Profits and margins along Uganda's charcoal value chain

G. SHIVELY[1,2], P. JAGGER[3], D. SSERUNKUUMA[3], A. ARINAITWE[3] and C. CHIBWANA[6]

[1] *Department of Agricultural Economics, Purdue University, 403 West State Street, West Lafayette, Indiana, USA*
[2] *Department of Economics and Resource Management, Norwegian University of Life Sciences, Ås, Norway*
[3] *Department of Public Policy, University of North Carolina at Chapel Hill, CB#3435 Abernethy Hall, Chapel Hill, NC,USA*
[4] *Department of Agricultural Economics and Agribusiness, Makerere University, P.O. Box 7062, Kampala, Uganda*
[5] *USAID, P.O. Box 7856, Kampala, Uganda*
[6] *International Food Policy Research Institute, P.O. Box 31666, Lilongwe, Malawi*

Email: shivelyg@purdue.edu

SUMMARY

This paper characterizes the charcoal value chain in Uganda, focusing on production and trade in three districts in the west central region of the country. Data come from surveys of 407 charcoal value chain participants undertaken in 2008. The surveys included 171 charcoal-producing households and 236 non-producer participants including agents, traders, transporters and retailers. Linear regression models are used to study overall profits and per-unit marketing margins along the value chain and to test several hypotheses regarding the importance of location, human and social capital, and asset ownership on observed economic returns and scale of activity. Evidence suggests the greatest overall returns to participation in the charcoal value chain are found among traders. Returns are positively correlated with the scale of activity. Controlling for a participant's role in the charcoal trade, his or her characteristics, and available assets, we find little or no evidence of differences in economic returns among districts, despite widespread popular views of differences in available supply of charcoal. Location of production relative to major markets, and location-specific levels of monitoring and enforcement are not strongly correlated with observed outcomes.

Keywords: forestry, marketing, sustainable forest management, supply chains

Profits et marges dans la chaîne de valeur du charbon en Uganda

G. SHIVELY, P. JAGGER, D. SSERUNKUUMA, A. ARINAITWE, ET C. CHIBWANA

Cet article inspecte les traits caractéristiques de la chaine de valeur du charbon en Uganda, en se concentrant particulièrement sur la production et le commerce dans trois districts dans l'Ouest de la région centrale du pays. Les données proviennent d'études des 4007 participants de la chaine de valeur du charbon conduites en 2008. Ces études comprenaient 171 foyers producteurs de charbon et 236 participants non-producteurs, comme les agents, les commerçants, les transporteurs et les détaillants . Des modèles de régression linéaires sont utilisés pour étudier les profits totaux et les marges de marketting par unité au long de la chaine de valeur, et pour tester plusieurs hypothèses concernant l'importance de la location, le capital humain et social, et la posession des valeurs sur les bénéfices économiques observés et sur l'échelle de l'activité. Les résultats suggèrent que les bénéfices totaux les plus importants provenant de la participation dans la chaine de valeur du charbon résident chez les commerçants. Une corrélation positive existe avec l'échelle d'activité. En contrôlant le rôle des participants dans le commerce du charbon, leurs caractéristiques et leurs ressources disponibles, on trouve peu, voire aucune preuve de différences dans les bénéfices économiques, contrairement aux vues courantes et répandues de différences dans les quantités disponibles de charbon. La location de la production comparée aux marchés majeurs, et les niveaux de gestion et sa mise en application en location spécifique ne sont pas liés fortement aux résultats observés.

Los beneficios y los márgenes de ganancia en la cadena de valor del carbón vegetal en Uganda

G. SHIVELY, P. JAGGER, D. SSERUNKUUMA, A. ARINAITWE Y C. CHIBWANA

Este estudio dibuja la cadena de valor de carbón vegetal en Uganda, centrándose en la producción y el comercio en tres distritos de la región centro-occidental del país. Los datos provienen de una encuesta que fue realizada en el año 2008, con la participación de 407 interesados de la cadena de valor del carbón vegetal. La encuesta abarcó 171 hogares productores de carbón y 236 participantes no productores, incluyendo agentes, comerciantes, transportistas y detallistas. Se utilizaron modelos de regresión lineal para estudiar las ganancias globales y los márgenes de venta por unidad en toda la cadena de valor, y para probar varias hipótesis sobre la influencia de la ubicación, el capital humano y social y la posesión de recursos sobre el rendimiento económico observado y la escala de actividad. Las evidencias sugieren que el mayor rendimiento global para la participación en la cadena de valor de carbón se encuentra entre los comerciantes, y que los ingresos tienen una correlación positiva con la escala de actividad. Un análisis de los papeles desempeñados por los participantes en el comercio de carbón y de

sus características y activos disponibles demuestra poca o ninguna evidencia de una diferencia en el rendimiento económico entre distritos, a pesar de las opiniones expresadas de forma extendida sobre diferencias en la disponibilidad del carbón. Basándose en los resultados observados, no parece existir una correlación fuerte con el lugar de producción y su distancia de los mercados importantes, ni con los niveles de monitoreo y aplicación de los reglamentos en los diferentes distritos.

INTRODUCTION

A considerable body of research has focused on global commodity chains for high value forest products (Gellert 2003, Smith 2005, Jensen 2009). Nevertheless, forestry's role in the development discourse has recently shifted, and observers are increasingly interested in the contribution of small-scale forestry and minor forest product markets to sustainable development and poverty reduction (Singh 2008, Vyamana 2009). Moreover, little is known about the distributional implications of the structure of these forest product markets (Angelsen and Wunder 2003, Ribot 2006). As a result, the importance of understanding the structure and function of value chains for commodities produced, marketed and utilized – both domestically and internationally – has increased (Bardhan *et al*. 2001, Panya 1993, Shyamsundar and Kramer 1996). Knowledge about the structure and distribution of profits and margins along value chains provides information to policy makers about potential opportunities for improving the welfare gains from forestry-related activities, identifying points of entry for mechanisms that influence levels of production and distribution, and brings to light the degree to which forestry related activities contribute to local and national economies. Value chain analysis is both a descriptive and analytical tool. In addition to providing valuable information about markets it provides key insights about inter-firm cooperation and competition, governance, barriers to entry and geographic coverage (Kaplinsky and Morris 2000, Kaplinsky 2001).

The characteristics of charcoal value chains remain largely ignored in the literature. Understanding charcoal production, trade and consumption has important implications for sustainable development in the forestry sector. Charcoal is the primary cooking and heating fuel for urban populations in sub-Saharan Africa. Charcoal is an attractive fuel for urban households because it offers far greater energy per-unit volume than unprocessed fuel wood. The majority of urban and peri-urban areas surrounding African cities are deforested or highly degraded, which means that biomass must be transported over relatively long distances. Given high transportation costs throughout sub-Saharan Africa, charcoal is much more efficient to transport than the energy equivalent volume of fuel wood. Further, charcoal is known as a transition fuel. As incomes rise and cities become more heavily populated and congested, charcoal is called upon to meet the needs of consumers in established and rapidly urbanizing environments who cannot afford more costly sources of energy (Barnes *et al.* 2005). At a global level, use of wood fuel in many developing regions of the world has been shown to grow at a rate roughly in line with population (Broadhead *et al.* 2001). This suggests that the size and importance of the charcoal sector in sub-Saharan Africa will continue to grow for the foreseeable future, particularly where income growth is slow, electricity infrastructure is sparse, and technology adoption to support alternative fuels is sluggish. Moreover, as climate changes, the importance of forest loss and forest degradation due to energy demands is likely to increase (Bonan 2008).

In most countries, charcoal consumption tends to occur on a small scale, and involves numerous end-users who make frequent purchases in small quantities, without much concern for the economic and environmental impacts of their consumption. Charcoal production generally (though not always) takes place on a small scale and threatens the long-term sustainability of forest ecosystems and the livelihoods of the rural poor who depend on forest resources (Arnold *et al.* 2006, Girard 2002). Although studies of charcoal producers and consumers are relatively rare (but see Ribot 1998, Brouwer and Magane 1999, Sankhayan and Hofstad 2000, SEI 2002, Singh 2008, World Bank 2009), some stylized facts are known: charcoal producers are likely to be poor, with low agricultural capacity and few productive assets. They often turn to charcoal production because they lack the skills or opportunities for diversifying into other livelihood activities. Charcoal consumers, on the other hand, are drawn from all points of the income distribution and are primarily, though not exclusively, urban. In most settings, knowledge of the characteristics and role of other actors in the value chain – including middlemen, transporters, traders and retailers – is limited and largely based on anecdotal evidence.

The focus of this paper is the structure and function of the charcoal supply chain in Uganda. Previous work on Uganda's forest product sector includes ESD (1995), Kisakye (2001, 2004), Knöpfle (2004) and Namaalwa *et al.* (2009). Information on the charcoal value chain is critical to forecasting the biomass requirements for charcoal production in the face of increasing deforestation rates, and provides important information about the capacity for charcoal production and trade to enhance livelihoods. Further, small and medium enterprise development in the forestry sector is an overarching objective of Uganda's new National Forestry Policy (MWLE 2001). Better information about the charcoal value chain facilitates identifying opportunities for the more efficient organization of charcoal markets, producer cooperatives, and other institutions that enhance returns to value chain participants (Auren and Krassowska 2004). The objective in this paper is to provide an accurate and detailed portrait of the supply side of the value chain from several of the dominant charcoal producing regions of the country. The analysis draws on survey data collected in 2008 in three districts, among 407 individuals participating in charcoal production and trade. A characterization of the participants and institutions relevant to the charcoal value chain is provided, along with a comprehensive analysis using

linear regression of profits and margins for participants on the supply side of the charcoal market.[1] Several hypotheses are tested regarding the importance to economic returns of human and social capital, asset ownership, and location of activity.

STUDY AREA, DATA AND METHODS

Study Area

Charcoal is produced throughout Uganda. The highest levels of production occur in areas with woodland ecosystems that support high-quality vegetation for charcoal production. The major charcoal producing regions include central Uganda and parts of western and northern Uganda. The main species utilized for production include: *Combretum; Terminalia; Albizia; Acacia; Allophylus* and *Grewia spp.* Woodlands constitute roughly 3 975 000 hectares or 81 per cent of Uganda's total forested area (MWLE 2001). Most of Uganda's woodland areas are characterized by relatively low rainfall resulting in the dominance of extensive mixed crop-livestock farming systems. Charcoal production is frequently undertaken as a primary activity by households with few other income generating opportunities, or as a complement to land clearing which produces large volumes of raw material suitable for conversion to charcoal.

For this study, two major charcoal producing districts (Masindi and Nakasongola), and one emerging charcoal producing district (Hoima) were purposively selected. Namaalwa *et al.* (2009) estimate that these districts, combined with Luweero and Southern Apac account for roughly half of the total charcoal consumed in Kampala, the urban end market for the bulk of charcoal produced in Uganda. Charcoal production and trade is a significant activity in Masindi district. The eastern part of Masindi is dry with low agricultural potential. Masindi's range lands were ranches controlled by the central government and the Bunyoro kingdom until they were abandoned during the insurgency in the early 1980s. Woodlands on abandoned ranches underwent significant regeneration, favouring species particularly well-suited to high quality charcoal production. Former government ranches are currently being privatized, leading to re-establishment of pastures. This transformation is often preceded by land clearing and charcoal production. In addition to small-scale charcoal production, Masindi attracts large-scale charcoal merchants from Kampala who purchase standing trees on areas as large as a square mile and then bring crews of 100 or more workers to clear the land. The economics of converting woodland to pasture in this way are quite favourable. For example, an acre of land costs about 300 000 UgShs (approximately 166 USD), but a landowner can sell the associated timber to a charcoal producer for as much as 200 000 UgShs (111 USD) (1 800 UgShs = 1USD). Landless refugees and internally displaced people from northern Uganda supply much of the labour used in this activity. Many of these individuals consider themselves to be temporary visitors to Masindi. Relative peace in northern Uganda and repatriation of Sudanese refugees, many of whom were believed to have been involved in charcoal production suggest the supply of labour for large-scale charcoal production may be declining in Masindi. Trader networks are well established in Masindi; the bulk of charcoal is transported to Kampala via the Gulu-Kampala highway. In Masindi town (population roughly 39 000) there is a small urban market for charcoal.

Charcoal production in Nakasongola is generally undertaken by local residents. The area is heavily wooded with species well-suited to charcoal production. This area is in the cattle corridor but contains some crop production and presents an overall mosaic of land uses. The area is dry, with occasional crop failures; many households use charcoal production to cope with production risk. Given its proximity to Kampala, farm-gate charcoal prices in Nakasongola are relatively high and deforestation and forest degradation has been rapid. Long-established charcoal traders operate in the district. There is a very limited urban market for charcoal in Nakasongola district. Virtually all charcoal sold by producers makes its way to markets in nearby Kampala.

Of the three charcoal producing districts included in this study, Hoima is a relative newcomer. Several factors are perceived as contributing to the increase in charcoal production in Hoima district. These include declining stocks of biomass suitable for charcoal production in traditional charcoal producing areas, land clearing for agriculture and livestock production, and completion of a good quality all-season tarmac road which has vastly reduced travel time and improved conditions for transporters and traders. Much charcoal production is confined to marginal areas with low population density, especially along the Kafu River. Many charcoal producers are immigrants from West Nile district who are either landless or rent small parcels of farm land. The presence of charcoal traders and transporters in Hoima is a relatively new phenomenon. Transporters pick up charcoal at various points along major roads after brokers and traders have organized its delivery to specified pick-up locations. Hoima town has a population of approximately 37 000 people. While some of the charcoal produced within the district is sold in Hoima, the bulk of it is transported to Kampala. Characteristics of the three districts are summarized in Table 1.

Kampala and its surrounding suburbs are the final destinations for the bulk of the charcoal produced in the three districts. This capital city has an estimated population of 1.5 million, and an annual population growth rate of 4.4 per cent (UBOS 2009, United Nations 2009). Demand for charcoal has increased substantially since the early 1990s and is projected to continue to increase despite evidence that the supply of wood suitable for charcoal production is severely compromised (Namaalwa *et al.* 2009).

[1] There is a dearth of information about the demand side of Uganda's charcoal value chain; surveying a representative sample of consumers in urban areas was beyond the scope of this study. Limited information about energy demand in Uganda is provided by Sebbit *et al.* (2004).

TABLE 1 *Characterization of districts included as study areas*

	Hoima	Masindi	Nakasongola
Rural households (#)	67 815	85 390	24 121
Area (hectares)	593 300	944 290	350 990
Forest type	Tropical high (partially degraded); Forest savannah mosaic	Woodland savannah; Tropical high	Woodland savannah
Area under forest (ha)	160 511	446 398	128 759
DFS Staff(#)	3	1	5
Altitude (m.a.s.l.)	1000-1500	900-1200	1035-1160
Agroecology	Banana/coffee/cattle with moderate rainfall	Banana/coffee/cattle with moderate rainfall	Central Buruli farmlands; Central wooded savannah
Common crops and livestock	banana, coffee, maize, sweet potato, cassava, small ruminants, cattle	millet, sorghum, maize, banana, coffee, sweet potato, cassava, cattle	banana, bean, maize, sweet potato, cassava, groundnuts, cattle
Off-farm employment	none of note	businesses in Masindi Town, tourism, timber trade	charcoal production
Paved roads per area (km/km^2)	0.016	0.009	0.028
Sub-counties in the study	Kyabigambire, Wabinyonyi	Mutunda, Masindi Port	Nabinyonyi,Nabisweera
Majority ethnic groups	Banyoro	Banyoro, Alur	Baruli

Sources: Key informants; Nzita and Miwampa (1993); MAAIF (1995); Nakasongola District (2003); NFA (2005); UBOS (2006); UBOS (2009)

Data

This paper brings together data from two surveys implemented between June and September of 2008 in three purposively selected charcoal-producing districts of Uganda. The first is a household level survey of 300 rural inhabitants. A subset of those data (n=171) that includes all charcoal producing households that fell within the sample is used. Two sub-counties per district (n=6) were purposively selected where charcoal production was known to be a major economic activity. Within each sub-county two villages (n=12) were purposively selected for construction of the sampling frame. Households were randomly selected from a roster of names of households residing in the village. Data were collected on charcoal production, sales, financial costs, and labour inputs for the months of February and May, with February representing charcoal production during a dry month, and May being indicative of production during the rainy season. The survey took place in the months of June and July. Assuming that short recall periods would provide the highest quality data, respondents were asked about production in February, the most recent dry season month, and about production in May, the most recent wet season month In addition to detailed data on the contribution of charcoal to rural livelihoods, data were collected on all other major components of household livelihood portfolios including agricultural and livestock production, wage, salary and business income, and household reliance on commercial forest products other than charcoal (for example, fuel wood, sawn wood, wild fruits etc.), and other forest products used directly by households (e.g. poles, vines, medicinal plants, spices).

The second data source provides parallel data on value chain participants operating above the level of producer. A survey of charcoal value chain participants resulted in information for 236 individuals. These individuals are identified here as agents, traders, transporters, or retailers based on self-reporting of primary roles.[2] Agents serve as middlemen between producers and traders. They do not buy and sell charcoal, but rather collect commissions for connecting producers with traders. Traders, in contrast, purchase charcoal from producers and sell to retailers. However, they do not sell charcoal directly to consumers. They may contact producers directly or operate with the assistance of an agent. Transporters (typically truck owners, but also drivers responsible for loads) move charcoal from one location to the next point up the value chain. Retailers are the final point observed on the supply side of the value chain. Retailers sell charcoal directly to consumers. The value chain survey was undertaken in the same three districts as the household survey, and in Kampala. Because value chain participants are very busy and are sometimes hard to locate, a snowball sampling method was used to locate respondents. Initial respondents directed the survey team to new respondents, thereby building the sample until it was considered saturated. Time spent sampling in each district was roughly equal.

Retailers are generally concentrated in the various marketing centres of Hoima, Masindi and Nakasongola districts. Charcoal markets and independent charcoal

[2] Although a small number of participants reported secondary roles (e.g. a trader who also transports) the analysis associates all outcomes for an individual with the primary role reported.

vending stalls were the focus of the data collection in Kampala. As with the household survey, the value chain survey included data on purchases, sales and costs for the months of February and May. The months of February and May were ranked by the value chain survey respondents as 1st and 3rd in terms of the frequency of market participation, 1st and 4th in terms of peak profitability, and 5th and 8th in term of lowest profitability respectively. Additional information was collected on participant demographics, social capital (here proxied by the number of interactions with other types of actors in the value chain and the longevity of these business relationships), incidence of repeated interactions, and respondent estimates of the total number of participants in the value chain. The number of respondents by district and activity are summarized in Table 2. Producer data are drawn from the household survey; all other participant data come from the value chain survey. Although these samples provide considerable spatial and temporal coverage of charcoal activities in rural Uganda, the data cannot be considered representative of all charcoal participants. Moreover, aggregation of sample data across the calendar or within categories of activity, and comparison of sample data across categories of activity must be approached cautiously, since the size and composition of the underlying target population is not well understood and the true sampling frequencies and proportions within categories of activity are not known.

TABLE 2 *Survey respondents, by district and activity*

	Activity					
District	Producers	Agents	Transporters	Traders	Retailers	All
Hoima	49	0	2	1	24	76
Masindi	61	4	8	22	22	117
Nakasongola	61	2	3	24	21	111
Kampala	0	21	18	23	41	103
Total	171	27	31	70	108	407

CHARACTERIZING UGANDA'S CHARCOAL VALUE CHAIN

Participants in the Charcoal Value Chain

A priori five major roles for value chain participants were identified: producer, agent, transporter, trader, and retailer. The identification of these roles was based upon a scoping exercise involving key informant interviews conducted in Uganda in 2007. To ensure accurate and consistent capture of information the classification system was described to respondents. They were asked to indicate their primary and secondary roles in the value chain.

Table 3 provides characteristics of these participants in the charcoal value chain. Men dominate the charcoal business at all but the retail level. There are very low levels of female participation in the producer and transporter categories. Average age and education are fairly uniform across groups of value chain participants; producers and traders are the oldest and agents are the youngest. With the exception of producers, asset ownership is fairly similar across groups although, as expected, rates of truck ownership are high among transporters. Producers have high rates of bicycle ownership; bicycle is the dominant method used to transport sacks of charcoal from the point of production to local markets or pickup locations for transporters and traders. Twenty-one per cent of charcoal producers own mobile phones. While this is the lowest rate of phone ownership among value chain participants, it is nevertheless high relative to rates for the rural population as a whole. For example, data from an extensive survey of rural households in western Uganda indicate that mobile phone ownership was roughly 13 per cent in 2007 (Jagger 2009). Charcoal producers use mobile phones to contact agents and traders when they have charcoal to sell. Producers have the fewest years of education. As a group, traders had a significantly higher average level of education. Lower levels of education may indicate that retailers are at a disadvantage when bargaining, due to limited access and ability to process market information, but higher education may not be necessary to succeed in the charcoal industry. Although asset ownership is positively correlated with education at statistically significant levels in this sample, it is clear that many successful entrepreneurs are observed who have little education.

The variable describing whether the value chain participant is a member of the dominant ethnic group identifies several patterns. Sixty-two per cent of producers are from the dominant ethnic group, suggesting that the popular perception of landless migrants as the bulk of producers is misguided for the districts studied here. Secondly, transporters and traders are generally not from the dominant ethnic group in the area where they operate (i.e. where they load or purchase charcoal), though many transporters and traders are from ethnic groups that are dominant in Kampala, the end market for most charcoal. This finding is important as they are the value chain participants with the highest profits; it suggests that social networks at the end of the value chain may be a more important determinant of profits than social networks at earlier points on the value chain.

Part of the reason social networks may be of limited importance at early points in the value chain is that there are few opportunities for value chain participants to interact in person with forest officials. District forestry officers (DFOs)

TABLE 3 *Description of survey participants, by activity*

	Producer	Agent	Transporter	Trader	Retailer	All
Gender (% female)	4	22	6	19	69	27
Age (average years)	37	29	32	35	33	34
Education (average years of schooling)	4.7	6.7	6.4	7.8	5.4	5.7
Participant is member of dominant ethnic group (%)	61	59	29	44	55	54
Bicycle (% ownership)	75	37	42	76	51	64
Mobile phone (% ownership)	17	93	77	89	64	52
Radio (% ownership)	72	89	87	92	88	82
Motorcycle (% ownership)	2	22	35	23	9	11
Car (% ownership)	0	0	13	15	0	4
Truck/boat † (% ownership)	-	0	32	3	0	3
Contact with forest officials †(number of contacts in past 6 months)	-	8.4	16.2	25.4	16.6	10.6
Mean sales (kg)	1 745	1 266	1 250	20 245	2 796	6 991
Quantity sold as % of total volume sold (kg)	8.2	0.1	0.1	75.6	16.1	100
N	171	27	31	70	108	407

† Number of contacts with forest officials includes "in person" interactions with forest officials (DFS; NFA and UWA) regarding the charcoal business over a six month period. No data were collected from charcoal producers on the number of contacts with forest officials, or on truck or boat ownership.

and their teams are generally constrained by both their level of staffing and also lack of transportation. This means that they are limited to interacting with value chain participants either in district towns, or at check points set up along major transportation routes. As a result, forest officials interact primarily with transporters and traders. DFOs in each of the districts included in the survey noted their limited capacity to reach forest users, including charcoal producers, at the point of production or along the early points in the value chain. Traders reported the highest number of contacts with forestry officials regarding the charcoal business over a six month period (25.4). Transporters are those who physically move charcoal, but traders are those who most frequently deal with the official Forest Produce Movement Permit paperwork at the district level. Although for monitoring purposes one might desire a tax collection system that relies on widely scattered agents operating near points of charcoal consolidation, the point at which taxes are paid to facilitate marketing of charcoal outside of the district was found to be the district forest office. Transporters and retailers reported an average of 16.2 and 16.8 contacts with forestry officials respectively over a six month period (January through June 2008). Charcoal agents reported the lowest number of face to face contacts with forestry officials. Agents spend a lot of time in the rural areas looking for producers with charcoal to sell; thus they generally operate outside of the area where forest officials can be found and are generally dispersed across large geographic areas. No data were observed on interactions between producers and forest officials. Such interactions are likely to be rare.

Trends in Charcoal Production and Consumption

Questions were included in the value chain survey regarding respondent perceptions of recent trends in charcoal production and marketing. Overall, respondents perceived a downward trend in charcoal availability in the study locations and an upward trend in consumer demand. For example, 67 per cent of sample respondents reported a decrease in charcoal supply, whilst 82 per cent reported an increase in charcoal demand. While these figures are not directly comparable to available national statistics, they are consistent with those indicating that household expenditures on charcoal increased from 4.076 billion UgShs in 1995/96 to 9.345 billion in 2005/06, approximately 23% per annum on average in nominal terms and roughly 5% per year in real terms (based on changes in the CPI over the decade). More recent changes in prices have been more dramatic and demonstrate that changes in energy prices have outpaced overall price changes in Uganda. Quarterly price data from between 2004 and 2008 indicate that charcoal prices increased 69 per cent over this 5-year period, an average nominal rate of increase of approximately 14% per year. During this same period the price of kerosene increased at a slightly lower rate of 12% per annum (UBOS 2009). By comparison, the average annual rate of inflation in Uganda between 2004 and 2008 was 6.4 per cent (Uganda Revenue Authority 2008). Two-thirds of the charcoal market participants reported that the supply of charcoal had declined greatly since 2003. The major reason cited (by 64% of respondents) was a decline in the availability of trees from which charcoal can be

derived. Other reasons mentioned included an increase in the number of people venturing into charcoal production for a livelihood, growing consumer demand for charcoal, and an overall increase in the profitability of the charcoal trade. The general perception is that enforcement of regulations governing charcoal production and trade has remained unchanged since 2003 and that demand has increased steadily in the face of constraints on supply. A rapid run-up in prices has resulted.

In terms of overall charcoal activity represented by responses to our surveys, producers accounted for roughly 8 per cent of all reported charcoal transactions, and charcoal traders accounted for 76 per cent. Producers accounted for about 16 per cent of the total volume of recorded sales in the survey. On average, each trader sold 20 tons of charcoal over the previous year and earned 79 per cent of the final value of all charcoal counted as sales in the survey.[3]

Regulating Charcoal Production and Trade

The majority of charcoal produced in the three districts comes from private lands which fall under the jurisdiction of the district forest services (DFS). Since a major forest sector decentralization reform in 2003, DFS has had responsibility for monitoring and enforcing rules related to charcoal production on private lands, and plays a large role in regulating the transport of charcoal beyond district boundaries (Jagger 2009).[4] The role of forest sector decentralization in shaping forest management in Uganda is discussed by Turyahabwe *et al.* (2007). They argue that the positive aspects of decentralization have been hindered by lack of a clear policy regarding ownership, inadequate fiscal support and inequitable distribution of benefits. Francis and James (2003) also underscore some of the challenges and inherent contradictions of forestry decentralization in Uganda. Districts collect taxes at various stages in the value chain, and are experimenting with different regulatory frameworks for managing levels of production and trade.

The small number of DFS officials is an indicator of inadequate capacity for monitoring and enforcement. Masindi has only one District Forest Officer (DFO). Given the vast size of the district and the relatively poor transport infrastructure, it is nearly impossible for the DFO to monitor charcoal production. In recognition of this, and in an effort to capture charcoal revenues, in 2003 the district passed an ordinance abolishing the charcoal production licensing system and replaced it with a loading fee collected by individuals who work under contract at the sub-county level under the supervision of sub-county chiefs. Tenderers are selected by a district board with the assistance of the district forest officer. They collect fees by issuing receipts for each bag of charcoal sold. As charcoal moves up the value chain, for example as it is transferred from producers to traders, it is assessed a 1 000 UgShs per sack loading fee. Charcoal sold outside the district is charged depending on the size of the truck.[5] At the time of the survey, Nakasongola had one DFO and four forest rangers. The focus of the Nakasongola DFO's office is plantation development in select sub-counties throughout the district; monitoring and enforcing rules related to charcoal production and trade is not a major focus of DFO staff. There are no sub-county level forest officers working either in charcoal-producing areas or on enforcement efforts. Charcoal production is extremely widespread in Nakasongola. For example, according to the Nakasongola District Forestry Plan (2003) roughly 70 per cent of households in Nakasongola districts were involved in charcoal production, although data from the study sites suggest the rate of household-level participation in charcoal production was closer to 40 per cent in 2008 (Khundi *et al.* 2009). As a result, and because monitoring and enforcement would require a comprehensive effort, the district has abandoned efforts to issue licenses to producers. Nakasongola district relies on transport related taxes (or loading fees) tendered as a source of revenue at the sub-county level. The approach used in Nakasongola is similar to that used in Masindi. Private collectors are appointed by sub-county chiefs through a competitive bidding process. As in Masindi, permits are issued based on the size of the transporting vehicle and revenues are shared among different levels of administration. The official forestry revenue benefit sharing ratios are defined as 40% to the district government and 60% to the national government. A portion of the funds (i.e. 35 per cent) that remain at the district level are intended to be retained or remitted to the lower level sub-county governments. However, this redistribution rarely takes place. There are obvious incentives for sub-counties to underreport revenues from charcoal, given that they retain a minimal share of total amount collected; for example, for every 100 000 UgShs. of revenue collected at the sub-county level, by law the sub-county is permitted to retain only 14 000 UgShs.

Like Nakasongola, Hoima has a higher capacity for monitoring and enforcement than Masindi; at the time of our survey Hoima District had a relatively large DFS staff (including a DFO, his assistant and two forest guards). However, all staff members were concentrated in Hoima town and appear to have been too few in number to be effective on the ground. Lower levels of local government are not involved in regulating charcoal production in Hoima. Hoima district sells charcoal production permits, and has a similar system of transport related fees as Masindi and Nakasongola districts. In principle, forest revenues are required to be shared between the district and the sub-counties, but none of the sub-county officials interviewed during the study reported receiving forestry-related revenues.

[3] The weight of charcoal sacks was estimated by respondents and averaged 50kg/sack.

[4] Turyahabwe and Banana (2008) review the history of forest policy in Uganda.

[5] At the time of the survey, a tipper lorry (holding approximately 90 bags) paid 70,000 (≈ 15.55 UgSh per kg); a medium size truck (approximately 120 bags) paid 80,000 (≈ 13.33 UgSh per kg); and a large truck (150 bags) paid 120,000 (≈ 16 UgSh per kg).

ESTIMATING ECONOMIC RETURNS TO CHARCOAL PRODUCTION AND TRADE

Table 4 reports average charcoal sales per value chain participant by district for the months of February and May 2008. The bulk of all charcoal sales represented in the sample (62 per cent) took place in Kampala. The figures in Table 4 also illustrate the relative importance of Nakasongola as a charcoal-producing district, even though woodlands suited for charcoal production are highly degraded in much of the district. Conversely, the limited role that Hoima district plays as a relative newcomer to the charcoal value chain is highlighted.

TABLE 4 *Charcoal sales by district*

District	Average quantity sold per value chain participant (kg)	Total volume of sales (kg)	Sales as % of total volume in sample
Hoima	1 524	131 103	3.7
Masindi	2 868	438 749	12.5
Nakasongola	6 669	927 028	26.4
Kampala	16 230	2 012 571	57.4
All	6 991	3 509 451	100.0

Note: Data represent outcomes for the months of February and May 2008 combined.

Table 5 reports average prices per kilogram received by participants that sell charcoal to participants further up the value chain as well as the mark-up that occurs as charcoal moves up the value chain.[6] The difference between the selling price for the producer and the selling price for the retailer (i.e. the price spread) was 106 UgShs/kg in February and 154 UgShs/kg in May. No statistically significant differences in forest gate prices were observed across the three districts, with the exception of prices that producers in Masindi district received in February. The data on mark-ups suggest that, at least in terms of prices received, producers further away from major charcoal marketing centres (as proxied by district or sub-county) are not at a large price disadvantage vis-à-vis those closer to retail charcoal markets.[7]

Profit (P_i) received by each value chain participant is calculated as the total monthly revenue for each participant (R_i) minus his total variable costs (C_i) reported for the same month:

$$P_i = R_i - C_i . \quad (1)$$

Variable costs include the purchase of charcoal, costs associated with production, marketing and transportation, taxes, fees, reported bribes, and vehicle, facility or equipment rental.

Taking Q_i as a measure of each participant's total physical volume (in kgs) during the month, each participant's average per-unit margin (M_i) is also calculated. This is computed as the difference between the average amount received (per kg) and the average variable cost (per kg), or simply profit divided by volume:

$$M_i = \frac{R_i}{Q_i} - \frac{C_i}{Q_i} = \frac{P_i}{Q_i}\frac{R_i}{Q_i} - \frac{C_i}{Q_i} = \frac{P_i}{Q_i} . \quad (2)$$

Both profit and per-unit margins are reported in Table 6. In general, Kampala-based value chain participants have the highest profits. One might hypothesize that this reflects the scale of activity, since larger trade networks allow participants to mobilize supply from a larger set of points around the country. Transporters and traders have by far the highest profits, which is again a reflection of the scale of activity.

TABLE 5 *Average price received by seller and average mark-up (UgShs/kg)*

	February 2008		May 2008		Average	
	Price(UgShs/kg)	Mark-up(%)	Price(UgShs/kg)	Mark-up (%)	Price (UgShs/kg)	Mark-up (%)
Producers						
Hoima	120	-	113	-	116	-
Masindi	143	-	117	-	126	-
Nakasongola	123	-	120	-	121	-
Average	129	-	117	-	122	-
Traders	245	96	275	98	260	97
Retailers	235	48	267	49	251	48
Average	208	-	217	-	213	-

Note: Mark-up computed as sales price minus purchase price

[6] Mark-up is calculated as the difference between the purchase price and the selling price for a value chain participant that is engaged in both buying and selling charcoal. It does not represent profit per unit as it does not account for the cost of doing business.

[7] Although ideally one would like to know the distance from Kampala for each value chain transaction within a district, these data could not be reliably collected.

TABLE 6 *Average monthly profits (all participants) and average per-unit margins (producers, traders and retailers) by district (UgShs)*

	Hoima	Masindi	Nakasongola	Kampala	Average
Profits					
Producers	22 264	77 757	83 875	-	63 958
Agents	NA	217 188	135 500	163 200	169 146
Transporters	110 250	744 813	1 381 500	1 430 856	1 163 835
Traders	771 917	204 092	907 538	1 997 289	1 042 578
Retailers	111 580	66 197	55 487	194 742	122 478
Average	62 649	149 618	292 595	806 841	338 696
Per-unit margin					
Producers	83.4	77.2	96.9	-	85.6
Traders	30.0	49.8	60.0	54.3	54.7
Retailers	28.8	52.0	36.3	39.8	39.5
Average	54.1	62.7	69.3	45.0	58.8

Note: Profits for each participant category computed as average within category. Profit equals monthly sales minus purchases minus *variable* costs (see text for details). Average per-unit margins computed as monthly profits divided by monthly volume transacted.

Traders in Masindi reported particularly high profits, likely because those surveyed traded in particularly large volumes of charcoal. However, value chain participants operating in Nakasongola, the district which is closest to Kampala, the major market for charcoal have the highest per-unit margins, suggesting that these actors may derive some benefit from being situated closer to retail markets. A full analysis of the role of distance from market in influencing economic returns would require spatial information on each transaction, which is not available in these data.

On average, producers had the highest margins of all the participant categories in the value chain. Variable costs associated with production are low, largely because biomass for charcoal production is generally collected freely, and the primary production input is household labour. Among participants operating above the producer level, traders had the highest average margins, with the exception of Hoima district where retailers had higher margins than traders. High margins in Nakasongola may be partially explained by limited monitoring and enforcement of charcoal production and trade in the district. Conversely, low margins for traders in Hoima may reflect a higher degree of monitoring and enforcement by district level officials that collect Forest Produce Movement Permits (FPMPs) as charcoal is transported outside the district. Low margins for both traders and retailers based in Kampala are reflective of the relatively high costs of operating in an urban environment, vigorous competition, and the relative ease of monitoring and enforcement where there is a dense concentration of participants.

To further analyze the data, a series of regressions models are used. The regressions aim to identify factors correlated with observed marketing margins and measure the strength of these relationships. Many of the independent variables available for analysis are categorical. As such, the regressions should be viewed as attempts to measure conditional means within the sample, conditioning on as many observed characteristics of participants and their working environment as possible. The goal in doing so is to better understand the role of participants, the relative economic returns to their activities, and the implications of these patterns for possible policy changes in the forestry and energy sectors. Regression results for models examining factors correlated with profits and per-unit margins (as defined by equations (1) and (2) above) are presented in Table 7. The regressions are arranged in parallel, with two models for each dependent variable. In each case, the dependent variable is expressed in logarithmic form, so that the regressions take the general forms:

$$\ln y_i = \boldsymbol{\beta} \boldsymbol{X}_\mathbf{i} + \boldsymbol{\varepsilon}_\mathbf{i}. \qquad (3)$$

where y_i represents the variable of interest (either monthly profit or per-unit margin for respondent *i* in a particular month), $\boldsymbol{X}_i$ is a vector of explanatory variables for each respondent, $\boldsymbol{\beta}$ is a corresponding set of parameters (including a constant term) to be estimated, and ε_i is an error term. The unit of analysis in each case is based on reported values for one month of activity. As a result, each participant is represented in the dataset twice, once for the month of February and again for the month of May. This pooling could be justified based on results from two sets of statistical tests. First, we cannot reject the hypothesis of no statistically significant differences in margins or sales activity by month. Second, at standard test levels, the hypothesis of equivalent coefficients across models estimated with monthly sub-sets of the data cannot be rejected.

Models 1 and 3 are regressions that contain as control variables the basic characteristics of charcoal participants and their locations of operation. Models 2 and 4 add to these regressions an indicator for the overall scale of activity (measured as the total monthly volume of sales). In terms of total variation in observed outcomes, the regressions explain

TABLE 7 *Regression results for pooled sample, dependent variable natural log of monthly margin*

	Profit (P_i)		Per-unit Margin (M_i)	
	Model 1	Model 2	Model 3	Model 4
Constant	10.146**	4.131**	4.174**	4.262**
	(0.277)	(0.276)	(0.179)	(0.280)
Agent (0=No; 1=yes)	-0.697**	1.950**	—	—
	(0.232)	(0.431)		
Transporter (0=no, 1=yes)	1.054**	0.358	—	—
	(0.211)	(0.525)		
Trader (0=no, 1=yes)	0.833**	-0.517**	-0.609**	-0.589**
	(0.173)	(0.117)	(0.107)	(0.118)
Retailer (0=no, 1=yes)	-0.993**	-0.885**	-0.974**	-0.097**
	(0.167)	(0.105)	(0.105)	(0.105)
Education (years)	0.088**	0.036**	0.033**	0.034**
	(0.015)	(0.011)	(0.011)	(0.011)
Gender (0=M, 1=F)	0.089	0.311**	0.332**	0.328**
	(0.147)	(0.098)	(0.099)	(0.100)
Age (years)	0.013**	0.001	0.001	0.001
	(0.006)	(0.004)	(0.004)	(0.004)
Ethnicity (0=minority, 1=dominant)	0.156	0.212**	0.197**	0.197**
	(0.104)	(0.070)	(0.071)	(0.071)
Bicycle (0=no, 1=yes)	-0.202	0.082	0.128	0.125
	(0.121)	(0.084)	(0.085)	(0.085)
Mobile phone (0=no, 1=yes)	0.773**	-0.130	-0.084	-0.074
	(0.132)	(0.089)	(0.086)	(0.090)
Masindi (0=no, 1=yes)	0.055	-0.135	-0.129	-0.127
	(0.173)	(0.110)	(0.111)	(0.111)
Nakasongola (0=no, 1=yes)	0.350**	-0.081	-0.100	-0.095
	(0.177)	(0.111)	(0.111)	(0.112)
Kampala (0=no, 1=yes)	0.754**	-0.267**	-0.218*	-0.204*
	(0.182)	(0.123)	(0.119)	(0.124)
Ln volume of sales (1000kg)	—	0.997**	—	-0.014
		(0.033)		(0.034)
N	575	575	470	470
R^2	0.48	0.81	0.26	0.26

Standard errors in parentheses.
* indicates coefficient is significantly different from zero at the 90% confidence level.
** indicates coefficient is significantly different from zero at the 95% confidence level.

between 28 and 81 per cent of total variation, and somewhat larger proportions in the models of monthly profits. Looking across all models, 32 of 54 point estimates are significantly different from zero, 31 at the 95% confidence level or above.

The addition of volume of sales data (models 2 and 4) is aimed at discerning potential scale-related patterns of "market power" by participants. As one would expect, including sales volume improves the explanation of monthly profits considerably; monthly revenues increase with sales volume at a faster pace than costs. Several of the clearest and most significant patterns in the regressions indicate that, after controlling for other observable factors, transporters and traders receive higher monthly profits and higher per-unit returns compared with producers, agents and retailers. In the regressions for per-unit margins it is not possible to include analysis of agents and transporters, since due to the nature of their activity these individuals do not report purchase or sales volumes. Traders are seen to have lower per-unit margins, on average, than producers, but higher per-unit margins than retailers. Education is positively correlated with economic returns at statistically significant levels in all of the estimated models. On average, an additional year of education is estimated to increase an individual's per-unit economic return by about 3%, other things equal. A

significant correlation between economic returns and age is observed when one controls for an individual's role in the charcoal value chain. At the per-unit level, female participants received higher returns than their male counterparts.

In terms of geographic differences in economic returns, very few of the geographic variables significantly contribute to explaining variation in either monthly profits or per-unit margins. Participants operating in Nakasongola report higher economic returns overall, but the result is not robust to the inclusion of either volume of sales or measurement of returns at the margin. As one might expect, higher volumes of charcoal handled (as represented by the sales variable) are correlated with higher overall returns. This is consistent with both a conjecture that the underlying structure of activities can be characterized by increasing returns to scale, and with the general observation that the licensing and loading fees being implemented within the study sites decline with the scale of activity.

To further distinguish earnings patterns, a second set of regressions are used to examine the determinants of monthly returns within participant categories. These regression results are reported in Table 8. The purpose of this set of regressions is to understand the factors influencing the relative success of participants within categories of activity. Regression results for monthly profits among producers indicate that education, mobile phone ownership and being located in one of the traditional charcoal producing districts (i.e. Masindi or Nakasongola) are all positively correlated with returns. Margins tend to be lower, on average, for females. These findings do not carry over when considering per-unit margins as the dependent variable. Age, phone ownership and contacts with forest officials are important correlates with economic returns for agents and transporters, suggesting experience and connectedness are important. While the nature of contacts between agent/transporters and forest officials are not known (i.e. enforcement of rules vs. collusion with value chain participants), their positive relationship with high profits suggests that forest officials are not taxing or extracting bribes from these participants to an extent that negatively impacts profits. Education stands

TABLE 8 *Regression results for sub-samples, dependent variable natural log of monthly margin*

	Profit (P_i)				Per-unit Margin (M_i)		
	Producers	Agents and Transporters	Traders	Retailers	Producers	Traders	Retailers
Constant	10.403**	9.653**	12.32**	9.012**	4.140**	5.184**	2.864**
	(0.304)	(0.810)	(1.119)	(0.627)	(0.151)	(0.705)	(0.399)
Education (years)	0.059**	0.046	0.074**	0.133**	0.006	0.046**	0.058**
	(0.022)	(0.032)	(0.035)	(0.035)	(0.011)	(0.022)	(0.022)
Gender (0=M, 1=F)	-0.755**	-0.372	0.059	0.221	0.250	0.188	0.529**
	(0.384)	(0.320)	(0.301)	(0.283)	(0.190)	(0.190)	(0.180)
Age (years)	-0.006	0.080**	-0.001	0.008	0.006**	-0.013	-0.005
	(0.007)	(0.017)	(0.018)	(0.012)	(0.003)	(0.011)	(0.008)
Ethnicity (1=dominant)	-0.141	-0.314	-0.035	0.312*	-0.016	0.254*	0.356**
	(0.166)	(0.217)	(0.236)	(0.214)	(0.083)	(0.149)	(0.136)
Bicycle (0=no, 1=yes)	0.237	-0.849**	-0.683*	0.301	0.103	-0.159	0.267*
	(0.190)	(0.234)	(0.336)	(0.243)	(0.094)	(0.212)	(0.154)
Mobile phone (0=no, 1=yes)	0.914**	1.104**	0.538	0.452*	-0.017	-0.103	-0.110
	(0.183)	(0.392)	(0.406)	(0.225)	(0.091)	(0.255)	(0.143)
Contacts w/ officials (#)	—	0.028**	0.005	0.005*	—	-0.001	0.001
		(0.007)	(0.004)	(0.003)		(0.002)	(0.002)
Masindi (0=no, 1=yes)	0.715**	-0.784	-0.776	-0.220	-0.105	-1.28*	0.196
	(0.188)	(0.650)	(1.076)	(0.361)	(0.093)	(0.678)	(0.229)
Nakasongola (0=no, 1=yes)	0.724**	-0.811	0.273	-0.157	0.062	-0.990	-0.118
	(0.205)	(0.754)	(1.077)	(0.354)	(0.102)	(0.678)	(0.225)
Kampala (0=no, 1=yes)	—	-0.526	0.958	0.505*	—	-1.23*	-0.176
		(0.671)	(1.055)	(0.302)		(0.665)	(0.192)
N	160	110	123	184	160	123	184
R^2	0.34	0.54	0.44	0.17	0.10	0.14	0.14

Standard errors in parentheses.
* indicates coefficient is significantly different from zero at the 90% confidence level.
** indicates coefficient is significantly different from zero at the 95% confidence level.

out as an important correlate with high profits and per-unit margins for traders. This is consistent with expectation that more education gives value chain participants an advantage in their business dealings. Education also matters for profits and per-unit margins in the retailer category. Coming from the dominant ethnic groups is an important factor explaining outcomes for retailers, suggesting that charcoal consumers prefer to purchase charcoal from members of their ethnic group. Most charcoal producers are based in Kampala where the Baganda are the dominant ethnic group. Margins for retailers are positively associated with contact with forest officials, suggesting that forest officials are not widely engaged in regulatory functions such as tax collection when dealing with value chain retailers. Non-producer participants operating in Masindi district have smaller monthly profits and per-unit margins than those operating elsewhere. This may reflect the fact that, of the three districts in the sample, Masindi is least well connected with major charcoal markets due to long distances and poor road networks.

DISCUSSION AND POLICY IMPLICATIONS

The primary goal of this paper has been to provide a picture of the structure and function of the supply side of Uganda's charcoal value chain. The characteristics of value chain participants in two major and one emerging charcoal producing area were examined. Data on the characteristics of value chain participants demonstrate the degree of heterogeneity between participant groups both with respect to demographic and asset portfolios, and profits. Value chain participants in the middle of the value chain (i.e. traders and transporters) have the highest levels of education and asset ownership. In general producers and retailers are not as well off as transporters and traders. In addition, regression results demonstrate that traders and transporters are reaping very large monthly profits relative to other value chain participants, largely because they handle much larger volumes. The findings suggest that a tax on transporters or traders could be used to generate significant revenue for districts, and future research could focus on determining the potential magnitude of revenue and behavioural responses to taxes. Furthermore such a tax could be progressive from a distributional perspective and relatively easy to administer, given the small number of participants in these value chain roles. In contrast, a tax on producers or retailers is likely to raise less revenue because tax collection would be more costly and harder to administer, given the large number of widely-dispersed participants at these points in the value chain. A tax on producers and retailers is likely to be regressive; that is, it would have a disproportionate effect on lower income participants. In this sense, the data demonstrate that policies that change regulatory, fiscal and pricing frameworks focused on the central nodes in the value chain might be most effective in raising revenue. However, it is important to underscore that, when considering tax schemes as possible revenue sources, a tax on traders would likely be shifted at least in part (depending on the elasticity of demand) to consumers, through price hikes. We are not currently aware of any studies that have established a reliable estimate of price responsiveness by charcoal consumers, but one might reasonably expect that with high prices for alternative fuels such as propane and electricity, opportunities to substitute away from charcoal are somewhat limited, and that consumers would ultimately bear the brunt of efforts to levy taxes on charcoal trade.

When considering differences within participant groups, profits and per-unit margins are found to be correlated with a number of demographic and socioeconomic variables. Contact with forest officials has a positive correlation with returns for agents/transporters and retailers. The nature of these contacts is not known, but their correlation with favourable economic returns for some participant categories points to an opportunity for forest officials to play a larger or more effective role in monitoring and enforcement of existing regulations. However, more research is required to fully understand the economic effects of the various monitoring and enforcement mechanisms in place in the three districts. The underlying incentives influencing forest official behaviour may be an important factor explaining the limited regulatory focus on relatively powerful charcoal value chain participants. While it is not completely opaque, the charcoal industry is very challenging to study.

Despite reports of exceedingly high rates of deforestation and forest degradation in Nakasongola district, of the three districts for this study Nakasongola remains the primary source of charcoal destined for Kampala markets. Conversely Hoima's role as an emerging supplier of charcoal for the value chain is quite limited. Counter to expectations, district-level indicators of distance from major market were not found to be correlated with prices received or overall returns for producers. Evidence that distance matters for participants higher up the value chain is also statistically weak. High reported volumes from Nakasongola support the conjecture that this area remains a major charcoal producing region. Past forest loss does not appear to have curbed charcoal extraction. Qualitative data on trends in charcoal production and trade confirm that the supply of charcoal from traditional charcoal producing areas is diminishing, but currently there is only limited government support for establishing woodlots that would propagate species appropriate for charcoal production in Nakasongola and Masindi districts.

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