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Charcoal contribution to wealth accumulation at different scales of production among the rural population of Mutomo District in Kenya

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ABSTRACT

Charcoal is among the most important domestic fuels in many countries of Sub-Saharan Africa (SSA). Its production has been conventionally considered as an agricultural off-season activity to supplement household income and cope with harvest failures. This study used primary data at the household level from an important charcoal supplying dryland region in Kenya to evaluate if income from charcoal contributes to wealth accumulation. The findings show that small-scale producers were more dependent on income from charcoal and casual labor, the two sectors whose income was uncorrelated to wealth index. This group was the poorest among the producer groups and vis-à-vis non-producers in terms of both total income and wealth level. In contrast, large-scale producers derived about half of their income from charcoal production but had more diversified livelihood sources especially in business and agriculture. Despite the fact that charcoal income was not directly correlated with the wealth index, large-scale producers derived absolutely large income from charcoal activities which made them well-off among all the categories of households. The findings challenges the dichotomous policy debates on either promoting or banning charcoal production but necessitate better targeted policy interventions, which explicitly consider differences in charcoal producers to properly target social goals.

Introduction

Charcoal is the most widely used domestic fuel in the majority of urban centers of Sub-Saharan Africa (SSA) (Iiyama et al., 2014; Butz, 2013; Zulu and Richardson, 2012). Driven primarily by high rates of population growth and urbanization, charcoal consumption in SSA has been growing steadily and is projected to double by 2030 (Zulu and Richardson, 2012; World Bank, 2011). Correspondingly, the economic significance of the charcoal sector has also been growing through direct employment of millions of people as producers, transporters and traders and their dependents (Mwampamba et al., 2013; Arnold et al., 2006). The sector's contribution to the national economy of respective countries is reported to rival other highly valued sectors, usually hailed as the mainstays of economic development. For example, the charcoal sector in Kenya is worth as much as the tea industry and employs as many people as the Teachers Service Commission (Mutimba and Murefu, 2005) while in Tanzania, it generates much more revenue than both the tea and coffee sectors (Mwampamba et al., 2013).

Despite the contribution to national economies, charcoal production in SSA has been perceived to be associated with rural poverty. Some studies reported power relations and unequitable wealth distributions among the charcoal value chain actors, especially producers vs. intermediaries (Mwampamba et al., 2013; Khundi et al., 2011; Kambewa et al., 2007). Poorly organized or unskilled rural households scattered across the wooded landscapes have been subject to exploitation by much more organized, complex networks of intermediaries with varying degrees of resources and power who transport charcoal into cities (Minten et al., 2013; Zulu and Richardson, 2012; Arnold et al., 2006). Several factors have been reported as responsible for perpetuating this situation in many SSA

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countries: 1) a dispersed and non-regulated market undermined by corruption at checkpoints along charcoal transport routes (Iiyama et al., 2015; Minten et al., 2013; Zulu and Richardson, 2012); 2) high levels of competition and low farm gate prices which mean that producers are left with little or no surplus to invest in value addition or transportation to urban areas where they can fetch higher prices (Schure et al., 2014; Zulu and Richardson, 2012) and; 3) the perception that charcoal is invariantly a major cause of land degradation leading to illegalization of production and trade by many governments (Mwampamba et al., 2013; Arnold et al., 2006). Consequently, producers receive very low margins that disincentivize investments needed to secure a sustainable supply. Moreover, the lack of surplus forces them to rely on rudimentary technologies and non-regulated land management practices: earth mound kilns; permit-less clear-cutting or selective logging practices based solely in agreements with the land owner (in the best case); and use of household-based labor which has low opportunity cost as an agricultural off-season activity (Ndegwa et al., 2016; Njenga et al., 2013; Schaafsma et al., 2012).

The literature on income of rural households in SSA shows the important role charcoal plays in livelihood diversification strategies and regards it as one of the most important "environmental incomes", which refers to extraction from non-cultivated sources including natural forests, other non-forest wildlands, fallows, and wild plants and animals harvested from croplands (Angelsen et al., 2014). The charcoal producers are reported to generally engage in multiple income generating activities to spread risks associated with uncertainty of revenues from different undertakings (Schure et al., 2014; Zulu and Richardson, 2012). Charcoal production, despite its significance, is rather considered an agricultural off-season activity to supplement household income and a coping strategy in times of poor harvest or shock (Wunder et al., 2014; Khundi et al., 2011; Arnold and Persson, 2003), as charcoal has ready access to urban markets which guarantees quick cash (Wunder et al., 2014; Butz, 2013).

Some studies argue that charcoal production helps to alleviate poverty as revenues contribute to household savings, investment, wealth accumulation, asset building and lasting increases in income and well-being (Schure et al., 2014). Others claim that charcoal production is more of a poverty trap that perpetuates poverty among the poor producers rather than a way out (Wunder et al., 2014; Zulu and Richardson, 2012; Angelsen and Wunder, 2003). These dichotomous arguments mask the heterogeneity among rural charcoal producers and lead to simplistic conclusions either advocating or dismissing the current forms of charcoal production.

Producers are heterogeneous in the sense that income from charcoal may provide a safety net for the poorest, while others are involved in production as a regular business enterprise. Such heterogeneity may have implications on the capacity to save and invest in alternative livelihood sources, wealth accumulation as well as the sustainability of practices adopted. For example, marginal, small-scale producers earn little income which leaves them little or no surplus to invest in alternative livelihood sources. This consequently reinforces their chronic dependence on charcoal, which requires very little or even no capital investment (Schure et al., 2014; Arnold et al., 2006). On the contrary, more affluent households which operate charcoal production as a regular business enterprise, may afford to invest income derived from charcoal in diversifying their livelihood activities (Schure et al., 2014; Kambewa et al., 2007).

There has been little systematic research which investigates the heterogeneity of rural charcoal producers and its implications on wealth hence it is this knowledge gap our study addresses. The study used the primary data collected from Mutomo District in Kenya to evaluate the relationship between income from charcoal and wealth accumulation for different "types" of charcoal producers. The understanding may help in design and implementation of targeted interventions aimed at promoting sustainable charcoal supply chains that do not compromise the livelihoods of the poor producers.

Traditionally, charcoal production has been considered an agricultural off-season activity for rural households. Moreover, some studies that have examined the impact of charcoal income on households' wealth, tended to describe charcoal producers as a homogenous group against non-producers with little acknowledgement on their heterogeneity. For example, Schure et al. (2014), from their work in the Democratic Republic of Congo, found that the charcoal producers were generally poorer and resource-constrained than non-producers. They also presented evidence that charcoal production contributed to alleviating poverty by allowing producers to invest charcoal income in activities of other sectors such as agriculture. In contrast, Khundi et al. (2011) found that the majority of the charcoal producers in their sample were not the poorest in the community but moderately well-off households who produced charcoal to fill income gaps. They further argued that even though charcoal production did prevent households from getting poorer, the producers were not able to accumulate valuable assets, discounting the claim that income from charcoal contributes to poverty alleviation.

Others reported evidence that charcoal producers are heterogeneous in their level of engagement in production and dependence on income, and with implications of differentiated wealth accumulation (Kambewa et al., 2007). Kambewa et al. (2007) classified charcoal producers in Malawi into three similar categories where: small-scale producers who produced less than 30 bags (each weighing 38kg) per month; medium-scale producers who produced 30–100 bags per month and large-scale producers who produced more than 100 bags per month. Kambewa et al. (2007) further reported that; the small-scale producers were poor people who engaged in production as a coping mechanism against food shortage or cash needs; the medium-scale producers were business-oriented people who were not well cash-endowed while: the large-scale producers were fully-fledged businessmen who had enough financial capital for investment into large-scale production operations.

A synthesis of work on environmental incomes from the global south also revealed the differentiated reliance, in either relative or absolute terms, on income from woodfuel (both firewood and charcoal) among households of different income quintiles (Angelsen et al., 2014). Indeed, rural households were reported to have been highly stratified by their relative/absolute reliance on charcoal income relative to various farm and off-farm incomes, and their heterogeneous livelihood diversification strategies had divergent implications on poverty and wealth accumulation (Iiyama et al., 2008).

The main objective of this study is therefore to empirically explore the heterogeneity among rural charcoal producers in terms of relative/absolute dependence within a wider farm-/off-farm livelihood diversification strategy which would lead to better targeted interventions. Generally, charcoal is considered requiring little or even no capital investment, thus allowing the very poor rural households with fewer chances to invest in alternative livelihood sources to enter into its production (Schure et al., 2014; Arnold et al., 2006). We hypothesize that the relative and absolute levels of engagement in charcoal production and reliance on charcoal income have differentiated implications on wealth status, and thus on pathways for either poverty trap or poverty alleviation. For example, some small-charcoal producers who are restrained to expand their production capacity may not afford to spend their meager earnings to expand their production activities but rather spend it on their subsistence needs, thus are likely to be trapped in poverty (Khundi et al., 2011; Arnold et al., 2006; Luoga et al., 2000). On the contrary, charcoal producing households who manage to operate production as a business enterprise may afford to invest part of the derived income into supplementary income generating activities like cash crop farming and retail/wholesale business, which would otherwise not be possible without charcoal income.

Methods

Study area

Mutomo District is located in Kitui County in Eastern Kenya. The district is categorized as arid and semi-arid with limited agricultural potential (Muyanga, 2005). It has a population of about 180,000 people living in 32,896 households (KNBS, 2010). About 53% of the men and 89% of the women in the district are illiterate (GOK, 2009). The district lacks adequate infrastructure like paved roads, clean water supply and electricity (GOK, 2009). For example, it is common for people to walk over 5 km to access the few basic facilities like schools, water dams and health centers. Subsistence rain-fed agriculture is the main source of livelihood but due to low rainfall (500-1050 mm per annum) which 70% of the times is below expected levels, leading to droughts every second year, the households have diversified their sources of income to off-farm activities like charcoal production and casual labor (GOK, 2009; Muyanga, 2005).

The remoteness of the district, lack of basic infrastructure and harsh climatic conditions result in very few non-farming income generating opportunities except for the provision of basic services like education and health. A few people are also employed as permanent and pensionable employees or engaged on casual basis by the many local and international humanitarian nongovernmental organizations implementing livelihood related projects in the area. However, the low literacy levels and the limited number of such vacancies greatly limit the number of people engaged in such jobs. Most of the people have to contend with casual employment mainly (menial jobs like tilling land and fetching water) or consumer goods retail businesses. This has condemned the majority of the residents of the district to poverty with about 66% of the population reported to live below the poverty line (GOK, 2009).

According to the local forest officer, charcoal production in the district started on a small-scale in the 1990s, mostly as a coping strategy in time of drought. However, during the past two decades it developed into a widespread economic activity, mostly driven by urban growth in Nairobi and other neighboring urban centers like Kitui and Machakos. Even though some people are still producing charcoal as a coping strategy, some have made it their fulltime employment. As a consequence, charcoal production in Kitui County as a whole, is reported to have increased from 400,000 bags (each weighing around 35 kg) in 2001 (Practical Action, 2010) to over a million bags in 2013 (GOK, 2013). The local forest officer estimated that over 60% of the county's charcoal production comes from Mutomo District.

All the land in Mutomo is held in trust by the government for the people (Government Trust Land), hence the people do not have ownership documents (i.e. title deeds). However, farmers have traditionally assigned user rights to the parcels they reside in while some other parcels are fully gazetted as government forests, especially those around hills. The charcoal producing landscape is a fragmented mosaic of agriculture and tropical dry woodlands dominated by *Acacia* and *Comiphora* species (Ndegwa et al., 2016).

All charcoal in Mutomo is produced using traditional earth mound kilns whose efficiencies are estimated to range from 8 to 20% depending on factors such as the producer's kiln building and operation skills and the moisture content of wood (Chidumayo and Gumbo, 2013). This type of kiln is preferred mostly because it is cheap to establish as it involves covering the wood with soil and grass freely available on harvesting sites (Kambewa et al., 2007; Luoga et al., 2000). The charcoal is then packed in ≈35 kg bags and sold to brokers, transporters or resellers as observed elsewhere in Kenya (Mutimba and Murefu, 2005).

Charcoal production in Mutomo District has remained largely unregulated, as in the rest of the country. The lack of regulation has been blamed for keeping the rampant inequality in revenues across the supply chain: from producers to urban resellers; encouraging corruption along transportation routes; and allowing indiscriminate cutting of wood (Njenga et al., 2013; Mutimba and Murefu, 2005). The government in 2009 sought to bring order into the sector through legislation that requires all charcoal producers to be organized in groups and licensed after demonstrating that they would only produce charcoal from sustainably grown trees (GOK, 2013). As of today, most charcoal production is unregulated.

Sampling design

The study was done through a household survey using a structured questionnaire in five sub-locations (the smallest administrative unit) of Mutomo District namely; Kalia Katune, Kituvwi, Ilamba, Kasaala and Kituti (Fig. 1). These were selected randomly from a list of ten that border the Tsavo East National Park. Respondent households were selected through systematic random sampling where the first was selected randomly from the first 20, and then each 20th household was picked thereafter. A total of 189 households representing 5% of the total households in the 5 sub-locations were interviewed, with the household head or the spouse acting as the respondent. However, 7 households did not share their income details and were excluded from the analysis.

Data collection, processing and analysis

The study collected data on: basic household characteristics (such as size of household and household head gender and education level); household cash income activities (e.g. farming, formal employment, casual labor); household assets (e.g. land, livestock) and dwelling unit characteristics (e.g. number of rooms, type of roof).

Classification of charcoal producers

Charcoal producers (as opposed to non-producers) were those households that made charcoal at least once during the last year prior to the survey. The producers were then classified through hierarchical cluster analysis, a method that allows identification of homogenous groups which share common characteristics within a population (Mooi and Sarstedt, 2011). Six clustering variables were used: 1) total household income in KES[1] and 2) percentage contribution to the total income of the five income portfolios (i.e. formal employment, charcoal, casual labor, farm produce, business and others — mostly comprised of remittances) reported by the respondents. Total household income was calculated as the gross sum of all cash income without taking into account the consumptive income or the associated costs of generating this income as these are difficult to estimate (Iiyama et al., 2008). Clustering computations were done using Ward's method based on Squared Euclidean distances. Ward's method was preferred as it maximizes the significance of differences between clusters making them easy to interpret (Everitt et al., 2011; Mooi and Sarstedt, 2011). The number of clusters was set by plotting the *line of best cut* into the dendrogram at the point with the largest changes in fusion levels (Everitt et al., 2011). The resulting dendogram is shown in Appendix 1.

Calculation of the wealth index

The wealth index was calculated using Principal Component Analysis (PCA) as recommended by Smits and Steendijk (2013). PCA is a multivariate statistical technique that can be used to reduce the number of variables in a dataset by converting them into a smaller number of

[1] At the time of this study, 84 Kenya Shillings were equivalent to 1 USD.

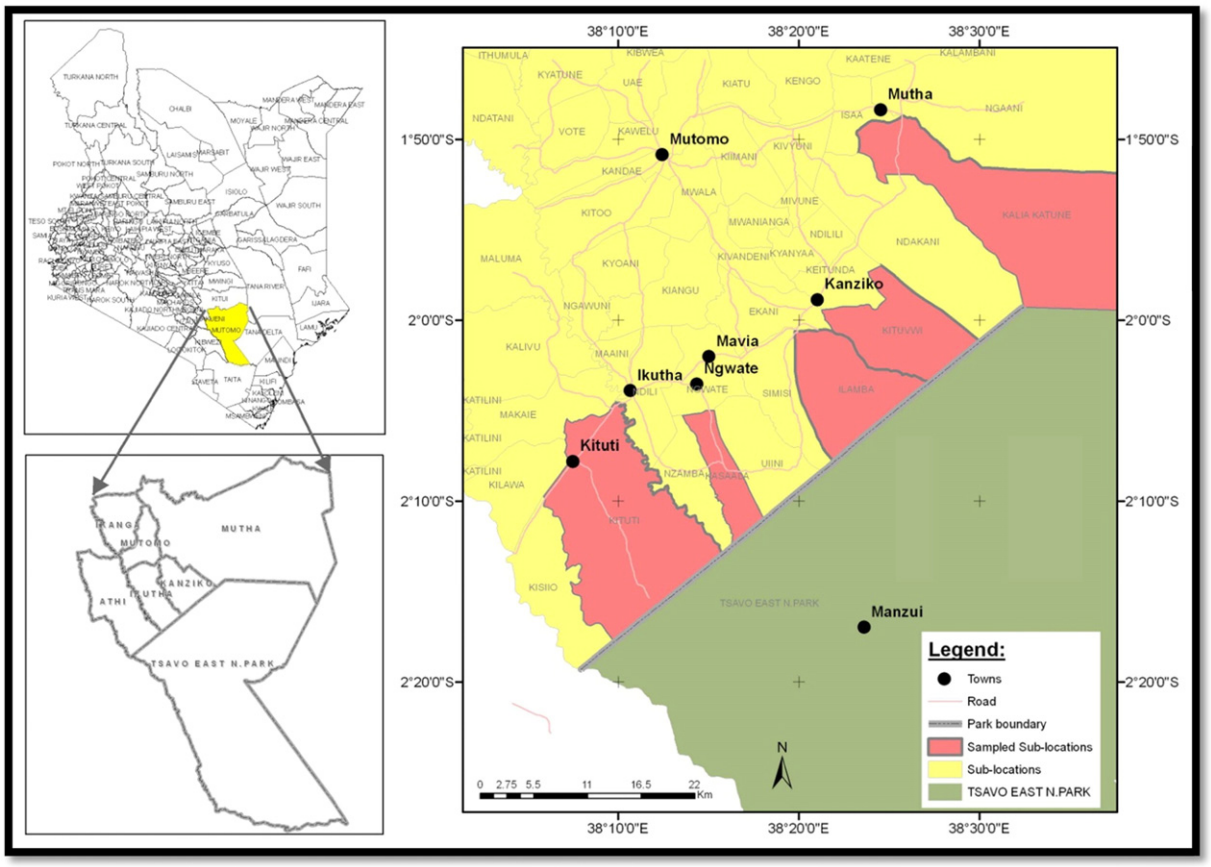

Fig. 1. Map of the study area.

components where each of the components is a linear weighted combination of the initial variables (Harttgen and Vollmer, 2011). The use of PCA for welfare and poverty analysis is particularly important where consumption and expenditure data is unavailable or hard to collect but ownership of key household assets can be retrieved from household's demographic surveys (Filmer and Scott, 2012; Cordoba, 2008). According to Harttgen and Vollmer (2011) ownership of assets is a better proxy for wealth as they are less prone to underreporting. The wealth index also accounts only for long-term economic status and not temporally fluctuations in economic well-being or shocks (Cordoba, 2008; Filmer and Pritchett, 2001). The first component in the PCA solution explains the largest part of the variation in the asset ownership data and is chosen as the wealth index (Smits and Steendijk, 2013; Filmer and Pritchett, 2001). The component yields scores with larger weight to assets that vary the most across households and zero to assets found in all households (Cordoba, 2008). The scores can take positive as well as negative values. Wealth indices based on this methodology have proved to be more robust compared

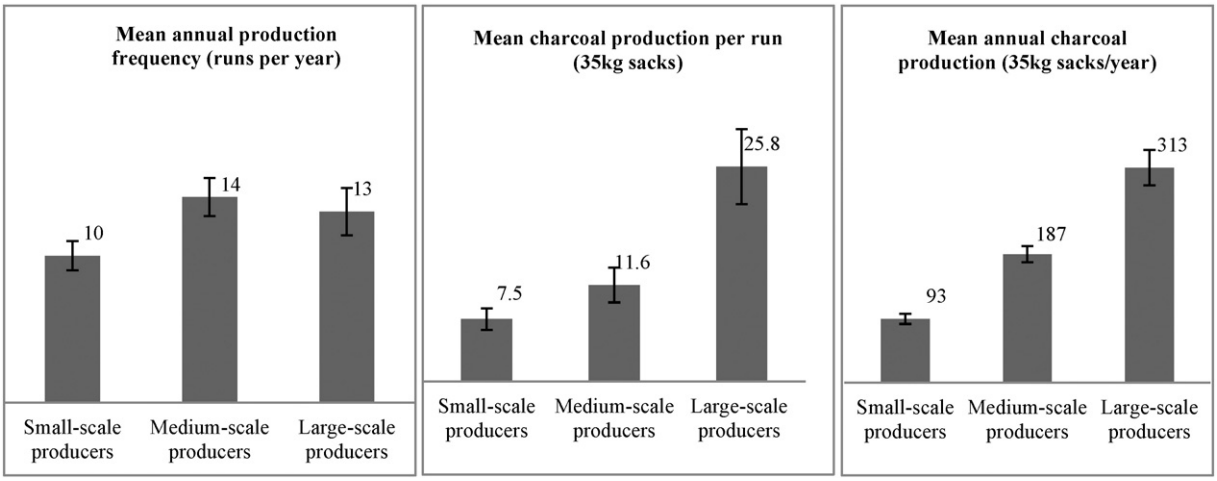

Fig. 2. Key charcoal production statistic for different producer categories.

Table 1
Annual income distribution for different charcoal producer categories and the non-producers in KES.

Mean	Non-producers (N = 87)		Small-scale producers (n = 51)		Medium-scale producers (n = 32)		Large-scale producers (n = 12)	
	Mean (KES)	% of total	Mean (KES)	% of total	Mean (KES)	% of total	Mean (KES)	% of total
Income from charcoal	–	–	27,258	64	56,063	54	121,333	58
Income from casual labor	17,926	33	9365	22	26,363	25	17,500	8
Income from business	12,497	23	1647	4	10,375	10	48,333	23
Income from farm produce	7851	15	2455	6	10,900	10	18,333	9
Income from formal job	12,736	24	941	2	–	–	5000	2
Income from other sources	2798	5	596	1	863	1	–	–
Total mean income[a]	53,807	100	42,262	100	104,563	100	210,500	100

[a] The total mean may differ slightly from the individual summations due to rounding-off.

to other welfare measurement indices like the Human Development Index (HDI) and the Poverty Headcount Ratio (PHR) (Smits and Steendijk, 2013). For the purpose of this study the first component was referred to as raw household wealth scores. The scores were then rescaled to the range of 0–100 by adding the opposite of the lowest value to each household score, dividing the resulting value by the new maximum and multiplying by 100 as shown in Eq. (1). These values were saved as the final household wealth indices and used for further analysis.

$$WI_n = 100.\left(\frac{\beta_n + y}{x + y}\right) \quad (1)$$

where: WI = Wealth Index for the n_{th} household, β_n = the raw wealth score for the n_{th} household, y is the opposite of the lowest raw wealth score (in this case the lowest score was −1.59572) and x is the highest raw wealth score (in this case the highest score was 4.97794).

To test the relationship between wealth and income, a Pearson test of correlation was applied to the total household income vs. household wealth index. The same test was also used to relate the impact of charcoal income (in both monetary value and as a percentage of total income) on household wealth for the different categories of producers previously identified.

Results

Classification of charcoal producers

Cluster analysis resulted into three groups of charcoal producers. Discriminant analysis to ascertain how accurately the households were classified confirmed that 96.8% were correctly classified. Segmentation was found to be along the income from charcoal production which was also proportional to the quantity of charcoal produced. As Fig. 2 presents, the three groups exhibited clear differences in engagement in charcoal production, more specifically, in terms of the frequency of production (Fig. 2 left), the quantity produced per run (Fig. 2 middle) and the total volume produced per annum (Fig. 2 right) and the as shown in Fig. 2.

The first cluster comprised of 51 households and produced a mean of 93 (std. dev. 54) sacks per annum which was the least among the three groups. The group was therefore named small-scale charcoal producers. The second group comprised of 32 households and produced a mean of 187 (std. dev. 66) sacks per annum. This group was named the medium-scale producers. The third group comprised of 12 households and produced a mean of 313 (std. dev. 89) sacks of charcoal per annum. This group was named the large-scale charcoal producers. A Kruskal–Wallis H test showed that there was a statistically significant difference in charcoal production per runs ($\chi^2(2) = 15.995, p = 0.000$) and annual production quantity ($\chi^2(2) = 51.055, p = 0.000$) between the three groups, while there was no significant difference in frequency of production between the three groups. The large-scale producers produced the largest quantity of charcoal per run[2] at 28 (±16) sacks compared to 18 (±12) sacks for the medium-scale producers and 13 (±10) for the small-scale producers.

Table 1 shows the mean annual income as well as the contribution from different components among the distinctive charcoal producer groups against those of the non-charcoal producers. In terms of income, the small scale charcoal producers had the lowest mean annual cash income at about KES 42,000 but the highest percentage was derived from charcoal sales at 64%. Indeed, the small-scale producers had 28% less income than the non-producers who had a mean annual income of about KES 54,000. The second largest source of income after charcoal for this group was casual labor at 22% followed a distance third by sale of farm produce at 6%. The medium-scale charcoal producers had an annual income about 2.5 times that of the small-scale producers (KES 104,000) with 54% of their income being derived from charcoal, the lowest share among the three charcoal producer groups. The second largest source of income for this group was casual labor at 25% followed by business and sale of farm produce each contributing 10%. The large-scale charcoal producers had the highest annual income at about KES 210,000 of which the percentage derived from charcoal was lower than for the small-scale producers but higher than that of the medium-scale producers (58%). The second largest source of income for this group was business which contributed 23% of their total income followed by sale of farm produce at 9%. Majority of the income for the non-producers came from working as casual laborers at 33% followed by formal employment at 24% and business (not related to any charcoal activities) at 23%. Income from selling farm produce also contributed a significant portion of the non-producers' income at 15%.

Household characteristics

The respondents comprised of 182 households of which 22.5% were female headed and 77.5% were male headed (Table 2). The non-producer category had the highest percentage of female-headed households at 29.9% followed by the small scale producers at 19.6% of the households. In contrast, only 8.3% (which was actually one household out of 12) of large-scale producing households was headed by a female. The non-producers had the lowest household size at 5.3 persons followed by the medium-scale producers at 5.8

[2] This is a full production cycle from tree harvesting, kiln preparation and operation to offloading and packaging.

Table 2
Household characteristics.

Category	Percentage female headed households[a]	Percentage male headed households[a]	Household size	
			Mean	Std. dev.
Non-producers (n = 87)	29.9 (26)	70.1 (61)	5.3	2.0
Small-scale producers (n = 51)	19.6 (10)	80.4 (41)	6.4	2.0
Medium-scale producers (n = 32)	12.5 (4)	87.5 (28)	5.8	2.0
Large-scale producers (n = 12)	8.3 (1)	91.7 (11)	7.2	1.5
Total	22.5(41)	77.5 (141)	5.8	2.0

[a] The number of households out of the total respondents (n) per category is in brackets.

(Table 2). The large-scale producers had the largest households at 7.2 persons per household.

Results displayed in Fig. 3 show that the non-producers had the lowest proportion of households whose heads did not complete their primary school education at 41% (8% never attended school and 33% dropped out in primary school). The category had also the highest percentage of household heads that had completed their high school education at 20%. For the small-scale producers, 59% of the household heads did not complete their primary school education (16% never attended school and 43% dropped out in primary school). Only 8% of the household heads in this category had completed their high school education. For the medium-scale producers, 60% of the household heads did not complete their primary school education (22% never attended school and 38% dropped out in primary school). None of the household heads in this category completed their high school education. All household heads in the large-scale producer category started primary school, but 67% dropped out. Likewise, none of the household heads in this category completed their high school education.

Relationship between income and wealth

The first component which represents the raw wealth index, derived from PCA explained 28% of the variation which is comparable to the 30% reported by Smits and Steendijk (2013) and 26% reported by Filmer and Pritchett (2001). The re-scaled final wealth indices showed that households with more and high value assets and better dwelling units had indices closer to 100 while those with fewer assets and poorer dwelling units had indices closer to 0. Fig. 4 shows that the small-scale producers had the lowest mean wealth index at 20.6 followed by the non-producers at 24.2. The large-scale producers had the highest mean wealth index at 28.4, with the medium-scale producers following closely at 27.2. All the categories had a mean wealth index less than a third of the highest possible (100) showing a relatively low wealth status of the entire sample population.

The correlation between total household income and household wealth index was significant at 0.01 level ($r = .458$), implying that wealth was directly correlated with income (Table 3). When the same test was done for different sources of income, it was found that wealth was directly correlated with income from business ($r = .419$, $p = 0.01$) and income from formal job ($r = .322$, $p = 0.01$) and weakly correlated with income from farm produce ($r = .186$, $p = 0.05$). However, wealth was found to be not significantly correlated with income from casual labor, charcoal, or even other sources like remittances.

A correlation test between the producers and non-producers' income and wealth showed a strong and significant correlation between non-producers' income and their wealth ($r = .613$, $p = 0.01$) and a weaker but significant correlation between the producers' income and their wealth ($r = .320$, $p = 0.01$) as shown in Table 4. However, there was no correlation between income from charcoal and household wealth accumulation for the different categories of charcoal producers except for the medium-scale producers where the absolute income was found to be moderately correlated with wealth ($r = .410$, $p = 0.05$).

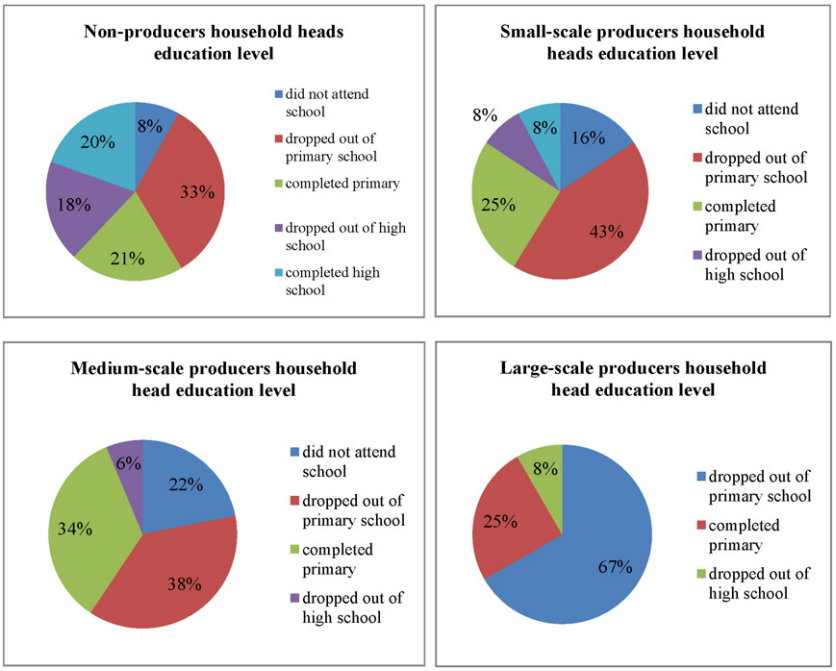

Fig. 3. Distribution of households by education level of households in different categories.

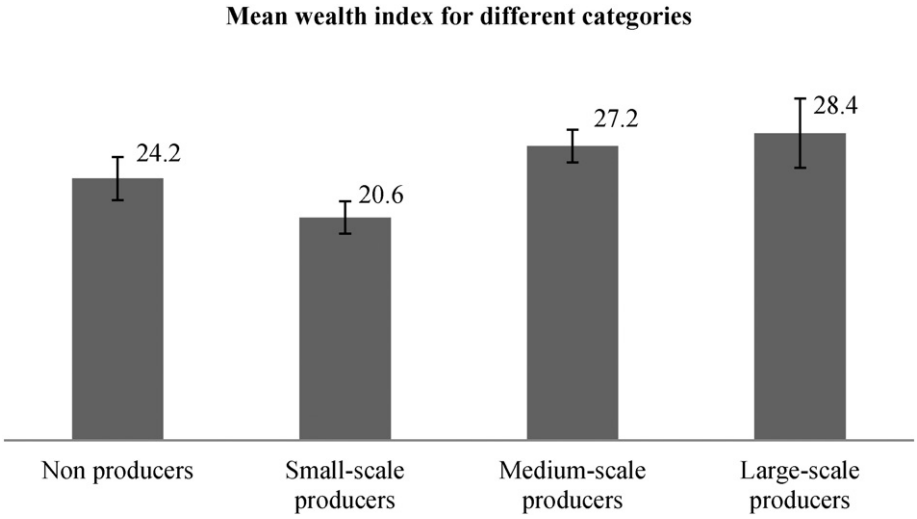

Fig. 4. Mean wealth index for different categories.

Discussion

Our findings revealed that charcoal production in the study area seemed to occur regularly contrary to the argument that it occurs only seasonally to supplement agricultural incomes or as a coping strategy (Schure et al., 2014; Zulu and Richardson, 2012). The findings further confirmed the heterogeneity of rural charcoal producers in the study area, as Kambewa et al. (2007) reported from Malawi. Three distinctive categories of charcoal-producing households were identified; i.e., small-, medium-, and large-scale producers, differentiated by their production levels and relative/absolute dependency within diversified livelihood strategies. While the small-scale producers were relatively more heavily depended on charcoal income, the large-scale producers on average earned over 4.4 times more charcoal income, while yielding on average 2.2 times more sacks of charcoal per run than small-scale producers.

The findings of this study show that majority of the female headed households in the sample were less likely to be involved in charcoal production. Other authors have reported similar findings and stated this could be due to production being too labor intensive (Angelsen and Wunder, 2003; Arnold et al., 2006) or deterrents like physical confrontation, arbitrary exercise of bureaucratic power and corruption prevalent in the sector due to its informal and clandestine nature (Zulu and Richardson, 2012).

Furthermore, while the level of education was generally low in the study area, it was lower for charcoal producers than non-producers. As the level of education of a person determines their possibility of getting formal employment opportunities or engagement in skill-demanding entrepreneurial activities, the low levels of education of the charcoal producers may imply that their participation in charcoal production is due to lower chances of being engaged in more remunerative activities (López-Feldman, 2014; Muyanga et al., 2013). For example, a study by Minten et al. (2013) in Madagascar reported lower education levels among people involved in charcoal production than in other fields like agriculture and business.

Our study also showed the significant correlations between the income from business, formal employment and farm produce with the wealth index but no significant correlation of the share and level of charcoal income on wealth index. Indeed, 62% of the non-producers' income was derived from these three sectors (24% from formal job; 23% from business and; 15% from farm produce) and their income was strongly and significantly correlated with wealth. This was a stark contrast with the income portfolio and wealth index of the small-scale producers with the highest dependence on charcoal followed by unreliable casual labor income. The small-scale producers seemed "trapped" in perpetual poverty as they predominantly rely on income from charcoal and casual labor while making very little from productive farm/off-farm activities that play a key role in poverty alleviation. This phenomenon has been discussed in-depth by Angelsen and Wunder (2003) who explains that extraction of forest products, charcoal being one of them, attracts the poor due to low entry requirements (capital and skills) but has marginal returns that can only satisfy subsistence needs. Arnold and Persson (2003) further add that charcoal production could supply a household with subsistence income but does not generate surpluses that can be invested in poverty reduction. The above reasoning

Table 3
Correlation between income and wealth from different sources.

Correlated variables	N	Pearson correlation
Total HH income vs. HH wealth index	182	.458[b]
HH wealth index vs. income from casual labor	182	.021[c]
HH wealth index vs. income from charcoal	182	.086[c]
HH wealth index vs. income from business	182	.419[b]
HH wealth index vs. income from farm produce	182	.186[a]
HH wealth index vs. income from formal job	182	.322[b]
HH wealth index vs. income from other sources	182	−.105[c]

[a] Correlation is significant at the 0.05 level (2-tailed).
[b] Correlation is significant at the 0.01 level (2-tailed).
[c] Not significant.

Table 4
Correlation of wealth index for different producer categories with income from charcoal.

Correlated variables	Pearson correlation coefficient of wealth index with:		
	Total income	Charcoal income	Charcoal income share (%)
Non-producers (n = 87)	.613[b]	–	–
Producers (n = 95)	.320[b]	–	–
Small-scale producers (n = 51)	.014[c]	.014[c]	−.004[c]
Medium-scale producers (n = 32)	.410[a]	.311[c]	.038[c]
Large-scale producers (n = 12)	.209[c]	−.098[c]	−.164[c]

[a] Correlation is significant at the 0.05 level (2-tailed).
[b] Correlation is significant at the 0.01 level (2-tailed).
[c] Not significant.

may partially explain the situation of the small-scale producers but contradicts with that of large-scale producers in our case study. Majority of the large-scale producers turned out to be "school drop-outs" and were even less educated than the other charcoal producing groups as well as the non-producers. As a consequence they rarely derived income from formal employment. However, on average they derived relatively and absolutely more income from business than their small and medium counterparts as well as over twice as much absolute farm income than the non-producers. At the same time, the large-scale producers, with little formal education, turned out to be the wealthiest as shown by their higher wealth status among the surveyed households. Their ability to invest in business and agriculture, two of the sectors whose income contribution was found to be correlated with wealth, gives them a platform to create more wealth from the proceeds from charcoal. This indicates that charcoal income itself may not directly contribute to wealth accumulation for the households but may allow them to diversify into business and even farming which eventually leads to overall higher income and wealth hence complimenting their lack of formal education as a capital, which is usually considered a precondition for the entry to the formal job markets.

Conclusion

This study presented partial evidence on the inability of charcoal production to propel small-scale producers out of poverty but also highlights how this gives the large-scale producers deriving high absolute income, a platform to invest in other sectors that help them to accumulate wealth. One area that needs further investigation is the source of initial capital for the large-scale producers to invest in the large-scale charcoal operations, bearing in mind that their household characteristics are almost similar to the other groups. While not discussed in this paper, large-scale producers produce more volumes from large kilns placing much more pressure on the wood resources compared to the other groups. As such, their charcoal-led livelihood diversification and indirect contribution to wealth accumulation may be at the cost of the environment. This group may therefore need specially formulated interventions to encourage adoption of sustainable technologies and practices. On the other hand, small-scale producers need more fundamental capacity building initiatives for poverty alleviation.

The findings on the heterogeneity of producer findings further challenge the dichotomous policy debates whether charcoal production should be promoted or banned but calls for better targeted policy interventions which take into account the differences between different categories of charcoal producers.

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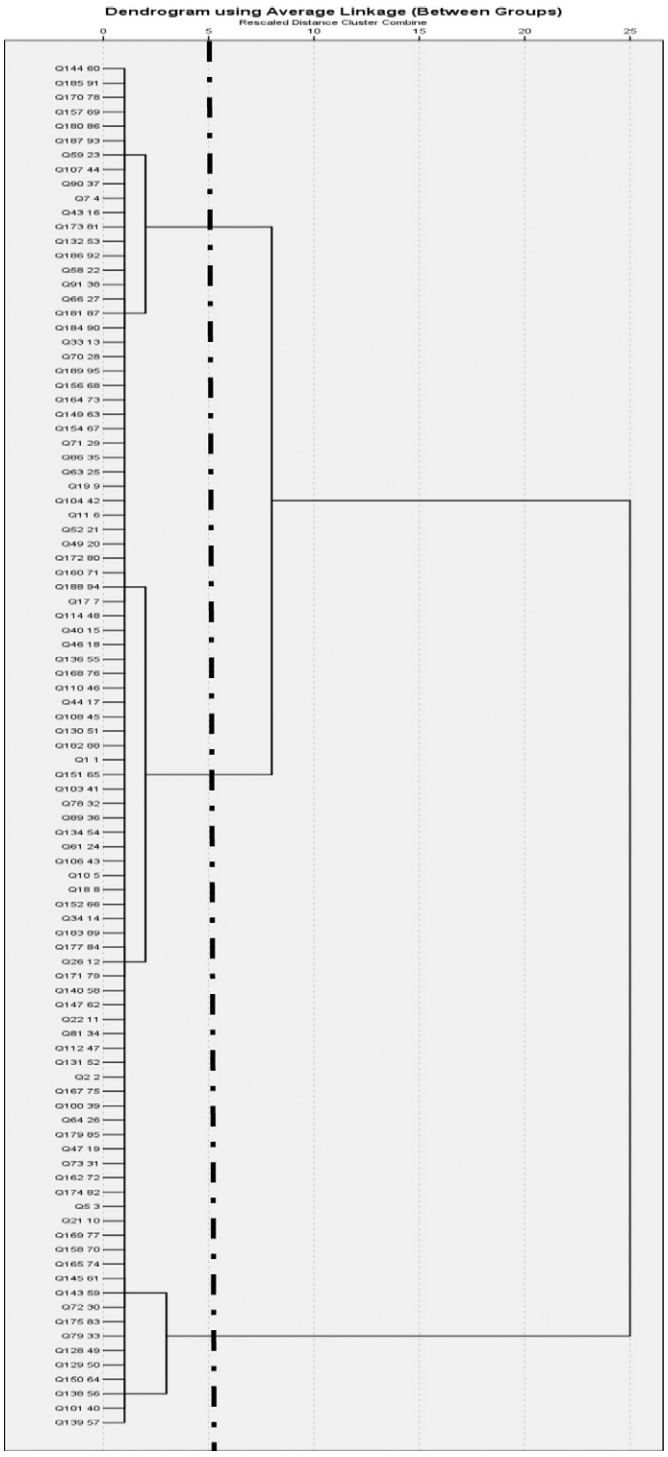
Appendix 1

Dendrogram resulting from cluster analysis. The dotted line is the *line of best cut* which shows segmentation into three distinct clusters.



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