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Livelihood diversification: The role of charcoal production in southern Malawi

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ABSTRACT

Growing urban populations in Sub-Saharan Africa are increasing demand for charcoal. This paper presents a detailed case study of three communities supplying charcoal to Zomba, a medium-sized city in Southern Malawi. Using the Sustainable Livelihoods Framework to structure our analysis, we examine individuals' motivations for producing charcoal, assess the seasonality of charcoal production, how livelihood outcomes vary between men and women, and identify sources of vulnerability for charcoal producer livelihoods. Drawing on data from four focus group exercises in each community and a total of 42 semi-structured interviews, we identify direct (e.g. financial) and indirect (e.g. strengthening of social networks, improved access to goods and services, opportunities for livelihood diversification) benefits that contribute to reducing producers' vulnerability to financial insecurity and improve their livelihoods. Irrespective of the benefits obtained and the actions (e.g. prioritising charcoal production over farming) of producers, participants did not perceive charcoal production as a desirable activity because the work was illegal, stigmatised hard and dangerous. Producers' primary motivations for engaging in production were to provide income to meet one-off purchases of expensive items, respond to an income shock, or to meet recurrent seasonal needs. Under certain conditions women were more dependent on income from charcoal production than men, as they had fewer alternative income generating options available to them. There was no reported management of charcoal resources in the study area, therefore the environmental sustainability of charcoal production and its associated benefits are uncertain. Malawi's current de facto charcoal ban leads to enforcement activities that exacerbate livelihood risks and increase producers' vulnerability to income insecurity.

Introduction

Forests provide a range of products and services, directly contributing to the livelihoods of an estimated 800 million people globally, living in or near tropical forests and savannahs (Chomitz et al., 2007; Naughton-Treves et al., 2007). Through the provision of timber and non-timber forest products (NTFPs) such as food, fodder, medicine, housing materials and fuel, forests contribute to livelihoods by providing access to basic materials and income generation (Ambrose-Oji, 2004; Shackleton and Shackleton, 2004; Sunderlin et al., 2005; Schreckenberg et al., 2006; Heubach et al., 2011; Shackleton et al., 2011). Forest-derived incomes contribute considerably to rural livelihoods and can reduce households' vulnerability by providing a source of savings, asset building, reducing poverty levels and improving wellbeing (Sunderlin et al., 2005; Angelsen et al., 2014).

Across sub-Saharan African (SSA), charcoal has the potential to provide accessible, affordable and reliable energy to millions of households, in addition to supporting millions of rural and urban livelihoods through income generation, providing urban–rural financial flows and contributing to the national economy. For example, in Malawi, the charcoal sector contributes an estimated $40 million, roughly 0.5% of national GDP (Kambewa et al., 2007). If managed effectively, charcoal is a sustainable energy source and can contribute substantially to reducing carbon emissions and greenhouse gases (Iiyama et al., 2014). Its production and trade will become an important source of income for an estimated 12 million people by 2030 (Mwampamba et al., 2013) yet there are large research gaps in the charcoal literature, which has led to a lack of evidence-based decision-making (ICRAF, 2015). In Africa, 75% of urban growth is expected to occur in small and medium-sized urban areas, with populations of less than 1 million (UN-Habitat, 2014). Yet, the charcoal markets of smaller cities are severely under-researched and there is no evidence to suggest that their value chains, participants or governance structures are comparable to larger cities (Smith et al., 2015).

There is good evidence that involvement in the charcoal trade can generate substantial incomes for participants (Monela et al., 1993;

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Knöpfle, 2004; Khundi et al., 2011; Schaafsma et al., 2012; Minten et al., 2013), though incomes may be unevenly distributed. Middle-men are frequently portrayed as the most exploitative actors in the value chain, yet they play essential entrepreneurial roles connecting producers and consumers (Schreckenberg, 2003; te Velde et al., 2006). Highest profits often accrue to urban-based 'elite' businessmen (or women), as they typically own motorised transporting links, monopolise the trade and are politically connected (Ribot, 1998; Brouwer and Magane, 1999; Kambewa et al., 2007; Kwaschik, 2008; Shively et al., 2010; Schure et al., 2013; Luz et al., 2015). Aside from an economic contribution however, there has been little attention to how involvement in the sector contributes to broader livelihood components.

The contribution to livelihoods of economic activities encompasses more than just income, and there is a need to consider a wider range of factors such as health, access to goods and services, social relations and food security, especially when measuring progress in development and poverty reduction (Chambers, 1995; DFID, 1999; Millennium Ecosystem Assessment, 2003; Scoones, 2009). Poverty Environment Network studies have recently taken an explicit livelihoods perspective in examining the use of forest resources (see Wunder et al., 2014); broader livelihood assessments of other NTFPs such as woodcraft have noted substantial benefits associated with engagement in natural product trade, such as strengthening of social assets, livelihood diversification and risk reduction (Shackleton et al., 2008). Broader analyses of the charcoal trade tend to focus on the negatives, such as the correlation of unregulated production and environmental degradation (e.g. Chidumayo and Gumbo, 2013; Rembold et al., 2013), detrimental health impacts (Bautista et al., 2008; Johnson et al., 2011) and negative livelihood impacts from enforcement activities (Smith et al., 2015).

Rural livelihoods experience numerous stresses that can increase household vulnerability. One of these is seasonality, which creates variability in labour, income and food availability (Ellis, 2000). Many households diversify their livelihood strategies to cope with stresses during challenging periods and diverse livelihoods tend to be less vulnerable as they allow households to adapt to change (Ellis, 1999). In Mozambique, charcoal production has been found to provide a flexible source of income for rural households, making it an important seasonal diversification strategy (Jones et al., 2016). However, there is still insufficient systematic analysis of the extent to which involvement in the charcoal trade contributes more widely to livelihoods, for example how it affects vulnerability and risk, capability and empowerment (Shackleton et al., 2008), its seasonal contribution, and peoples' motivations for involvement in the trade. Yet, understanding people's motivations and how various underlying factors influence them, could help deliver more effective policies (Smith et al., submitted for publication).

Charcoal producers in SSA are often portrayed as young, poor men (Hamilton and Hamilton, 2006; Bekele and Girmay, 2013), who benefit least from the trade because they are unorganised, are unable to access benefits and are less visible in decision-making processes (Schure et al., 2013). However, recent evidence from East Africa indicates that women also participate (Butz, 2013; Jones et al., 2016; Smith et al., submitted for publication). Roles, responsibilities and outcomes of rural livelihoods are often considerably gendered (Ellis, 1999) and differences in the way that men and women value, access and use NTFPs, resources and markets are well documented in the literature (Paumgarten and Shackleton, 2011; Ingram et al., 2014a, 2014b; Sunderland et al., 2014). Within the charcoal literature, male charcoal transporters typically earn higher wages than women (Smith et al., 2015). Perhaps the relatively recent presence of charcoal production within some communities has led to non-gendered production practises (Jones et al., 2016), but there is limited data to suggest whether men and women achieve comparable outcomes from engaging in charcoal production.

Limited understanding and punitive political attitudes towards the charcoal trade, coupled with difficulties in accessing secure resource tenure, market security and start-up costs (e.g. licence fees) means that SSA's charcoal status quo makes it challenging for poor communities to invest in the sector. Many charcoal-based livelihoods are thus informal, and therefore fraught with uncertainty and risk from enforcement activities, and often ignored or penalised by governments (e.g. Smith et al., 2015). Benefits to individual producers are just one of the many positive aspects of the charcoal industry that are poorly understood and often overlooked in favour of environmental arguments against the industry. A better understanding of the role charcoal production plays in producers' livelihoods is therefore required if charcoal policies are to benefit the rural poor.

Research objectives

This paper is one component of a larger study that examines charcoal-related livelihoods in and around Zomba, a medium-sized city in southern Malawi (see Smith et al., 2015, submitted for publication). Here we aim to address the research gaps outlined above and examine the contribution of charcoal production to livelihoods of charcoal producers who supply to Zomba.

Our specific objectives are to:

- Identify factors that motivate an individual to be involved in charcoal production;
- Analyse gender differences in livelihood outcomes generated from charcoal production;
- Identify sources of vulnerability for charcoal producer livelihoods.

Materials and methods

Sustainable livelihoods framework

We used the Sustainable Livelihoods Framework (SLF) as a conceptual framework to structure our analysis (see Scoones, 1998; DFID, 1999), due to its holistic and multidimensional approach that acknowledges the complexities entrenched in rural livelihoods (Fisher et al., 2013). A livelihood can be considered sustainable when it "can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long-term" (Chambers and Conway, 1992, pp. 7).

The SLF describes livelihoods as comprising a diverse combination of subsistence and income generating activities and strategies. These depend on assets (human, physical, natural, social and financial), which are deployed within a context of vulnerability (e.g. seasonality, shocks and trends). Transforming structures and processes are important external factors that shape people's livelihood strategies. In the case of charcoal production, particularly important transforming structures are local bodies such as the Department of Forestry, police and village committees charged with the forest protection, while key processes include government policies on charcoal and resource access. When applied to charcoal production, the SLF allows assessment of the socioeconomic and underlying vulnerability context in which producers' livelihoods operate. It incorporates their livelihood assets and outcomes, including how involvement in the trade and the governance structures affect livelihood outcomes, and assists in exploring factors that influence power and access to charcoal resources and markets. Sustainability aspects relate to how governance of the sector affects the environmental sustainability of the resource management and extraction practices and thus the overall sustainability of producer-based livelihood outcomes.

Study site

The main charcoal resources for Zomba are located in Machinga and Zomba Districts, in mountainous outcrops located north of Zomba city

within Zomba forest reserve, the adjacent Malosa forest reserve and Liwonde forest reserve (Kambewa et al., 2007; Smith et al., submitted for publication). In 2015, Zomba's urban population was expected to exceed 164,000, increasing annually by 4.21% (NSO, 2013). Machinga and Zomba Districts are some of the most densely populated areas of Malawi (130 people km^{-2} and 230 people km^{-2} respectively). The two districts are also the second and third poorest in Malawi; 73% of the population in Machinga and 70% of the population in Zomba District fall below the national poverty line (Zomba District Assembly, 2009). The principal livelihood activity is rain-fed subsistence agriculture, focused on maize production. Rural households do not use charcoal themselves but charcoal production for the urban and peri-urban markets of Zomba town is an important income generating activity in many communities surrounding the forest reserves.

According to the 1997 Forestry Act, charcoal can be produced legally in Malawi subject to an agreed sustainable management plan. Although enacted in 1997, the first licence to produce charcoal was not granted until September 2015. This charcoal is produced as a by-product from stands of *Corymbia citriodora*, primarily harvested for an essential-oils business (Personal comm. Tanya Clarke, Kawandama Hills Plantation Director). Apart from this one licence, to-date there is currently no domestic source of legally produced charcoal within Malawi.

Malawi's domestic energy market will continue to be dominated by charcoal, with demand for charcoal predicted to increase in the future regardless of whether the country's electricity expansion scenarios are achieved (MARGE, 2009). Domestic urban consumers in Zomba frequently mix fuel types for cooking; an estimated 82% of urban households consume charcoal as part of their energy mix, 42% consume firewood, 29% consume electricity, and charcoal demand fluctuates seasonally corresponding with higher rainfall and lower temperatures (Holmes, 2015).[1]

Malawi has three main seasons. The warm, wet season stretches from November to April, with the Zomba region experiencing an annual average rainfall of 1433 mm. A cool, dry season follows from May to August with mean national temperatures varying between 17 and 27 °C, falling to between 4 and 10 °C, with the coldest period occurring in June and July. The hot, dry season runs from September to October with mean national temperatures varying between 25 and 37 °C (Department of Climate Change and Meteorological Services, 2006). Nearly 95% of Malawi's electricity supply is provided by hydropower (ESCOM, 2016) and heavy rainfall is known to disrupt electricity supplies across Malawi in the rainy season (ACAPS, 2015). In response to the erratic supply of electricity and increased frequency of load-shedding, some urban households increase their consumption of charcoal during periods of high rainfall (Afriem, 2015).

Sampling procedure

This study focuses on charcoal producers in three case study villages that produce charcoal for Zomba city. We selected the villages from a sample of 28 charcoal-producing villages identified through a survey of charcoal transporters and discussions with agricultural extension officers (see Smith et al., submitted for publication for more details). From this larger set, we purposively selected the three case study villages to be as representative as possible of the charcoal production area according to five criteria:

(1) Size of the village;
(2) Proportion of households perceived to be actively engaged in charcoal production at the time of data collection;
(3) Perceived amount of time charcoal production had existed in the village;
(4) Distance of the village to the forest reserve boundary; and
(5) Perceived contribution of charcoal income to the village economy.

We analysed the mode and mean for each criterion to identify the 'most representative' village in each of the three production areas. As no village represented the mean or mode for all criteria, villages with the closest responses to the modes and means were selected. To protect village anonymity and participants' identities, the locations and names of villages are not given; however as described by Smith et al. (submitted for publication), the villages were located in the north, east and southwest of the production area (Fig. 1). The three case study villages represent communities at different stages of production (Table 1).

Data collection

To obtain a thorough understanding of the contribution of charcoal production to rural livelihoods, we used a mixed methods approach, combining focus group based rapid rural appraisal tools (Carruthers and Chambers, 1981; Marshall et al., 2016) and semi-structured interviews. Between them, the methods addressed the different components of the SLF. Data were collected in two phases, in September–October 2013 and June–July 2014, with the help of trained interpreters.

Rapid rural appraisal tools

In each case study village we undertook four focus group discussions with men and women who were actively engaged in producing charcoal. Each focus group lasted 1–3 h and comprised 6–8 charcoal producers in gender-separated groups.[2] Village chiefs selected the initial participants; subsequent participant selection was carried out through snowball sequential sampling and different participants were used during each rural appraisal exercise. We addressed a core set of questions with all participant groups. However, as is often the case with participatory research, we followed the interests and experiences of the participants of specific groups, which resulted in some data being collected only from certain groups. We have indicated where this occurred within the results section. The four focus groups discussed the following topics:

Charcoal production calendar. Participants ($n = 57$)[3] from all focus groups were asked to recall the number of charcoal bags they had personally produced each month, over the previous 12 months. Subsequently, focus groups discussed reasons for unusually high or low levels of production. Independent t-tests were used to examine whether there were significant differences in the number of bags men and women produced each month. Analyses were carried out using IBM SPSS statistical software, version 22.

Seasonal income and expenditure calendar. The income and expenditure calendars were designed to assess the seasonal importance of charcoal income. We constructed a matrix, with months on one axis and either income generating activities (IGA) or household expenditures on the other[4] (See Marshall et al., 2016). The group used counters to indicate relative values of earnings from different activities and main expenditures over the preceding 12 months. Participants then discussed, justified and explained their distributions.

Livelihood assets. Participants discussed how and why charcoal production affected natural, physical, financial, human and socio-cultural assets, and what impact this had for household livelihood strategies.

Value chain governance. This focus group discussion was designed to elicit data on how formal and informal structures affected producers'

[1] In Holmes' (2015) study, respondents highlighted that charcoal was used for both cooking and heating purposes.

[2] No women were known to produce charcoal in the Southwest village, therefore we did not undertake group discussions with women in this specific village.

[3] The lead author carried out other focus groups that are not detailed in this particular article. The charcoal production calendar was a final exercise at the end of each session. In this way, a total of 57 participants from the North village (25 men and 32 women) took part in this survey.

[4] We included IGAs or expenditures that participants identified as doing/spending within the 12 months prior to data collection.

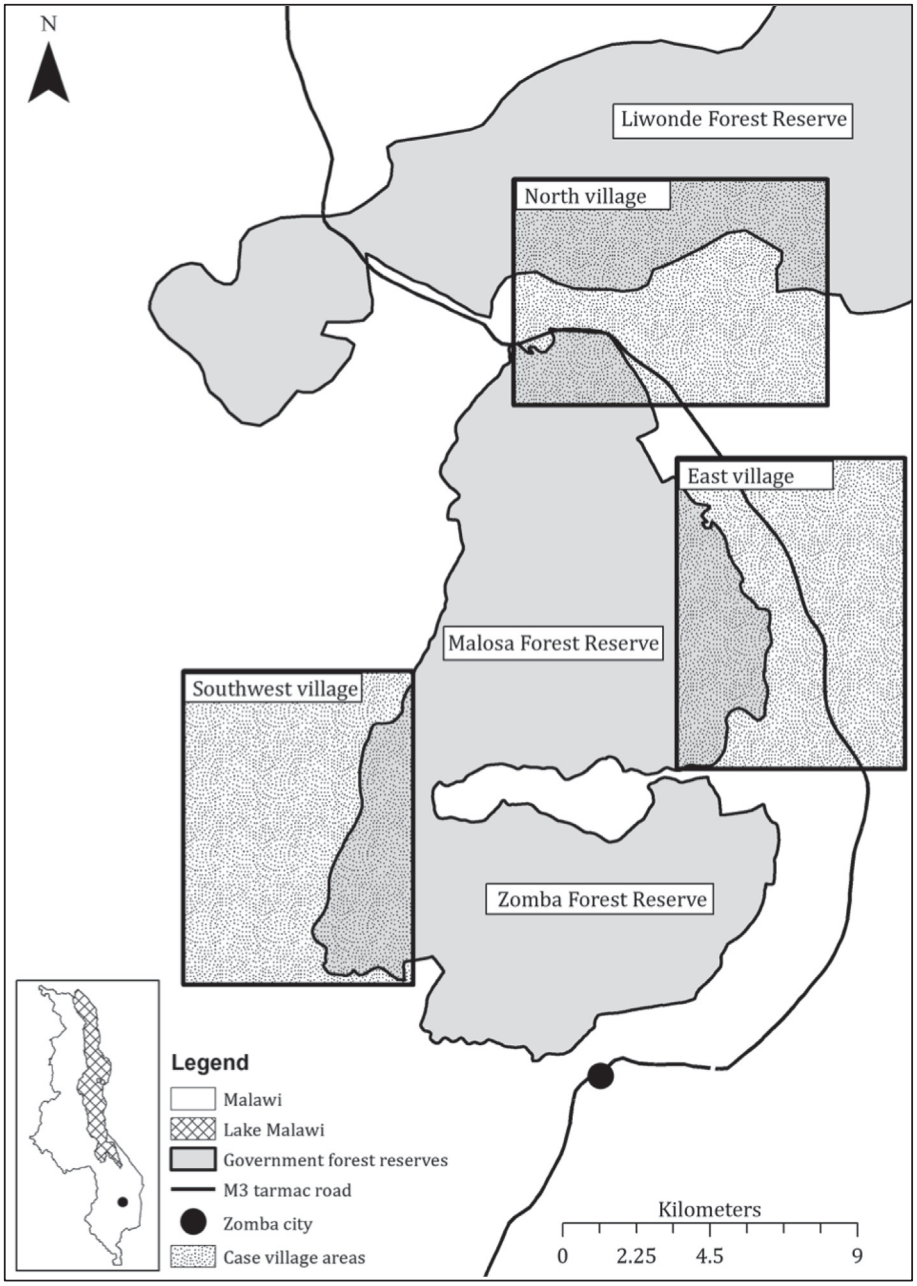

Fig. 1. Locations of the three case study villages within Zomba's charcoal production area (Data supplied by the National Statistics Office of Malawi).

access to charcoal resources and markets. The researcher and participants jointly constructed a diagram of the charcoal value chain. Participants identified the roles and responsibilities of different actors and institutions along the value chain, indicated the challenges to their involvement in charcoal production and the coping strategies they implemented in response.

Semi-structured interviews.

We carried out 42 individual semi-structured interviews with 28 men and 14 women from the three case study villages.[5] The interviews lasted between 15 and 30 min and were designed to elicit information about producers' personal histories, thematic reasons for engaging in production, their experience with the trade and to corroborate information from the value chain governance and livelihood assets focus group discussions. Quantitative data were analysed in Microsoft Excel for Mac, version 14.4.7.

Results

We first focus on the contribution of charcoal production to livelihood strategies, then outline the impact of the activity on different assets and describe the perceived role of transforming structures and processes in promoting or obstructing charcoal production. While we mention shocks, trends and seasonality in this section, we examine vulnerability in more detail in the discussion.

Livelihood strategies

Participants in the focus groups and semi-structured interviews never portrayed charcoal production as a desirable livelihood strategy.

[5] We interviewed 14 participants in each village: 7 men and 7 women. However, in the Southwest village, only men participated in charcoal production, therefore we interviewed 14 men.

Table 1
Stages of charcoal production and forest degradation of East, Southwest and North case study villages constructed with data from Smith et al. (submitted for publication).

	East village	Southwest village	North village
Perceived start of charcoal production	1986/90	1970	1996/2000
Perceived peak of charcoal production	2001/05	2013/14	Not yet reached
State of forest resource	Heavily degraded with agricultural conversion.	Degraded with some remaining patches of forest.	Largely undisturbed, low level of degradation.
Tree species availability	High-grade species[a] scarce, indiscriminate harvesting of trees including domestic and fruit and digging of roots.	Patches of high-grade species increasingly scarce. Indiscriminate harvesting of trees including domestic and fruit and digging of roots.	Selective harvesting of abundant high-grade species.
Hours walk to resources (one-way)	5–6	3–4	0–1
Gendered participation	Mainly men, some women	Only men	Men and women

[a] Species that are perceived to produce high-grade charcoal include *Brachystegia bussei*, *Brachystegia speciformis*, *Brachystegia stipulata*, *Pericopsis angolensis* and *Dalbergia nitidula* (Smith et al., submitted for publication).

Engagement in production was never undertaken because an individual valued being a charcoal producer, in some circumstances lower paid jobs were preferred over charcoal production (Box 1).[6] Semi-structured interviews from all villages (n = 42) identified six reasons for an individual's initial engagement in production. The most frequently cited reason (n = 18) was a lack of alternative employment opportunities, the loss of previous employment (n = 10) and the need for money for a specific expenditure (e.g. school fees, fertiliser) (n = 9). Additionally, shocks in the forms of loss of a family member (n = 6), birth within a household (n = 3) and famine[7] (n = 2) also motivated individuals to engage in production.[8]

Seasonal production practises

Data on charcoal production from the North village focus groups[9] display a seasonal pattern (Fig. 2), with highest mean levels of production occurring in July and lowest mean levels of production occurring in October. Participants did not produce consistently every month; no participant recorded producing charcoal every month, which points to the part-time nature of the work. More people were engaged in July and the least number of people were engaged in production in October.

Men and women produced similar amounts throughout most of the year, however women produced significantly more bags[10] than men in January (men mean = 3.5 ± 6.7, women mean = 6.1 ± 11.8, $t(54) = 1.42$, $p < 0.01$), March (men mean = 2.8 ± 3.3, women mean = 5.0 ± 7.7, $t(54) = 1.37$, $p < 0.05$), May (men mean = 5.1 ± 5.5, women mean = 8 ± 7.7, $t(54)1.66$, $p < 0.01$) and June (men mean = 4.1 ± 5.9, women mean = 12.6 ± 11.1, $t(54) = 3.43$, $p < 0.01$). There was no significant difference between the number of months men (mean = 6.2 ± 2.4) and women (mean = 7.2 ± 2.6) spent producing.

Focus groups gave a number of reasons for low levels of charcoal production:

- Sickness (could occur in any month, with the wet season a particularly high-risk period for malaria)
- Exhaustion (could occur in any month)
- Resting (could occur in any month)
- At school (term time runs from September–July)
- Living away from village (could occur in any month)
- Farming responsibilities (Field preparation in August–October; planting and weeding from December to February; maize harvest in March.)

Participants attributed particularly high levels of production to:

- Food scarcity (highest in January and February)
- Paying casual (farm) labour (farming labour mirrors the months of farming responsibilities: August–October, December–February and March)
- Paying school fees (paid termly in September, January and April)
- Buying school items such as stationery and uniforms (September, January and April)
- Buying fertiliser (July–January)
- Paying for building work and materials (June–July)
- Buying clothes (could occur in any month)
- High market price for charcoal (December–February and June–July)

Box 1
Charcoal producer semi-structured interview samples- Livelihood strategies

24-year-old male producer from the East village: "*I now own a small chip stall. I could earn more money from producing charcoal, but cooking chips gives more time to farm. I'm happier selling chips than producing* [charcoal]. *In 10 years time, I think I will still be cooking chips.*"

31-year-old male producer from the East village: "*Last year I worked in a shop, but now I'm producing. I only produce when I have no other source of income. I can't predict how long I will be producing for, but if I find an alternative source of income I will stop charcoal.*"

38-year-old male producer from the East village: *"Even though producing earns more money, when there is seasonal* [farm] *labour, I stop producing charcoal. Labour is easier work."*

37-year-old male producer from the Southwest village: *"In 2 years I will stop producing because the trees will be gone. I will start farming again. I think farming is more profitable* [than charcoal], *but the money from farming comes once a year, whereas charcoal money is continuous."*

56-year-old male producer from the Southwest village: *"Charcoal money is difficult, it's not stable like farming* [income]. *Charcoal money comes in small amounts, and it's hard to save anything."*

21-year-old female producer from the North village: "*I will stop* [producing] *this year, because I have capital to start a rice* [buying and re-selling] *business with money from producing."*

33-year-old male producer from the North village: *"I think in a year I will have enough capital to change business. If there was no enforcement, it would only take me 3 months to save the money* [from production]."

[6] Interview quotes were translated from Chichewa into English by interpreters.
[7] In 2001/02, Malawi experienced its worst recorded famine, prompting individuals to start producing charcoal in order to purchase food.
[8] Participants could identify several reasons for their engagement in charcoal production as these are not mutually exclusive.
[9] In the remainder of this section we only use data from the focus groups in the North village as the Southwest village had no women producers (thus not allowing for any comparison between men and women), and we considered the data from the East village on incomes, expenditures and charcoal production to be unreliable because, at the time of data collection, charcoal production was scarce due to high levels of resource degradation.
[10] The lead author conducted a survey of bag weights in Zomba market (n = 35), and found a mean weight of 32.56 kg ± 7.3 kg, which is comparable to Kambewa et al.'s (2007) estimation of 38 kg.

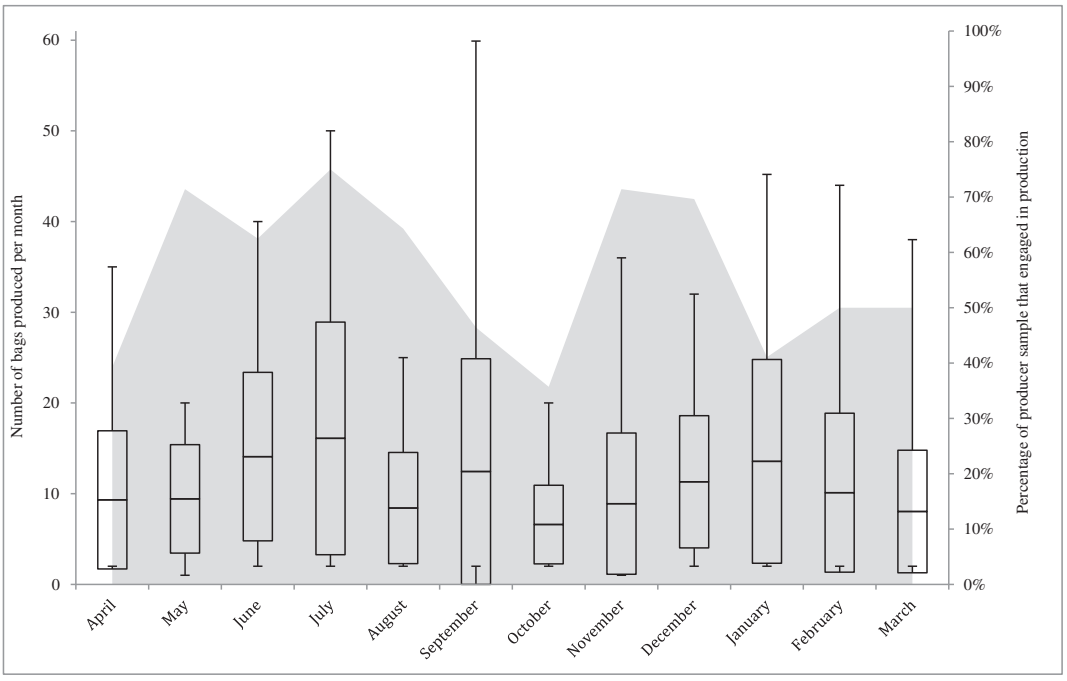

Fig. 2. Box and whiskers plots displaying the mean, standard deviation, minimum and maximum number of bags produced by individual focus group participants in the North village (n = 57) in the 12 months prior to data collection (left axis); and (continuous line with shading) the percentage of sampled participants engaged in production per month (right axis).

Income generating strategies

Charcoal production provided the largest single source of annual income for both men and women, contributing to 26% of the total annual income for men, but almost twice as much (45%) for women (Fig. 3). High levels of charcoal income were generated between March and July amongst men and in May–July and December–January amongst women.

Women engaged in a narrower range of IGAs than men as they did not generate an income from skilled labour, transporting charcoal or football,[11] and a smaller proportion of their income was generated from agriculture (Table 2). Women's income relied more on small enterprises and charcoal production. Discussions with the female participants indicated that start-up capital for the small enterprises predominantly came from charcoal income.

Men generated income from agriculture at different times than women, suggesting higher agricultural diversification due to various fruit and crop harvest times. Charcoal producers spent much of their time making charcoal in the forests, and were conscious of time conflicts with other livelihood strategies. As one 35-year-old male charcoal producer explained: *"Charcoal delays my farming because I'm busy producing. My wife works on the farm, but two hands are better than one"*. Some participants felt they generated lower agricultural yields than non-producing households as they prioritised charcoal production over farming activities.

Male charcoal producers dominated the harvesting and sale of NTFPs and harvested a wider range of NTFPs (5 types) than the women (2 types). Women did not harvest firewood for sale, which was attributed to lower potential profits (compared with those from charcoal) and lack of time available to participate due to conflicting household responsibilities.

Expenditure patterns

The three highest expenditure items for both men and women were food (purchasing food items and maize processing fees), assets (e.g. bicycle, radio, household items) and agricultural inputs (e.g. labour, fertiliser, tools, seeds) (Table 3, Fig. 4). Women proportionately spent the most on food (48%), whereas men spent the most on assets (32%).

All semi-structured interview participants were subsistence maize producers, with just 21% estimating that their maize reserves would last until the following harvest in March. Seven per cent of participants expected to run out 5 months before the harvest, a quarter (25%) 4 months before, 22% 3 months before, 11%2 months before and 14% 1 month before the harvest. As a result, a principal expenditure item for participants was buying food, especially during seasonal food shortages in the pre-maize harvest period from October–February.

Spending levels were similar in both the dry (May–October) and wet (November–April) seasons for both men and women. During the dry period, men invested more income in shelter (e.g. for building materials or construction labour)[12] and in purchasing assets, and began investing in agricultural inputs and business capital towards the end of dry season. Women's spending on assets was also greater in the dry period, but they also reported higher spending on clothing and food. During the wet season, both women and men reported spending more on food, with men also increasing investments into agriculture and business capital.

Amongst men, charcoal consistently contributed at least 14% of the total income needed to meet monthly expenses, and only contributed to more than half (98%) their expenditures in March (Fig. 4). Amongst women, the contribution of charcoal income to expenditure was much more variable across the year ranging from 4% to 99%, with charcoal contributing to at least half of their monthly expenditure in 4 months.

Livelihood assets

We summarise the livelihoods assets focus group discussions from all three case study villages, and highlight details of individuals' experiences collected from the semi-structured interviews.

[11] Men were paid to play football in local leagues.

[12] In this region, construction work typically occurs during the dry months, as certain activities (e.g. drying bricks) are difficult to do when it rains.

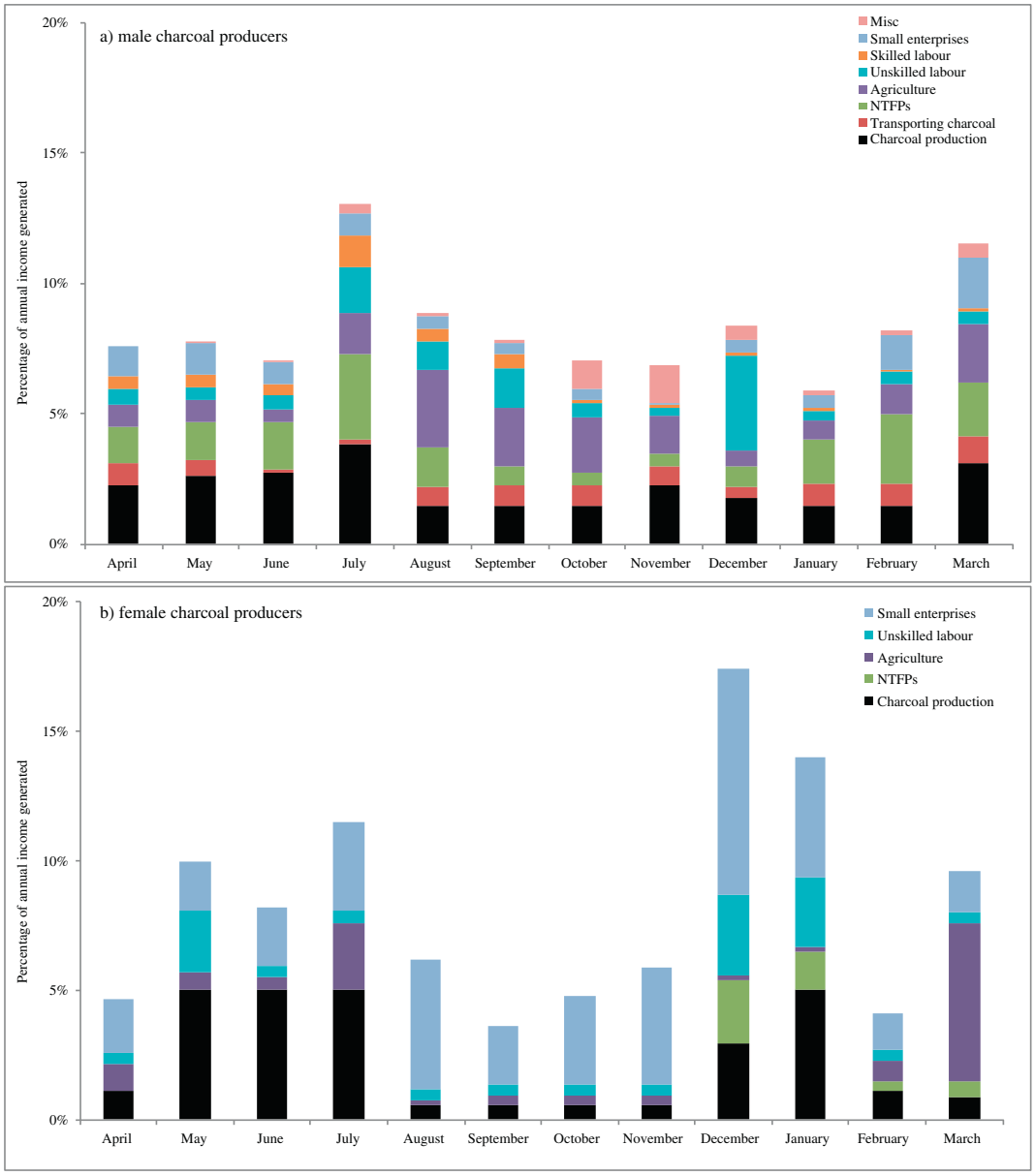

Fig. 3. Perceived seasonal variability of income in the North village for a) male and b) female charcoal producers. Data from the seasonal income calendar focus groups.

Financial assets

In all villages, income from charcoal production improved participants' access to village savings and loans groups and ability to invest in other IGAs. Participants purchased farm inputs such as fertiliser, tools and seeds with charcoal income. In the North village, it was more affordable overall to focus on producing charcoal and pay for farm labour with the charcoal income. In this respect, the benefits of considerable cash income from charcoal outweighed and overcame the issues of time conflicts with farming responsibilities. In the Southwest and East villages however, available charcoal resources were limited, and thus income from charcoal was not substantial enough to hire farm labour.

Charcoal-based financial assets were vulnerable to fines and confiscations from the regulating authorities. The impact on individuals and households varied depending on the severity of the enforcement activity. Nevertheless, participants linked income loss from enforcement activities with vulnerability to increased food insecurity, debt, financial insecurity, stress and reduced access to goods and services (Box 2).[13]

Natural assets

All focus groups perceived that localised forest depletion due to the complete removal of trees (and roots in the East and Southwest villages) from unsustainable charcoal production practises (e.g. not replanting cut trees) had degraded their natural assets. All focus groups perceived that localised forest loss (due to charcoal production) was linked to a change in rainfall pattern and increased frequency and

[13] Interview quotes were translated from Chichewa into English by interpreters. Exchange rates varied in the two periods of fieldwork: September–December 2013 (US$1 = K325 to US$1 = K407) and June–September 2014 (US$1 = K375 to US $1 = K394) (Oanda Corporation, 2015). For indicative purposes, we use a rate of USD $1 = K 394 for the rest of the paper.

Table 2
Men and women's reported income generating activities and their contribution to participants' total annual income. Data from the seasonal income calendar focus group in the North village.

IGA group	Men		Women	
	Specific IGAs	Contribution to total annual income (%)[a]	Specific IGAs	Contribution to total annual income (%)
Charcoal production	–	26	–	45
Charcoal transporting	–	8	–	0
Agriculture	Selling cultivated crops Selling cultivated fruits Selling livestock	17	Selling cultivated crops Selling cultivated fruits Selling livestock	9
Small enterprises	Brick burning Hoes Mats Buying and selling vegetables	10	Beer brewing Mandasi (donuts) Buying and selling fish Buying and selling vegetables	33
Unskilled labour	Casual seasonal farm labour	12	Casual seasonal farm labour	9
Skilled labour[b]	Builder Carpenter Tailor	4	–	0
NTFP[c]	Firewood Grass Poles Wild fruits	18	Grass Mushrooms	4
Misc	Football	5	–	0

[a] Percentages calculated from the numbers of counters distributed amongst income generating activities.
[b] Skilled labour required specialised training for the specific skill.
[c] NTFPs were defined as the harvesting and selling of unprocessed NTFPs.

intensity of run-off from the forest reserves. Focus groups from all villages perceived that forest loss was leading to lower agricultural yields due to increased prevalence of flooding and reduced soil quality in agrarian lands. They additionally stated that tree loss was responsible for the heavy siltation and subsequent drying of smaller streams in the dryer months, resulting in reduced potential for irrigated agricultural systems.

All focus groups perceived increased scarcity in NTFPs, which included firewood, edible plants (including fruits and mushrooms), wild animals, medicinal plants and construction materials such as poles and grass. Prior to their engagement with charcoal production, participants reported that all NTFPs used to be available closer to villages and were easy to source. Greater difficulty in accessing these products meant that collection of firewood, for example, had shifted from women and children to men in all three villages. However, while wild firewood resources were increasingly scarce, participants also explained that the availability of domestic alternatives (e.g. from planted eucalyptus in the village) reduced the possible impact on households. The loss of wild foods was perceived as a permanent situation; however, focus groups also felt that sufficient alternatives were available, such as cultivated fruit in the village, market vegetables and livestock, and that income from charcoal production could enable producers to access these alternatives.

Social assets

Participation in charcoal production strengthened social assets, through improved ability to support others. All focus groups described notions of camaraderie amongst charcoal producers, assisting each other to avoid enforcement activities, lending each other tools and exchanging labour. They expressed their ability to financially support family members with charcoal income, for example by paying school fees or giving financial support to elderly or infirm relatives. Non-producing community members also benefitted from the charcoal trade, as income from production would be spent within the village, thus supporting local businesses. Participants purchased gifts, expensive items (such as meat) or donated to cultural celebrations and ceremonies using charcoal income.

In the North village, following the start of charcoal production in the village, focus groups perceived lower levels of theft. Participants explained that previous incidences of theft in the village were linked to poverty and food insecurity, as people would steal crops or assets to sell for cash to buy food. The growth of charcoal production in the village, accompanied by increased incomes amongst community members had led to an apparent decline in thefts. Participants perceived increased levels of trust between community members as a result. However, participants anticipated that when the tree resource declined to a point when charcoal production was no longer possible, poverty levels and incidences of theft might increase again.

The illegality and informality of the sector weakened producers' social assets through increased risk of conflict with authorities including the Forestry and Police Departments, internal community authorities such as Village Natural Resource Management Committees (VNRMC) and traditional leaders. In the Southwest village, focus groups reported conflicts with other community members, as non-producers would threaten to report producers to the authorities. Additionally, female focus groups in the East village perceived a stigma associated with their involvement in the trade, as non-producer women in the community were known to deride female producers for participating in a 'dirty' job.

Table 3
Reported items of annual expenditure by men and women. Data from the seasonal expenditure calendar focus group in the North village.

Expenditure item	Proportion of total annual expenditure (%)[a]	
	Men	Women
Business investment	8	6
Clothing	5	8
Food	21	48
Shelter	11	2
Assets	32	18
Agricultural inputs	24	18

[a] Percentages calculated from the numbers of counters distributed amongst income generating activities.

Human assets

Income from charcoal production increased producer households' access to formal health services, however households also still relied on traditional medicines. Accompanying the degradation of natural assets, all focus groups perceived a reduction in the availability of medicinal plants due to the complete removal of trees (which were either medicinal plants or provided habitats for others) by unsustainable

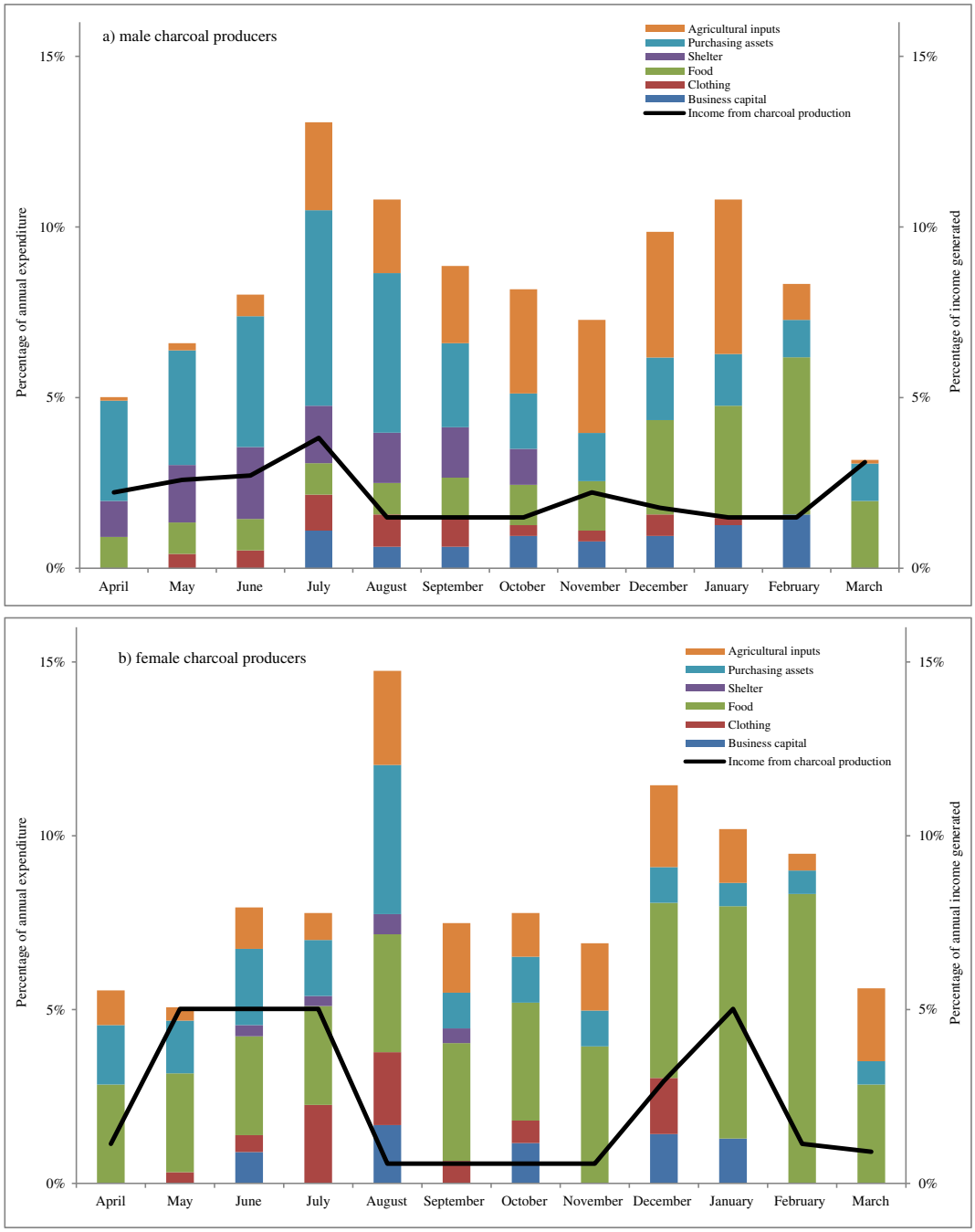

Fig. 4. Perceived seasonal variability of expenditure in the North village for a) male and b) female charcoal producers (left axis) with charcoal income shown (black line) for comparison (right axis). Data from the seasonal expenditure calendar focus groups.

charcoal production practises. Focus groups in the North village had also perceived a recent reduction in the local medicinal plant market, as people were increasingly using the remaining plants for their own use rather than selling them.

All focus groups made observations of feeling exhausted after work, which affected their abilities to pursue alternate livelihood strategies and socialise. In the Southwest village specifically, group participants perceived a correlation between charcoal production and a reduction in intimate spousal relations. Producing charcoal was also associated with increased risk of respiratory illnesses from exposure to kiln smoke and dust. All group participants perceived it to be a dangerous activity, as constructing charcoal kilns in unstable, mountainous and rocky terrains increased producers' risk of accidents and serious injury. In the Southwest village for example, at the time of data collection one producer was hospitalised from a producing-related injury and one man had died the previous year after a tree he was cutting had fallen and crushed him.

The links between charcoal production and access to education and skills development were both positive and negative. The attraction of substantial incomes from production increased the risk of children dropping out of school, either to produce charcoal themselves or to look after younger siblings whilst their parents were producing charcoal. However, charcoal income could pay for school fees, uniforms, stationery and vocational skills training (e.g. drivers licence, carpentry training).

Physical assets

Increased income generated from producing charcoal improved participants' ability to purchase expensive assets such as bicycles, radios, livestock, passports and farm inputs such as tools, seeds and fertiliser.

Box 2
Charcoal producer semi-structured interview samples: Impacts of enforcement

38-year-old male producer from the East village: "*I was sent to prison* [for producing] *for one week, and had to pay a fine of K5, 000. My relatives paid the fine. I was too scared to go back into the forest, so spent 6 months at home. But I needed money, and had no other choices, so I had to start producing again."*
50-year-old female producer from the East village: "*My husband was sent to prison for 1 month* [for producing] *and was fined K10, 000. My children had to leave school to help me produce, so we could pay the fine to release him.*"
46-year-old male producer from the Southwest village: *"I feel anxious when I produce charcoal; I'm always worried of the Forest Department finding me* [with charcoal]*."*
20-year-old male producer from the North village*: "I once had five bags confiscated. I was going to use the money to pay for* [farm] *labour. Another time, I couldn't afford to buy fertiliser* [due to a confiscation]. *I bought it late in the season and my* [maize] *yield reduced from 20 to 16 bags."*
22-year-old male producer from the North village*: "I had seven bags confiscated by the Forest Department from my home. This happened in February during the hunger period. I didn't eat for 2 days, and had to borrow K25,000 from the village bank, paying 20% interest."*
33-year-old male producer from the North village: *"During time in prison* [because of producing charcoal]*, my child was sick and my wife had to sell firewood to support the family. I couldn't support my family, we had less food at home. I had to take a loan and gave my bike as security."*
37-year-old female producer from the North village: *"I had 15 bags confiscated. I couldn't pay* [my children's] *school fees, and had to borrow from the village bank. Another time, I had 20 bags confiscated. I was using the money to pay off a debt, but instead had to take an additional loan from the village bank. I'm still only paying off the interest."*
56-year-old male producer from the North village: *"In June, I had 15 bags confiscated by the Forest Department. I was going to use the money to pay off an outstanding loan. Instead I had to borrow more money from the village bank. The initial loan was K34, 000 then borrowed an additional K10, 000, with 20% interest."*

Construction and maintenance of buildings was a seasonal activity that only occurred in periods of low rainfall, from April–November. Higher charcoal production rates in the cooler months of June–July coincided with this seasonal demand for building materials and increased producers' access to improved building materials, such as iron roofing and burnt bricks, thus strengthening producers' physical assets. Group participants in the Southwest village explained that their income had contributed to the development of community infrastructure, through funding the construction of a local religious building, which they additionally linked to the strengthening of social assets, as they were able to contribute to their community. In the North village, the recent boom in charcoal production enabled widespread purchase of solar panels, an effect not seen in the other villages where increases in charcoal production had predated technological advances in solar energy.

Group participants from all villages perceived a reduction in the availability of traditional building materials, particularly NTFPs sourced locally such as poles and grass. Although there were market substitutes for many of the lost or degraded NTFPs, some substitute products such as eucalyptus poles were considered inferior to the wild products and participants had perceived an increase in their market price.

Transforming structures and processes

We present information from the value chain governance focus groups and semi-structured interviews from all three case study villages to explore how formal and informal structures impact individuals' access to charcoal production, in terms of influence over and access to the resource and markets.

Formal structures and processes

In accordance with the Forestry Act (1997), VNRMC members, Forest and Police officers may seize any forest produce which they suspect has been illegally removed or obtained and must issue a certificate of seizure. Any person who, "without authority under this Act […] fells, cuts, takes, destroy [sic], removes, collects, uproots any indigenous tree or forest property in a forest reserve or protected area […] shall be guilty of an offence and liable upon conviction to a fine of K5000 and to imprisonment for a term of 2 years" (Part X, 64, pp. 21). In all villages, the Department of Forestry were the primary enforcement body, implementing regulations in the forest reserves and villages. The North village indicated the widest range of institutions involved with enforcement, including the Police Department, the Department of National Parks and Wildlife and the Malawian Defence Force. In the East and Southwest villages, the VNRMC assisted the Department of Forestry by directing them towards known producers' houses.

Enforcement activities mentioned by interview respondents included bribes, confiscations, fines, prison sentences and beatings (Table 4). Sixty-six per cent of respondents had experienced at least one confiscation during the time they had been engaged in production and men reported more experiences of enforcement activities than women. In the forest reserves, producers' tools and charcoal would be confiscated and kilns destroyed. Focus groups were unsure of how frequently fines were paid, or how much would be paid, but explained that a bribe could be paid in lieu of a fine. The Southwest village focus groups indicated that Forest officers sometimes abused their powers. For example, if a group of producers were found together then officers were known to make them carry the charcoal to the homes of the Forest officers. Some participants from the Southwest village reported they had personally experienced incidents when officers had used corporal punishment on producers, ordering them to beat each other with sticks. Village patrols primarily carried out by the Department of Forestry with assistance from the police occurred in all three villages, but only included the confiscation of charcoal. If producers resisted the confiscations or fines, they would be arrested and charged through the court system, with the risk of a prison sentence. Producers from the North and Southwest villages were under the impression that a fine of K60,000 and K10,000 respectively, was required to be released from prison. If this cost could not be paid then the individual would remain in custody for an unknown amount of time.

Informal structures and processes

Given that no legal production existed in the study region, all recorded production processes were illegal and informal. Production was predominantly carried out as an individual activity, or jointly by household members and where both men and women participated, they performed the same roles in the production process. In the North village, there were agreed rates for casual labour in the charcoal production process.[14] Individuals involved in casual labour were not necessarily producers or from the same village. However, participants were not aware of the existence of an elite group (or individual) who dominated or controlled the local charcoal labour market. If an individual was looking for casual labour, they could either enquire within their immediate social network or speculatively go to the forest reserve in search of work. Due to competition with demand for casual labour in charcoal

[14] Neither the East nor the Southwest village confirmed the existence of a local charcoal production labour market, as the cost of labour and low availability of trees did not make it a profitable activity.

Table 4
Charcoal producers' experience with enforcement (n = 42). Data from individual interviews with participants from all case study villages.

	Bribe	Confiscation	Fine	Prison	Beating	Carrying charcoal	None
Female producers	2	6					7
Male producers	3	22	5	4	1	4	5
Total[a]	**5**	**28**	**5**	**4**	**1**	**4**	**12**

[a] The totals add up to more than the number of participants (n = 42) because some participants identified multiple experiences with enforcement.

production, the price of casual labour for agricultural activities in the village had increased.

In the Southwest village, participants described a different type of organised production. Due to the scarcity of forest resources and suitable production grounds, there were specific locations within the forest reserves where production occurred, which were known and named by producers. The production locations favoured rock-free, relatively flat areas of ground near a water source and it was common for producers to organise travelling together. Unlike the North village however, only producers (as opposed to people in search of casual labour) would travel to the production sites. Producers constructed temporary shelters and cooking areas, and would transport unprocessed wood to a central kiln burning location. The sites were semi-permanent, existing for as long as there were sufficient woody resources nearby.

Other informal structures evolved around charcoal producers and their social networks evading enforcement. For example in the three villages, traditional leaders were not directly involved in the enforcement of formal regulations, but advance warnings from village leaders were not uncommon. Village patrols would be announced during village meetings, forewarning producers not to enter the forest reserve on a particular day. Additionally, participants from all villages indicated that friends or relatives working for the Department of Forestry would informally warn them of upcoming patrols. If a patrol was seen entering, friends, relatives and other charcoal producers would signal up to producers in the forest reserves using mobile phones or by whistling. Most producers explained that they would leave their kilns in an attempt to hide from enforcers. However in the East village, producers had found a more assertive solution: if enforcers were sighted, a producer would whistle to others nearby to form a group which would then threaten the enforcers by shouting verbal abuse or even throwing stones to dissuade them from approaching. They also reported a more proactive and hostile approach to village patrols, for example by barricading enforcers' transport with rocks and logs. Participants in the North and Southwest villages conceded that there was little they could do to avoid village patrols, other than receiving warnings from the roadside, giving producers the advantage to hide their charcoal, or leave their houses. They clarified that enforcers would increase the severity of the sanctions if they became antagonised, but if houses were locked and unoccupied, regulators would usually not force entry to confiscate charcoal.

In all villages, participants reported selling to bicycle transporters either from their village or surrounding areas, or selling directly to consumers in peri-urban markets of Zomba (travelling either by bike, using public buses or lorries and, in the Southwest village, also travelling on foot). Market access specific to each village was also reported: the East village sold ad hoc to consumers travelling in personal vehicles, the Southwest village sold to transporters travelling to Zomba on foot, both the Southwest and North villages reported selling to transporters using public transport and, in the North village, participants reported selling to staff of local authorities, who would travel in official vehicles to buy large quantities of charcoal to resell in Zomba.

Discussion

Motivation to engage in charcoal production

Forest resources provide safety-net, gap-filling and income-smoothing functions to meet households' everyday and seasonal requirements (Shackleton and Shackleton, 2004; Sunderlin et al., 2005). Our data indicate that an individual's primary reasons for engaging in charcoal production were for one-off, large, unexpected expenses related to purchasing expensive items (e.g. school fees or fertiliser); in response to a shock, such as a birth or death in the family or unexpected loss of employment; in response to higher urban demand for charcoal; or for recurrent seasonal needs, such as purchasing food during periods of food scarcity or building materials in the dry months. Natural product trade is known to assist rural households generate some, if not all their cash income (Schreckenberg et al., 2006; Mahapatra and Shackleton, 2012; Angelsen et al., 2014; Schaafsma et al., 2014) and the data from this case study demonstrate that Zomba's charcoal trade provides an important source of income for rural livelihoods.

Malawi's charcoal sector presents a much-needed opportunity for those who have access to the resources and markets to generate an income, as a key issue in the region is the lack of income generation opportunities available to rural communities (Zomba District Assembly, 2009). Charcoal production generated the biggest source of income for all producers, provided start-up capital required for other income generating activities and was prioritised by some over alternative livelihood strategies such as agriculture. Yet, charcoal production was not perceived as a desirable livelihood activity. These apparently conflicting views can be reconciled by the fact that unlicensed charcoal production is not only an illegal activity (subject to frequent and costly enforcement activities) but also one that is stigmatised within the village and considered much harder and more dangerous work than alternatives such as agricultural labour.

Livelihood outcomes

Natural product trades tend to generate only modest cash incomes (Schreckenberg et al., 2006). In the study region, engaging in charcoal production did not only generate financial benefits, but also improved access to goods and services such as education and training, increased producers' ability to participate in village savings and loans associations and invest in alternative livelihood strategies such agriculture or other IGAs. These livelihood outcomes increased producers' opportunities for livelihood diversification and risk management, which are important factors for reducing vulnerability to poverty amongst rural livelihoods (Ellis, 1998; Hussein and Nelson, 1998). Although reporting from a very different context, our data confirm work from Mozambique that highlights the importance of charcoal production as a livelihood diversification strategy (Jones et al., 2016).

Well-functioning supporting structures (such as the alarm systems for forest patrols) relied on the development of producers' good social relations and networks. Additional livelihood outcomes included strengthened social assets through the ability to support others financially and contribute to the community and the development of new and expanded social networks, which extended beyond the immediate family relationships upon which rural households predominantly rely (Shackleton et al., 2008). The importance of social benefits generated from the harvesting and trade of other commercial natural products have also been noted by several authors (Leakey et al., 2005; Shackleton et al., 2007, 2008; Shackleton and Gumbo, 2010).

Data from the seasonal income and recall calendars indicate seasonal variability in production practises, with higher levels of production in the cooler months from May to July and during the cold-wet season from November to February. Agriculture was the primary livelihood

strategy in the study region, used for both income generation and subsistence food generation (Zomba District Assembly, 2009). Seasonal food shortages between November and February preceded the maize harvest in March, with most participants running out of personal maize reserves before the harvest season. Cash generated from charcoal production during this period was therefore important and timely for participants' food acquisition and in reducing their vulnerability to seasonal food insecurity.

Negative livelihood outcomes were related to degraded natural assets, time conflicts created by increasing scarcity and distance to remaining forest resources and vulnerability to punitive enforcement activities. The relationship between decreasing forest resources, declining availability of alternative forest-based income and increasing time commitments to travel to remaining resources restricted the ability of an individual to further diversify their livelihood strategies, and instead stimulated specialisation in, and dependence on, charcoal production as a livelihood strategy.

Negative and positive livelihood outcomes were interrelated, for example: increasing time required to travel to remaining resources reduced time available for alternative livelihood activities such as agriculture. However, the income generated from charcoal production enabled producers to hire casual labourers to tend to their agricultural responsibilities. This scenario only existed in the North village where sufficient forest resources meant that charcoal production was much more profitable than in the other two villages, where higher levels of resource degradation meant that charcoal income was on the decline.

Gender differences in livelihood outcomes

Gendered participation in the charcoal production process varied between the three case study villages. In the Southwest village the production process was male-dominated with no record of any women participating in the trade. Where both men and women participated in the trade, they performed the same roles during the production process. Participation of women in charcoal production has also been observed in Mozambique (Jones et al., 2016) and in Tanzania, where women specifically engaged in the activity in order to obtain some financial independence from their husbands (Butz, 2013).

Trade in natural products is sometimes one of the few accessible local IGAs available to the rural poor, particularly crucial for marginalised and vulnerable groups and especially for women (Shackleton and Shackleton, 2004; Khundi et al., 2011; Schaafsma et al., 2014). In the North village, men had more opportunities than women to generate income, perhaps due to the gendered roles and responsibilities amongst rural households (Quisumbing, 2003; Blackden and Wodon, 2006). Independent income is an important social benefit for women (Shackleton et al., 2008) and engagement in independent income generation may raise the status of women within a household (Ellis, 1998). Data from the seasonal income and expenditure calendars from the North village indicated that female producers were considerably more dependent on charcoal production for income generation, which was especially crucial given their limited available IGA options.

There is a large focus on gender dimensions in participation in forest management and decision-making (FAO, 2007; Mwangi et al., 2011; Manfre and Rubin, 2012). However, there is limited information on the gender dimensions in the enforcement and conviction of forest law. Even though men and women performed the same roles in the production process, evidence from this study highlights that female participants did not suffer the same level of enforcements as their male counterparts. This was also observed by Smith et al. (2015) amongst enforcement of charcoal transporters, suggesting that perhaps gender influences the degree of forest law enforcement. In developing countries, women frequently have fewer income generating options available to them (Jiggins, 1989; UN, 2013). Additionally, men disproportionately control household financial decisions; women often have less opportunity to participate in decision-making and are less familiar with administration systems (ibid). As a result, perhaps enforcers are more lenient, or may have less to gain from convicting women.

Sources of vulnerability for Malawi's charcoal producer livelihoods

Potential livelihood benefits were marred by insecure resource access, uncertainty in the trade's future, environmentally unsustainable production practises, increasing trends in environmental and forest resource degradation and increased vulnerability to income loss due to the risk of punitive enforcement. Because charcoal resources were not managed, specialising in charcoal production was inevitably an insecure livelihood strategy, thus increasing producers' vulnerability to change.

Insecure or limited resource access rights undermine the potential for sustained livelihood support for communities (Ellis and Allison, 2004; Angelsen et al., 2014), which is certainly the case presented in this study. Under Malawi's current de facto ban, informal charcoal production in rural communities is an important poverty mitigation strategy, but one that is limited in the long-term, thereby only preventing the deepening of poverty, as opposed to achieving real poverty reduction (Timko et al., 2010). Although resource access rights were not secure for the communities engaged in production, formal enforcement of the trade appeared to have only limited impact on an individuals' level of engagement in production. Enforcement appeared to temporarily deter producers from engaging in the production and sale of charcoal, but daily cash requirements, lack of alternative employment opportunities and limited livelihood diversification options, especially for women, undermined the desired long-term impacts of forest protection measures.

Formal sanctions associated with the protection of the government-owned forest reserves, such as fines and confiscations, increased producers' vulnerability to reduced income. Loss of income reduced producers' access to goods and services, thus increasing their vulnerability to food insecurity, financial insecurity and stress. Variability in the implementation of sanctions reported by participants, and the participation of local authorities in the commercial trade of charcoal, only serve to highlight the tendency for the regulations to be modified by informal practises due to weaknesses in the formal sector. Low capacity for policy implementation and enforcement of charcoal policies have been reported elsewhere in Africa (e.g. Shively et al., 2010; Sander et al., 2013) and have also been found in the regulation of charcoal transport within the same region (Smith et al., 2015). Vested interests of illicit taxes, coercion and corruption for personal gains are deeply embedded in Malawi's charcoal value chain, which are a central source of vulnerability to charcoal-based livelihoods and may impede any changes to the sector. Addressing this particular issue is paramount to endorsing a professionalised and transparent system that delivers political confidence in the trade and encourages participation.

The study demonstrates that producers had the capacity to be self-organised, having developed groups and structures to combat enforcement, built infrastructure within the forest reserves and established a local labour market for the production process. However, informal structures and processes governing wild products are often invisible to policy makers and thus ignored, undermined or contradicted (Laird et al., 2010a). Rural stakeholders are rarely represented in formal decision-making structures (Laird et al., 2010b) and poor integration and coordination between formal and informal charcoal production practises can lead to ineffective resource management and risk marginalising rural livelihoods, increasing their vulnerability to falling further into poverty (Schure et al., 2013). A formalised sector, such as Malawi's current legal system, imposes barriers (e.g. costs involved in obtaining a licence) to participants. Indeed, Malawi's current formal requirements are unrealistic for most people to comply with and are therefore a main source for unsustainable production. Charcoal governance should involve recognising and formalising informal institutions (Wiersum et al., 2014) and should be developed to reflect local

circumstances and needs (Wynberg and Laird, 2007). However, as highlighted by Jones et al. (2016) in Mozambique, formalisation of charcoal production practises must be handled carefully to ensure they do not end up restricting access to the most vulnerable households using charcoal as a flexible income source.

In developing countries across Latin America, Asia and Africa, environmental incomes contribute 28% of rural households' incomes, 77% of which comes from natural forests (Angelsen et al., 2014). This study has shown that commercial NTFPs like charcoal generate positive livelihood outcomes. However, supportive formal systems are crucial if charcoal is to contribute to reducing livelihood vulnerability and levels of poverty (Tieguhong et al., 2015).

Limitations and further research

This study draws on data from just three communities in the Zomba region, thus our ability to draw generalised conclusions is limited. Indeed, the variability found between three producer communities, even within a small study region, highlights further gaps in knowledge and understanding and the need for additional empirical research on charcoal-based livelihoods. Data were only collected from participants actively engaged in production therefore further research is required to compare producer and non-producer households.

It is important that the developers of charcoal policies across SSA make efforts to recognise the presence of existing informal structures and processes and find ways of supporting them. Formalisation of the charcoal sector has been undermined by low implementation capacity of regulations and unclear and insecure resource rights elsewhere across Africa (Sander et al., 2013). There is still limited understanding of how informal charcoal structures and processes function, therefore further research is required to assist their integration into the development of formalised systems and understand the impacts of enforcement mechanisms (Shively et al., 2010).

The misconception that producers are young, poor men (e.g. Hamilton and Hamilton, 2006; Bekele and Girmay, 2013) could be detrimental to the development of improved and equitable governance of the charcoal sector, as gender dimensions are unlikely to incorporate the needs, motivations and outcomes of women in charcoal production policies. A more nuanced understanding of gendered participation and livelihood outcomes, for example through a disaggregated analysis of producer-groups, would help inform any new developments. Given women's dependency on charcoal income in this study, any developments should recognise women's involvement in the sector and should include mechanisms that do not marginalise or inhibit their participation.

In examining the seasonality of charcoal production practises, this study has highlighted further nuances in charcoal production dependence, as there are temporal motivations (e.g. seasonal food scarcity or higher charcoal prices) that encourage rural producers' engagement. However, temporal relationships (e.g. between urban consumer demand and the seasonality of rural producers' livelihood requirements) are yet to be explored in great detail. Longitudinal studies would be helpful to explore seasonal variation in production and also overcome the weaknesses associated with recall data used in this study.

Conclusion

Broader definitions of poverty emphasise moving beyond an assessment of income, to also understanding wider dimensions of people's wellbeing, vulnerability and risk, capability and empowerment (Shackleton et al., 2008). An in-depth analysis of charcoal producers' livelihoods presented in this study has revealed clear direct (e.g. financial) and indirect (e.g. strengthening of social networks, improved access to goods and services, opportunities for livelihood diversification) benefits that contribute to reducing producers' vulnerability to income insecurity and poverty, and improve their livelihoods. This study generates new insights into gendered production practises, highlighting that women were more dependent on income from charcoal production than men, as they had fewer alternative income generating options available to them. The study also demonstrates that producers are organised, having developed informal groups, structures and local labour markets. We argue that charcoal-based livelihoods should be recognised accordingly, and any developments in policy should reflect the importance of charcoal as an integral livelihood diversification strategy.

Our case study demonstrates that livelihood benefits derived from charcoal production are dependent on resource availability and their long-term sustainability is therefore uncertain given there is currently no management of charcoal resources in Malawi. Under Malawi's de facto ban on charcoal production and trade, livelihood risk and vulnerability is exacerbated by enforcement activities, which further undermine market security, livelihood security and the overall environmental sustainability of the sector.

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