomass energy is often governed by different sectors, ministries and agencies across forestry, energy and environment portfolios at national and sub-national levels, leading to conflicting responsibilities, overlaps and complex governance structures (Owen et al. 2013; Sander et al. 2013). For example, in Tanzania, four ministries share responsibility for charcoal, each of which has issued legal policy documents relating to the charcoal sector over the years (World Bank 2010). Poor governance combined with regulatory overlaps and gaps are reasons why initiatives to make the sector more environmentally and economically sustainable have to-date been ineffective (Sander et al. 2013).

Weak governance frameworks result in the uncontrolled use of resources, limited regulation and enforcement, price distortions and corruption (Owen et al. 2013; World Bank 2010) as demonstrated by the failed 2006 ban on charcoal in Tanzania; see case study: *Tanzania's Charcoal Ban*. Corruption, combined with unclear policy and legal frameworks, is seen as a major cause of unregulated or even illegal charcoal businesses in many parts of the tropical world (Chidumayo and Gumbo 2013).

Case study: Tanzania's charcoal ban

Amid fears that rapid deforestation in Tanzania was leading to declining hydroelectric capacity and causing a severe energy crisis in 2005-2006, the Minister for Natural Resources and Tourism placed a total ban on charcoal in January 2006.

Most urban households in Tanzania had no alternative fuel. Cheaper firewood was not available and they could not afford or access kerosene, LPG or electricity to satisfy all their energy needs. Not surprisingly, there was a large public outcry over the ban, and the production, trade and consumption of charcoal continued, though illegally.

Transactions had to be done in secret, such as through back routes or at night. Corruption and collusion increased, such as the paying off of law enforcement staff at checkpoints. The high cost of doing business (resulting from the risk of being caught and the confiscation of illegally produced and traded charcoal) was passed on to consumers. Charcoal prices almost doubled during the ban (from around US\$11 per bag before the ban to US\$20 during the ban). The ban was lifted after only two weeks but charcoal prices generally remained higher (US\$14 after the ban), highlighting how little enforcement power lies within government control in relation to the charcoal sector.

(Sources: World Bank 2010; Sander et al. 2013)

Corruption

Informal rules and market-led arrangements prevail in the charcoal sector (Schure et al. 2013). Even when a system of permits for charcoal extraction or transport is in place, few charcoal producers and traders obtain the necessary licenses or they evade paying the required fees. Instead, many opt to pay bribes when challenged at government checkpoints or by traffic police (World Bank 2010), evidenced by limited prosecutions or confiscations of illegal charcoal (Iiyama et al. 2014b). In Central Africa, Schure et al. (2013) found producers were not confident that permits would bring benefits in terms of less 'unofficial tax levying'. Studies indicate that 'private taxes' (bribes) account for 12 per cent of the final price paid by consumers for charcoal in Malawi and 20 to 30 per cent in Kenya (Mwampamba et al. 2013a; Bailis 2005).

In a study that compared 'rents' in the regulated charcoal sector with the unregulated agriculture sector in Madagascar, Minten et al. (2013) found that gross margins in charcoal trade are more than twice as large as in agricultural trade, and that traders in the charcoal sector with more government connections have greater access to rents from charcoal regulation. Central government stakeholders in Tanzania are often perceived to be informal 'shareholders' in the charcoal sector with an interest in the profits of dealers, vehicle transporters or wholesalers (Sander et al. 2013).

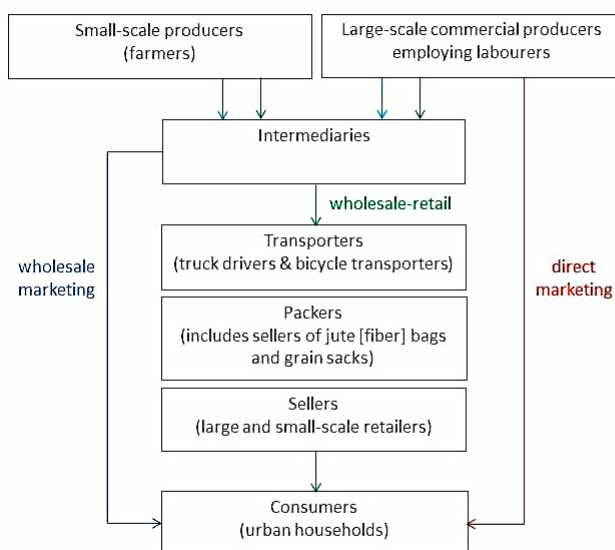
Case study: Illegal payments during charcoal transportation from Namanga to Nairobi, Kenya

The Lead Field Researcher was allowed to accompany one of the transporters ferrying 350 bags of charcoal, using a truck, from Bisil (Namanga) to Ngara (Nairobi) on 19 June 2013 – a 150-km journey. The driver was issued with a charcoal movement permit by the Kajiado Ecosystem County Coordinator after paying the requisite fee of Kshs 20 per bag. He also had all the necessary paper work including police inspection certificate, insurance etc. However, the truck was stopped 16 times and ended up paying Kshs 23,400 (ca. US\$260) in total, or on average Kshs 2,000 (US\$22) per police/traffic officer.

(Source: KFS 2013)

Traders control the market

The dealer-transport-wholesaler networks are *de facto* controllers of the charcoal sector (World Bank 2010) and are powerful and politically connected (Zulu and Richardson 2013). Dealers, in collaboration with transporters and wholesalers, dominate all other stakeholders in the charcoal sector, including the government. They finance the sector, are privy to all relevant information and connect non-government actors with central, district and village level authorities (Sander et al. 2013). As such, they have a strong interest in maintaining the current status of a largely informal system where continued high demand for charcoal by urban consumers guarantees high profit margins and the functioning of the sector (Sander et al. 2013). Figure 4 provides a representation of the charcoal value chain in sub-Saharan Africa.



Derived from: Zulu and Richardson 2013; World Bank 2010

Figure 4: Representation of the charcoal value chain

Lack of fiscal empowerment

The World Bank (2010) estimates that in Tanzania, around 80 per cent of the charcoal trade takes place outside the formal market and only 20 per cent of all payable taxes and fees on charcoal-related activities are collected and paid. A similar scenario of informal operation exists for the charcoal sector in most other sub-Saharan countries.

Revenues, fees and fines that do get collected are generally directed to central governments. District and village level authorities, who are primarily responsible for licensing and regulating charcoal production and trade, receive little incentive for doing so, which may explain the under-collection and under-reporting of charcoal revenues (World Bank 2010) and the lack of reinvestment in sustainability initiatives.

Low capacity for policy implementation and enforcement

The informal nature of the charcoal sector means that it only contributes marginally to national economies, often through the forestry sector. As a result, forest governance receives little attention and insufficient budget, which leads to sub-national forestry offices that do not have the human, technical and enforcement capacities required to monitor areas under their mandate (Chidumayo and Gumbo 2013; World Bank 2010).

The low capacity for policy implementation and enforcement by government exacerbates the uncertainty that exists among stakeholders about which regulations apply to charcoal production, trade, or utilization (World Bank 2010).

Lack of legal empowerment

Government officials and non-government stakeholders at the village or district level often lack knowledge or awareness about land use rights and ownership of forest resources, i.e. whether a state or communal forest is protected or can be harvested, such as for charcoal production (World Bank 2010).

The result is that a large share of wood for charcoal comes from unreserved forest areas on village land or from farmland being cleared for agriculture (Iiyama et al. 2015). Harvesting is therefore often unsustainable and environmentally damaging (Sander et al. 2013). Few communities proactively engage in managing the forest areas that surround them for sustainable harvesting or longer-term forest management objectives such as afforestation and reforestation activities (World Bank 2010).

Key areas for intervention and improvement to improve sustainability

In the short to medium term, charcoal cannot easily be replaced with affordable alternative energy sources. It will likely rise in importance as a fuel source in sub-Saharan Africa, providing basic energy needs to millions of people, especially urban households (Brew-Hammond and Kemausuor 2009). This section outlines key areas where intervention and reform is needed across the charcoal value chain and in policy frameworks to help sub-Saharan Africa meet its growing demand for charcoal while supporting livelihoods and poverty reduction, and ensuring environmental sustainability.

Charcoal production and management

Improve sustainability in production

To achieve greater sustainability in charcoal production, countries would need to develop and implement clear guidelines on the sustainable harvesting of trees and the sustainable production of charcoal (World Bank 2010).

Most charcoal producers use inefficient traditional earth kilns with an efficiency of only 9 to 15 per cent; 85 to 91 per cent of the biomass energy is lost in the process (Iiyama et al. 2014b). While there have been many technological advances that increase the efficiency of wood conversion to charcoal, considerable investment in capacity building and training is clearly needed to transfer this knowledge. It also requires incentives to invest in more efficient but less mobile kilns as long as the unregulated production of charcoal with earth kilns promise such high profits.

Improve forest management

Charcoal production from co-managed public or protected forests is a promising policy option for improving sustainability in the sector and providing livelihood benefits (Zulu 2010). Management arrangements could involve developing management plans/charcoal harvesting plans for forest areas administered by central or local governments. It could also involve identifying forest blocs on village land that are of sufficient size and condition to support extensive charcoal production under community management (World Bank 2010). In Sudan, the organization of communities into charcoal associations has enhanced orderly charcoal production and trading, as well as producers' bargaining power with wood purchased from government plantations (Mugo and Ong 2006); see case study: *Sudan's Charcoal Sector*.

Case study: Sudan's charcoal sector

In Sudan, where 71 per cent of energy comes from wood fuel, the government has recognized the importance of charcoal and formalized the sector, putting in place clear planning, marketing and regulatory measures.

Both natural forests (68 per cent of the total forested area) and plantation forests (32 per cent) in Sudan are regulated by the Forest National Corporation.

For natural forests, the corporation oversees management plans that lease forest land to farmers for the first 5 years, after which it is left to regenerate for 14 to 20 years. At the beginning of each lease, charcoal producers are contracted to clear the land for crop production and they use the wood to make charcoal.

For plantation forests, the department sets aside land and funds so that 100,000 hectares of trees can be planted and managed each year with specific species planted for charcoal. Designated charcoal producers (primarily large-scale contractors, with a few individuals) purchase trees by tender. The charcoal they produce is sold to merchants who transport it to wholesalers in urban centres for distribution to retailers and users. The royalties and taxes received by the government are reinvested in establishing and maintaining plantations. The Sudan Charcoal Producers Association provides a platform for producers, transporters and traders to negotiate with government.

(Source: Mugo and Ong 2006)

Community-based forest management (CBFM) has been adopted in most sub-Saharan countries since the 1990s and has the potential to enhance charcoal-based poverty reduction by being more locally relevant, pro-poor and equitable (Zulu and Richardson 2013). CBFM requires communities to enter into a formal agreement with key stakeholders, under which they are obliged to manage forests or woodlands sustainably; restricting outside access and ensuring forest health and rapid post-harvest natural regeneration, as well as making use of improved kiln technologies (Chidumayo and Gumbo 2013).

Any such arrangements would require secure long-term tenure and appropriate property rights. Management plans would need to meet management capacities of local institutions and people (World Bank 2010) and ongoing monitoring would be required to ensure compliance.

Promote tree growing outside forests

Trees grown outside forests, such as in agroforestry systems, woodlots and small-scale plantations, have the potential to provide a more sustainable alternative to wood fuel harvesting from natural forests and woodlands. However, incentives and technical support are required to encourage their establishment and maintenance.

In Malawi, up to 40 per cent of wood fuel is sourced from trees grown in agroforestry systems (Openshaw 1997). Iiyama et al. (2014a) state that agroforestry, if widely adopted together with improved kilns and stoves, can significantly reduce wood harvest pressures in forests by sustainably supplying trees from farms.

Agroforestry can also provide other products and services that benefit smallholder farmers. However, multi-purpose agroforestry systems need to be promoted in a systematic way that takes into consideration local environmental conditions and the needs of local farmers, rather than purely focusing on providing wood fuel (Iiyama et al. 2014a). It is also important to match the right tree species for the purpose. For example, improved charcoal kilns may require trees to be of a particular diameter (Iiyama et al. 2014a).

Rotational woodlots using fast-growing and nitrogen-fixing tree species have been shown to provide quality biomass for charcoal and fodder for livestock without reducing farmers' food crop yields (Nyadzi et al. 2003).

Producers who engage in agroforestry or establish woodlots or small plantations for charcoal production need to be linked to markets and technology (World Bank 2010) with improved kiln technologies developed to fully utilize the biomass grown in these systems (Iiyama et al. 2014a).

Prioritize supply over demand interventions

To date, the majority of efforts in addressing the charcoal 'problem' have focused on user-end interventions such as improved cook stove programmes and fuel switching to 'modern' and 'cleaner' fuels. For example, Mwampamba et al. (2013b) found that the availability of charcoal briquettes only displaced small volumes of charcoal demand, increasing energy options for limited consumer groups within niche markets, suggesting that these interventions are unlikely to have a significant impact on improving the overall wood fuel situation. Therefore end user interventions need to be carefully monitored to determine if they are targeting the appropriate consumers, such as those who can afford to adopt new technologies in the long run (Mwampamba et al. 2013a).

Production-end interventions, such as improved forest management, assisted regeneration and short rotation plantations, as well as agroforestry and woodlots are likely to achieve better results in addressing impacts related to the high demand for charcoal and therefore should be given priority (Mwampamba et al. 2013a, Iiyama et al. 2014a). Mwampamba (2007) found that small changes to production-end practices could have large positive impacts on feedstock availability in the long-term, whereas altering the number of charcoal users and per capita consumption rates had the least impact on forest availability.

In the past, however, efforts to address the wood fuel supply tended to have limited success, as focusing singularly on wood fuel provision while failing to address farmers' more complex livelihood needs in the context of local farming systems. Along with ensuring an enabling policy environment, systematic options need to be explored to encourage farmers to increase their supply of wood for charcoal as a co- or bi-product of their strategies for incorporating and managing on-farm trees and shrubs for purposes such as fodder, timbers, soil fertility, through not only woodlots but also other innovative approaches such as farmer-managed natural regeneration (FMNR) (Iiyama et al. 2015).

International-level policy

Change the image of charcoal

Charcoal is more often seen as a problem (i.e. unsustainable production and insufficient forest to meet demand) rather than being part of a solution to addressing energy-related and economic challenges facing developing countries.

Despite its almost universal dominance in supplying energy to sub-Saharan Africa, wood-based energy is typically overlooked in national energy strategies (Owen et al. 2013) which tend to focus on access by the poor to 'modern' energy sources such as kerosene, LPG and electricity (Brew-Hammond and Kemausuor 2009). Biomass is generally portrayed as traditional, unsustainable and primarily a subsistence fuel, and therefore excluded from consideration alongside renewable energy sources.

The image of charcoal needs to be changed and promoted in light of reality, recognizing that:

- Charcoal can be a modern, renewable fuel that contributes to low-carbon development (Mwampamba et al. 2013a)

- Domestically-sourced biomass can help diversify domestic energy supply, leading to increased energy security and independence from imports (Owen et al. 2013)
- While charcoal production is linked to deforestation and forest degradation, tropical forests have high potential for natural regeneration, and in many cases areas regenerate and can produce subsequent cycles of charcoal (Chidumayo and Gumbo 2013)
- Modernization is required in the way biomass fuels are produced, processed, distributed and consumed (Owen et al. 2013)
- Charcoal can be burned cleanly and safely if properly prepared and used in efficient appliances (Global Alliance for Clean Cookstoves 2014).

Owen et al. (2013) suggest the most promising way to change the image of charcoal is through linking it to high-level or internationally-recognized processes such as REDD+, NAMAs, CDM and emissions trading, while focusing on poverty alleviation and food security. In addition, international policy initiatives such as the United Nations Sustainable Energy for All (SE4ALL) initiative need to pay attention to biomass energy in general and charcoal in particular.

International mechanisms that could support sustainable charcoal production

The REDD+ (Reducing Emissions from Deforestation and Forest Degradation) climate change mitigation framework could potentially provide incentives for sustainable charcoal production through the rehabilitation and sustainable management of degraded forests and woodlands. Owen et al. (2013) suggest structurally disadvantaged regions that lack alternative options for employment and commerce could be a focus for pilot REDD projects.

Payments for Ecosystem Services (PES) schemes may also be an option for creating incentives to sustainably manage forests, recognizing the contribution that improved charcoal harvesting practices can make to soil, water and biodiversity. There is also potential for the afforestation of denuded, degraded and marginal lands to be eligible for credits in voluntary carbon markets (Owen et al. 2013).

Through the Clean Development Mechanism (CDM) industrialized countries that have signed up to the Kyoto Protocol can implement emission-reduction projects in developing countries from which they earn saleable certified emission reduction (CER) credits. In relation to charcoal, an example might be a project that introduces new and efficient charcoal production technologies such as high efficiency kilns from certified plantation forests. This would represent a reduction in emissions compared to traditional earth kilns that rely on non-renewable biomass.

Nationally Appropriate Mitigation Actions (NAMAs) under the United Nations Framework Convention on Climate Change (UNFCCC) comprise policies and actions that individual countries commit to undertake in order to reduce greenhouse gas emissions. With financial and/or technical assistance from developed nations, developing countries may incorporate into their NAMAs measures to reduce emissions through improved charcoal production and use.

Studies by UNDP into the opportunities for using NAMAs to implement sustainable charcoal value chains in Côte d'Ivoire (UNDP 2014a) and Ghana and (UNDP 2014b) propose formalization of the sector and establishment of a cross-sectoral charcoal unit in each country to coordinate interventions across various elements in the value chain, such as measures to establish relationships among the many stakeholders and improved communication, particularly at a policy-making level.

A phased approach toward a sustainable charcoal value chain is recommended in both countries. In Côte d'Ivoire, the first phase focuses on establishing the charcoal unit which will begin coordinating government entities and play a vital role in engaging the private sector and civil society organizations (CSOs). The unit is expected to build capacity among the private sector and CSOs in topics such as improved forest management, use of efficient kilns, how to set up cooperatives, and the sale of

improved cook stoves. It will also help organizations develop business plans for sustainable charcoal operations and set up a grant programme to provide NAMA funds to the private sector and CSOs.

For Ghana, the first phase would involve establishing charcoal producer associations and the signing of formal agreements between these associations and the government that outline the benefits and responsibilities for engaging in legal production. New technologies such as briquettes would be investigated, and effective licensing systems and eco-labelling for cook stoves established.

Projects addressing improved charcoal production and management could be implemented through the VCS or many of the other actors on the voluntary carbon market (e.g. Gold Standard, Plan Vivo, etc.). The Verified Carbon Standard (VCS) is the global market leader for voluntary carbon offset programmes in the forestry sector. Since 2008, VCS has included guidelines on Agriculture, Forestry and Other Land-use (AFOLU) projects (Peters-Stanley et al. 2013). There are already baseline standards in place that support the assessment of GHG emissions from forest degradation and leakage due to charcoal production. However, there is currently no methodology available that looks at the emissions generated within the entire charcoal value chain, from production to end user (VCS 2015).

The Climate, Community and Biodiversity (CCB) standards recognize land management projects that deliver net positive benefits for local communities and biodiversity in the context of voluntary mitigation projects. CCB standards can be applied to any land management project, including those that reduce greenhouse gas emissions and projects that remove carbon dioxide by sequestering carbon (e.g., reforestation, afforestation, re-vegetation, forest restoration, agroforestry and sustainable agriculture).

The main use of CCB standards at the moment is in combination with VCS. Around 80 per cent of sales achieved through the VCS in 2012 were from projects that sought dual certification to VCS and CCB standards (Peters-Stanley et al. 2013). VCS and the CCB standards have introduced a joint approval process for dual certification which is designed to lower audit costs for projects seeking credit for both emissions reductions and co-benefits.

Controlling illegal trade

Significant measures need to be taken to restrict the rapidly growing illegal trade in charcoal driven by rising international demand for charcoal as an inexpensive fuel, especially in the Gulf States. The environmental impacts of wood harvesting for charcoal production, such as forest degradation and deforestation, are exacerbated by this growing demand, and social inequalities become more apparent as powerful militant groups control a majority of the charcoal supply chain and trade. This trade involves extensive tax evasion and fraud, and supply of fuel from the informal sector (Nellemann et al. 2014).

Decision-makers need to weigh the value of international charcoal export against the local environmental and socio-economic impacts. Nellemann et al. (2014) suggests measures such as greater research and strengthened environmental legislation, compliance and awareness, and support to enforcement agencies in order to reduce the role of such trade in financing non-state armed groups and terrorism.

National-level policy

Reform national charcoal policies and laws

At the country level, legalizing charcoal use and clarifying the regulations that govern the sector in one coherent framework would facilitate all subsequent reform steps toward making the charcoal sector more environmentally, economically and socially sustainable (World Bank 2010); see Figure 5.

Such a framework would serve to coordinate policies across all relevant government ministries (Zulu and Richardson 2013) and create a regulated industry that ensures the sustainable production, distribution and trading of charcoal (Zulu and Richardson 2013; Sander et al. 2013). It would help to enhance net positive poverty-alleviation outcomes for a larger number of participants in the charcoal value chain, especially the poor, and minimize the arbitrary use of bureaucratic power, incentives for corruption and mistreatment of charcoal producers and traders (Zulu and Richardson 2013).

New charcoal laws and policies need to promote sustainability across the value chain (World Bank 2010), ensure social equity (Owen et al. 2013), be business-oriented and pro-poor. Importantly, regulations must be effectively communicated to all relevant stakeholders in the sector. In particular, producers and rural communities need to know their roles, rights and obligations (World Bank 2010).

A coherent policy and legal framework would provide an opportunity for the charcoal sector to be integrated formally into a country's economy, contributing revenue and increasing GDP through licensing and taxes (World Bank 2010; Sander et al. 2013). At national level, charcoal revenues could strengthen interest in a sustainable charcoal sector through sustainable forest management and promoting more efficient use of charcoal (Sander et al. 2013). Allowing some of the revenue from charcoal to be retained at the sub-national level should enhance the participation of village and district governments in the charcoal sector and promote sustainable production (Sander et al. 2013).

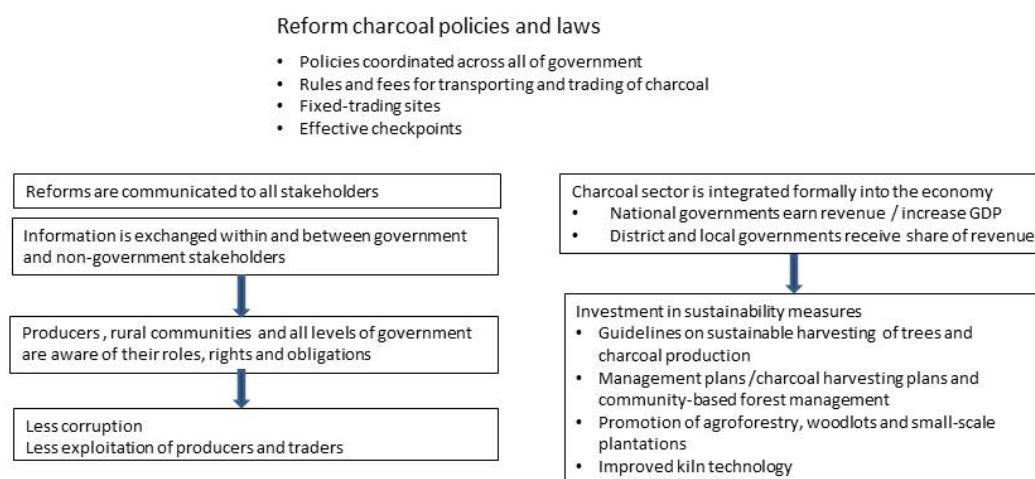


Figure 5: How a coherent policy and legal framework can facilitate reform in the charcoal sector leading to improved sustainability. (Derived from: World Bank 2010).

Introduce transport and trading regulations

Legal rules on the transporting of charcoal need to be developed that include transport-based fees. Fixed trading sites could be established for the transport and trade of charcoal and to improve the effectiveness of checkpoints. Any new regulations would require a strong information campaign and training of law enforcement staff. (Source: World Bank 2010).

Sub-national policy

District level authorities currently have little incentive to monitor compliance with rules and regulations or to proactively engage in sustainable management of the charcoal sector, largely because they receive limited revenues from charcoal-related taxes (Sander et al. 2013). At the village level, authorities tend to be unclear or unaware of their rights and obligations regarding the forest areas in and around their communities and have no alternative but to let members of their communities produce charcoal unsustainably because of a lack of livelihood alternatives and little incentive to enforce regulations (Sander et al. 2013).

If village and district governments were able to retain a percentage of charcoal revenues, this would create an incentive for them to be knowledgeable about charcoal regulations and to monitor and enforce these regulations effectively (World Bank 2010). It could also serve as an incentive to reinvest in charcoal sustainability initiatives.

Implementing a benefit-sharing arrangement would require greater transparency across all levels of government, with central, district and village government actors aware of their respective rights, responsibilities and obligations in relation to charcoal production, trade and use. Districts would require support with financial management and reporting on charcoal-related revenue collection (World Bank 2010; Sander et al. 2013). Technical support would also be needed in relation to reinvestment in initiatives such as participatory forest management and community-based forest management at the village level (Sander et al. 2013). World Bank (2010) suggests the establishment of a 'forest fund' in the long-term to manage increased revenues from charcoal.

Market interventions

Financial incentives for sustainably produced charcoal

The introduction of financial incentives for sustainably produced charcoal would make unsustainably produced charcoal less attractive.

Standards such as that developed by the Forest Stewardship Council (FSC) provide certification that forest products are produced in ways that are environmentally appropriate, socially beneficial and involve economically viable forest management. Certification, national or international standards could be applied or developed for sustainably produced charcoal. Owen et al. (2013) suggest the establishment of a system that documents the origin of biomass and places a surcharge on wood from non-documented sources. A surcharge would fund a verification and control system as well as sustainable forest management.

Regulate charcoal markets

Unregulated charcoal trade is estimated to involve a direct loss in revenue for African countries in the range of US\$1.5 billion to US\$3.9 billion annually (World Bank 2009). If wood fuel prices were to increase and market distortions removed, then improved conversion technologies and cook stoves would become more competitive, leading to greater efficiency and safer appliances that compensate for price increases (Owen et al. 2013). The regulated collection of taxes would also generate revenue to cover operational expenses, incentives and subsidies for the poorest in society. In Senegal, where charcoal producers have been encouraged to organize their own marketing and contribute to taxes, producers have achieved higher profits and benefited from local social and environmental improvements (Schure et al. 2013). Valorizing forest resources through establishing regulated markets would also help to ensure their protection and sustainable management for the direct benefit of rural communities (Owen et al. 2013).

In Tanzania, the government is incurring an estimated revenue loss of US\$100 million per year due to foregone taxes and licensing fees from charcoal production and utilization (Sander et al. 2013). World Bank (2010) suggests a realistic goal in Tanzania is to increase the share of taxes and fees paid for charcoal from 20 percent to 40 percent and to impose a sustainability premium of 10 percent. This would increase the retail price of charcoal by 7 per cent. However, this cost could be absorbed by wholesalers who currently receive the greatest share of profits. A sustainably regulated charcoal market would therefore also be in the interest of governments (Sander et al. 2103).

Knowledge and capacity development

Facilitate knowledge sharing

There is virtually no exchange of information about the charcoal trade between government and non-government stakeholders. Due to the clandestine and informal nature of the charcoal sector, there is a scarcity of data on charcoal production and consumption (Mwampamba et al. 2013a; Schure et al. 2013). Governments find it difficult to control a sector about which they have little information and non-government actors can hardly be expected to influence government policy, about which they do not have information (Sander et al. 2013).

While leadership for a sustainable charcoal sector needs to come from central governments, there is a strong need for open communication to occur both within government systems and between government and non-government actors. In its review of Tanzania's charcoal sector, World Bank (2010) advocates for key central government agencies to scope out a mode of engagement with the dealer-transporter-wholesaler networks. This could be along the lines of a 'Charcoal Roundtable' supported by an independent body of experts from research institutions, NGOs, CSOs and development partners (Sander et al. 2013).

Empower stakeholders

The empowerment of non-government stakeholders in the charcoal sector (such as producers, consumers, women, bicycle transporters and improved stove producers) would enable them to be more active in shaping the sector's rules and practices, and counter the pricing and bargaining power of dealer-transporter-wholesaler networks (World Bank 2010).

The necessary empowerment could come from information campaigns, the promotion of efficient technologies, more sustainable management practices and ownership of production assets such as through secure, long-term property rights to wood resources grown in small-scale plantations and woodlots (World Bank 2010). The latter would provide direct economic benefits and financial income to charcoal producers, and has the potential to result in improved charcoal production and more sustainable land management (World Bank 2010).

Develop capacity

In improving governance and sustainability in the charcoal sector, substantial investment in training and capacity development is required, specifically:

- Training on law enforcement, financial management and reporting for charcoal-related revenue collection
- Technical support for the establishment of agroforestry systems, woodlots and small-scale plantations
- Technical support for participatory forest management and community-based forest management
- Dissemination of knowledge about improved kiln technologies that more efficiently convert wood to charcoal.

Research gaps

There is a need for further empirical research to support the hypothesis that a legalized and regulated charcoal industry can help alleviate poverty for a larger number of participants in the charcoal value chain, particularly the rural poor. Evidence gathered through value chain analysis

would support policy interventions that ensure small-scale producers and retailers retain more of the total value of charcoal. Such analysis should consider how factors such as gender and age influence the distribution of wealth and benefits, and how power imbalances might be addressed.

The social and economic impact of any new policy interventions must be monitored and assessed right across the value chain, taking into consideration the health and wellbeing of stakeholders and the energy security of nations. The potential for effectively incorporating local knowledge into national and sub-national policies also warrants investigation.

The links between charcoal production and deforestation and degradation need further clarification so that the current and future impacts on land cover, the regional water balance and the global climate can be appropriately addressed. The capacity of agroforestry systems, woodlots and small plantations to meet growing demands for charcoal, and reduce pressures on forests, needs urgent investigation.

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