“God made the soil, but we made it fertile”: gender, knowledge, and practice in the formation and use of African dark earths in Liberia and Sierra Leone

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"God made the soil, but we made it fertile": Gender, knowledge and practice in the formation and use of African Dark Earths in Liberia and Sierra Leone.

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Abstract

This paper fills a significant knowledge gap by describing the West African farming practices and knowledge that lead to the formation of carbon-rich high-fertility African Dark Earths

(AfDE) – human-made soils analogous to Amazonian terra preta - yet subject to continuing production and use. Gender relations and women's roles are central to how these soils are produced and used. We develop a gendered political ecology perspective through social and ecological field studies in Liberia and Sierra Leone. We detail how AfDE formation and associated knowledge is gender-differentiated; the central roles of women's deposition of charred organic materials from cooking, oil palm processing and potash production in producing AfDE, and the gendered dynamics of AfDE use and distribution in the landscape. Different species are cultivated in AfDE compared to non-anthropogenic soils, and AfDE are differentially valued by women and men for horticultural and tree crops. The spatial distribution of AfDE across the landscape reflects shifting household, marriage and settlement practices. Gender relations, subjectivities and interdependencies, and the ecology of soils and landscapes, mutually shape one another. National policy makers and NGOs (such as Care and Rainforest Alliance) planning or managing agricultural carbon projects in West Africa should attend to the knowledge and practices of Loma and Mende women and men who have made and cultivated carbon-rich anthropogenic soils in the region for generations.

Keywords: Liberia; Sierra Leone; agriculture; terra preta; biochar

INTRODUCTION

Our research in the forest and forest-savanna transition zones of Liberia, Sierra Leone, Guinea and Ghana has revealed the widespread presence of carbon-rich high-fertility African Dark Earths (AfDE) - analogous to Amazonian terra preta - yet subject to continuing production and use (UNPUBLISHED – SUBMITTED TO NATURE). The research presented in this paper seeks to fill a significant knowledge gap by investigating the practices that contribute to AfDE formation, the ways in which people perceive AfDE within broader agro-ecologies, and the social context in which anthropogenic soil formation takes place. When we asked as to the provenance of the anthropogenic soils that we found occurring throughout the landscapes they inhabit, Loma people of NW Liberia frequently said that "God made the soil, but we made it fertile" This statement expresses a common understanding across the Upper Guinea region of West Africa that farming and everyday human activities can upgrade soils into highly-valued states of enhanced productivity. Such soils have not featured in soil science and ethnopedological literature to date (Barrera-Bassols et al., 2003) but are suggested in archaeological literatures (Bailey, 1999). Only particular activities and certain people produce AfDE however, and these soils are used by different people in different ways. In particular, and as this paper explores, the production and use of African Dark Earths are highly differentiated by gender. This paper takes a gendered political ecology approach to understanding the hitherto unappreciated ecological knowledge and practice surrounding the formation and use of these soils.

The interrelationships between gender, environment and ecology are the focus of a multi-disciplinary research field, extending from geography to cultural and political ecology, anthropology and development studies. From an early focus on 'women and nature' (Shiva, 1989; Mies et al., 1993), research moved to address gender divisions and relations in environmental roles – including labour, resource access and control, and the use of spaces and products (Agarwal, 1992; Rocheleau et al., 1996; Green et al., 1998). Gendered activities, taskscapes (c.f. Ingold, 1993) and the 'micro political economy of gendered resource use' (Leach, 1994) shape landscapes and environments (Schroeder, 1999). The subfield of feminist political ecology emphasises the significance of gendered forms of environmental knowledge and power, as well as the interactions between local, intra-community processes and those extending up to global scales (Thomas-Slayter et al., 1995; Rocheleau et al., 1996; Hovorka, 2006; Elmhirst et al., 2008; see also themed issues on feminist political ecology in Gender, Place & Culture (16,4,2009), and Geoforum (42,2,2011)). In this work and elsewhere, it becomes clear not only that gender relations are implicated in the shaping of environments but that also, reciprocally, environmental practices and struggles shape the nature of gender relations (and are even constitutive of gender). Gendered subjectivities and identities – and those that cross-cut them (such as age and ethnicity) – are performed, instantiated, embedded and contested through people's actions in experiencing, creating and using environments (Leach, 1994; Nightingale, 2006; Sultana, 2009).

This article draws on these theoretical perspectives, captured in Hawkins and Ojeda's (2011:250) call for more studies of the 'entangled processes of the production of nature and subjectification/subjection as this relates to gendered roles, landscapes, bodies, livelihood strategies...'. Like them, we are interested in 'the production of gendered environments and the gendered subjectivities they produce' (ibid). However, we are also interested in the detailed ecology of these entanglements (see Barad, 2007). In their emphasis on social and political dimensions of environmental access, use and struggle, works in political ecology – feminist or otherwise - have paid relatively less attention to biophysical processes, technological applications and their material effects on landscapes (Walker, 2005). Notwithstanding sometimes heated debate about the origins, extent and seriousness of this apparent neglect of ecology in political ecology (Vayda et al., 1999; Peet et al., 2004; Walker, 2005), there are growing calls for studies that genuinely interweave analysis of social relations and biophysical/technological processes, equilibrial and non-equilibrial, to show how these mutually shape each other in the constitution of landscapes (Scoones, 1999; Zimmerer *et al.*, 2003; Walker, 2005). Such a materially and ecologically-grounded political ecology can be informed by both 'expert' natural science and local and 'indigenous' forms of knowledge, attending to the convergences and contestations between them (Forsyth, 2003; Sillitoe, 2007; Leach *et al.*, 2010).

With this broad aim we explore three interrelated dimensions of the gendered political ecology of African *terra preta* analogues. First, we address knowledge dimensions, addressing how local people distinguish and understand the qualities of AfDEs in relation to other soils, how such knowledge is gender-differentiated, and the significance of such "ethnopedological" (Barrera-Bassols *et al.*, 2003) knowledge in relation to more formal scientific understandings. Second, we address gender relations in the formation of AfDE. We show how the practices and technologies that produce AfDE are embedded in gendered domains of work and household provisioning, and the central roles of women's production and deposition of charred organic materials from cooking, oil palm processing and potash production. Third, we explore the gendered dynamics of AfDE use and distribution in the landscape. We show that AfDE are differentially valued and cultivated by women and men for horticultural and tree crops, and examine the differences in species that are cultivated in AfDE compared to non-anthropogenic soils. Where AfDE form and who uses them depend on intra-household and tenure relations, themselves shaped by broader marriage and settlement practices in the context of a shifting political economy. Understanding these dynamics is central to appreciating the wide spatial distribution of AfDE across the landscape, and the pattern of continuity and change in their temporality. In turn, AfDE and the broader landscapes in which they are embedded constantly re-invoke in everyday life the social structures and meanings that shape gender, age and status relationships and subjectivities in this region.

Methods

The detailed, village-based case studies on which this paper draws forms part of wider social/soil science investigations in their respective countries (one year in Liberia, 6 months in Sierra Leone). In Liberia, in a regional survey in Gbarpolu, Bong, Lofa and Nimba counties, we identified African *terra preta* analogues at 134 locations, with dozens more reported. While no such survey was conducted in Sierra Leone, preliminary observations suggest that AfDE are as widespread there as in Liberia.

In Liberia, our case study was centred on the town of Wenwuta, a Loma settlement in Southern Zorzor district, Lofa county, NW Liberia (Figure 1), the satellite villages surrounding it, and southern Zorzor district more broadly. This region provided a unique opportunity to examine AfDE formation since it is characterised by a high degree of cultural continuity when compared to other regions of NW Liberia. Wenwuta is an old settlement, around 2ha in size with a ring of AfDE up to 1.80 meter deep within and around it. Written accounts confirm that this town was thriving and four times its current size in the mid-nineteenth century (Fairhead *et al.*, 2003:132). In Sierra Leone, our case study focused on three Mende settlements in Pujehun, Kenema and Bo districts in the SE of the country, which were chosen at random from within the area covered by a rural development project working in the region. We obtained prior permission to conduct the research from all informants interviewed, regional leaders, and officials of the Governments of Liberia and Sierra Leone.

We used unstructured and semi-structured interviews, focus group discussions, participant observation and to transect walks to discern in depth local knowledge, intra-household dynamics of AfDE tenure and use, and practices involved in AfDE formation, including the detail of technical practices and their effects in both Liberia and Sierra Leone. These methods were contextualised within in-depth ethnography, observation and informal conversations during long-term residence in Wenwuta (Frausin, Fraser, Narmah), and long-term-research and project-related engagements in Sierra Leone (Leach, Winnebah, Lahai). In all categories of data collection we sought to balance numbers of male and female informants, apart from in the participant observation and surveying of leaves used for making soup and materials for potash production, where after discovering that men had limited knowledge and interest in this domain, we focused on women and adolescent girl informants.

In order to quantify perceptions of crop cultivation in different soils, we conducted a freelisting exercise (a type of cultural domain analysis, see Bernard, 2006:301-305) in Liberia with 116 individuals that were randomly selected after conducting censuses at Wenwuta, surrounding villages, and at the town of Borkeza (Table 1). These other locations were selected because of the presence of significant amounts of AfDE and a long history of its cultivation. We asked each individual 3 questions in Loma: which crops do you plant in AfDE? Which crops do you plant in the red soils of the uplands? Which crops do you plant in the soils of the lowlands? We also conducted a freelisting of fuelwood species amongst men and women in fifteen randomly chosen households in Wenwuta, who were asked, “Which kind of wood do you use to make fires.” In each freelisting, responses to each question were recorded in rank order. We then calculated the salience of each crop in each type of soil using the following algorithm

$$S = F / (N*mP)$$

where: S = salience index, F = frequency (# of people who cited the variety) N = number of people interviewed, mP = mean "position" (or mean "rank" of the species) (Sutrop, 2001). Plants and trees were identified by regional specialists (see acknowledgements) and checked at http://www.tropicos.org/.

Data from the case study Loma settlements of Wenwuta, NW Liberia and Mende settlements of SE Sierra Leone are primarily used in our analysis of gendered work and technical practices, and landscape patterns. The data from each country complement and compare with one another. The cases share broad agro-ecological similarities. The geomorphology of the landscape is characterized by low rolling hills that form a toposequence or soil catena – a hill to valley continuum – within which three major physio-hydrographic positions are distinguished by their source of water for cultivation and soil typology. These are pluvial (hilltop, cultivation reliant on precipitation), phreatic (hillside, groundwater from high water table) and fluxial (valley bottom water from surface flow, i.e. run-on and flooding by streams). Natural soils at the top of the toposequence are typically infertile and highly leached Oxisols or Ultisols, whilst those towards the bottom are more fertile Inceptisols and Entisols (Andriesse et al., 1991). In West Africa, a distinction is typically made between shifting rice cropping systems in the uplands and permanent, wet rice cropping systems in the lowlands (Richards, 1985). Rice fields often cut across these environments however, as farmers cultivate spaces that combine different toposequence positions; targeting specific crops to different areas (i.e. if a small area of valley bottom is available, more nutrient demanding crops such as banana and eddoe are often planted there). After harvest, in the second and even third years, fields are replanted with groundnut, beans and manioc (Leach, 1994). Loma and Mende are related languages within the south-west Mande group, and those speaking them share many common features of social and political organisation structured around the relations between landowning and late coming patrilineages, the importance of matrilateral marriage and social ties, the significance of age and gender in structuring labour and tenure relations, and the power of gender-specific initiation societies (Leopold, 1991; Leach, 1994; Ferme, 2001). Drawing these cases together reinforces appreciation of the interrelationships between gender relations, ecology and AfDE in a landscape patterning that extends beyond any single community to a wider social-environmental region.

Local soil knowledge, AfDE and Gender

People in both our Liberian and Sierra Leonean study sites – and indeed in neighbouring areas of Guinea (Leach et al., 1995; Fairhead et al., 1996) distinguish between soils that are ‘natural’ (usually describing them as created by God), and those transformed by their own activities. In contrast with dominant perspectives in scientific literature which assume that people only degrade natural soils, local knowledge and practice here importantly encompass transformations that ‘upgrade’ soils (upgraded at least from the perspective of the human farmer), rendering them more fertile and productive. Here we refer to transformations that convert the ‘red’ soils that are most widespread in this agro-ecological region to ‘black’ soils, a subset of which are AfDE. In this respect, local understandings and ethnopedological knowledge are commensurable with less mainstream areas of science that are beginning to recognise the soil-upgrading effects of adding char, whether in work on terra preta in the Amazon (Schmidt, 2010), or in recent research on biochar (Lehmann et al., 2009) – for instance in conservation agriculture in Zambia (Sparrevik et al., 2012), cookstoves in Kenya (Whitman et al., 2011); and on how biochar relates to bioenergy cropping systems (McCormack et al., 2013) and its relationship to plant productivity and nutrient cycling (Biederman et al., 2013). Existing ethnopedological studies have largely ignored these issues

(Fairhead et al., 2012) but as we show here, Loma and Mende understandings offer rich and nuanced accounts of soil processes that, like other areas of indigenous knowledge (e.g. folk-taxonomies) are compatible with the scientific categories (Berlin, 1992; Atran, 1993) while also extending beyond them.

When asked "what kinds of soils are there here?" people invariably reply that there are red and black soils, sometimes adding white soils as a third category. More detailed and repeated questioning confirms the salience of such broad categorisation of soils into three overarching "colours" across the region, reflecting the primacy of red, black and white colours in Mande languages. An ethnopedological study in the humid tropical region of Côte d'Ivoire similarly noted that people distinguish, dark, light and red soils (Birmingham, 2003). The terms plole-gee/porlei (black soil in Loma and Mende respectively) and plogba-gee/porgboi (red soil in Loma and Mende) have diverse meanings, and there are sub-categories within each reflecting variations in topography, ecology and land use history (see table 2). However, people associate certain overarching spatial and productive qualities with each. Red soil is the typical soil that is found "all over," as villagers put it, and that most cultivation of upland rice – the region's staple crop - takes place on. Black soil tends to be seen as more fertile, and this fertility comes from the presence of "dirt" (Loma kavar, Mende kawewe) in the soil. Black soil is not found all over, but is limited to places where it has been created. This can be by natural agencies – for instance Wenwuta villagers attribute the fertile black soils in lowland areas (kakebete) to erosion washing leaves and dirt down into them, and some areas of black soil under high forest to leaf decomposition. In addition, the origins of this dirt - that is seen to cause the soil to turn black - can be anthropogenic. This is the case, in particular, for places where people have thrown rubbish, organic waste and ash and char. The resulting soils are distinguished in Loma as tulupole – tulu [where you throw dirt] pole [soil] - dump site soil, and in Mende as kawei [dumpsite]. Such terms are the local equivalents of AfDE. They identify soils by the activities that produce them, in a way that extends beyond and adds valuably to the more static categorisations of soil science.

People recognise the significance of charred material from vegetation amongst the waste in rendering such soils black, and in this respect identify different degrees of blackness. For instance, some villagers in our Liberian study site acknowledged that the fallow burning carried out for upland rice cultivation also created black soils in field sites but that these are distinct from AfDE in that they exhibit only a surface layer (<10cm) overlying red soil, rather than being black to a depth of (30cm>1m80cm) as dumpsite black soils are. In Sierra Leone, villagers distinguish black soils (porlei) from ‘very’ or ‘black black’ soils (porleilei), describing the latter as a deeper black in colour, more fine grained and fertile, and with distinct soil organisms. Established dumpsite soils (AfDE) are porleilei, with porlei seemingly understood as an intermediate, transitional stage in AfDE formation.

As we describe in the following sections, AfDE form around settlements and farm kitchens through a variety of everyday activities that involve people dumping organic waste, ash and char. AfDE are also associated with old abandoned settlements, where ancestors carried out similar practices. These are referred to as tomboi in Mende and pulugizi in Liberia. In Liberian English the term is ‘old town spots’. Thus, a further form of categorisation in local ethnopedology distinguishes soils by the historical processes that created them. Human and non-human action may also be seen to combine in creating areas of black soil, which is recognised to happen, for instance, in towns on hills, where people make soils fertile, but that fertility is spread down the hill by erosion.

At a broad level, these soil categorisations are common amongst villagers, men and women, elders and youth. Yet in both our study areas, it is women who speak most knowledgeably and in most depth about soils in general, and about AfDE in particular. This does not reflect any formal cultural demarcation of soil knowledge as a gender-specific domain – in contrast with some other areas of productive and reproductive life including human fertility, where knowledge is carefully guarded by gender-specific initiation societies. Rather, it reflects the fact that within established gender divisions of labour and responsibility in farming and household provisioning, it is women – and the youth and children who often assist them - who engage most intimately and viscerally with soils. This is acknowledged by a young man (Bockarie Koroma) of Mapuma, SE Sierra Leone, who stated that the soils in the new settlement sites are fertile because:

> "The females contribute to the improvement of the soil by adding ashes mixed with *charcoal…The male members deposit the palm tree and the palm kernel shells on the* soil in order to improve its fertility".

In household production of upland rice, women's work engages with soils directly in scratching, planting and weeding, whereas men's work is focused on initial field clearance and assistance with harvest. Women also cultivate vegetable gardens on their own account, both to fulfil their responsibilities in providing daily sauce ingredients and where possible to sell for income, as a valuable source of personal funds to meet their own and their children's needs. Indeed Loma and Mende women themselves claim to know more about soil than men, since, as they point out, it is women that work more with the soils around the town and on farms and are ultimately responsible for the feeding of their families – so this knowledge is a necessity. Furthermore, as we shall see later, women are those directly engaged in most waste-producing activities that create AfDE; most men only interact with AfDE later in its life cycle, where the decomposed organic matter is spread out spatially and is turned over to tree crops. This practical, everyday involvement in creating and using soils and AfDE in particular creates a rich domain of gendered knowledge in which many women speak with interest and sophistication about soil genesis and qualities. Older women, given both their longer accumulated knowledge and the status and authority they acquire with age in this region, offer particularly clear accounts.

As we emphasize in the title of the paper, when asked about the origins of AfDE, women would often say "It was god who made the soil, but we put the dirt there and made it fertile." This theme is repeated throughout women and men's narratives in the two countries. Thus as Gbolu Korlu, a female elder in Wenwuta, explained the differences between black and red soil**:**

> **"**Black soil is found around the town, in certain places in the bush. God made the soil, but the dirt is the food for the plants. On the farm when they pile the straw up and burn it makes the soil black too. In some old farmland that is how the soil becomes *black. Black soil is good because it is smooth, red soil is rocky. That's why things* grow better in the black soil than the red soil...Black soil is only found in small areas, but the red soil is found all over. Black soil in certain places is made by god, *elsewhere by man."*

An elderly woman in Wenwuta, Kortor Flomo, identified that black soil is the most fertile, that it is mainly found around the town, and some of the materials and processes that lead to its formation:

> *"What makes the soil so rich? The di*rt we there and burn over and over for a very long time will change the soil. The black soil is rich around the town because the things we throw there: rice straw, fire ash, other materials. Soils on the farm are not as rich as those around the town as they do not have things thrown on it like in the

> town.... The soil that god made, it never had pepper, bitter ball, okra, plantain, on it. But it was us that had that idea of planting things in the soil, and throwing things on the soil making the soil rich, i*t was not god.”*

In another Wenwuta narrative, Carmen Howard attributes the richness of AfDE to the actions of ancestors dumping, and how this has made the town soils the “chief” of all soils:

> *“The black soil was m*ade by god, but made rich by our old people way back. Those things that the old people used to throw in the soil way back are what made the soil rich for planting. Around the town you can plant pepper, bitter ball banana, plantain, they will grow best, better than on the farm. The reason for this is things we throw in *the gardens around town. The black soil is the chief of all soil around here”.*

Whereas some women describe fallow burning for farming as creating black soils, one elder woman (Yassa Ubu) claimed that they were mistaken, since it is only black on the surface:

> *“To know the type of soil you can’t just look at it, you’ve got to dig*. The soil can *appear black but when I dig below it is red…there is only real black soil around town…or in an old town spot. The reason why you only get black* soil around the town is because that is where people throw dirt. It was god that made the soil but we are the ones who change *the colour… I was born, observed the actions of people* throwing dirt, this changed the soil. Soil does not become black here in the field *because we are not throwing things here.”*

Her narrative went on to recognise a distinction between a richer but narrow inner ring of AfDE at Wenwuta, where dumping is still taking place, and more extensive AfDE further out:

> *"You find black soil at Wenwuta and at old town spots for Wenwuta…the blackest* soil is found closest to the town and then as you move out you can also find a black soil, but not as black as the one closest to the town...The inner black soils are darkest because we are still throwing things there, the outer ones only had dirt thrown there way back. Further out black soil was made because town was bigger before but *afterwards became smaller…when you see a big area of black soil at an old town* spot, that means the town was big, if it is small then the town was small"

This account alludes to the spatial patterning of AfDE in the landscape in relation to the dynamics of settlement, processes that we explore further in section 3 and show to be gendered in distinct ways. Next, however, we address the variety of ways in which 'dirt' is produced and distributed, so as to form the dumpsites that over time become the durably-transformed soils that are AfDE.

Gendered practices in AfDE formation

The 'dirt' that contributes to AfDE formation includes char ('biochar') from a number of sources: 1) charred wood from fires lit for cooking, palm oil, soap, and potash production and blacksmiths' forges; 2) charred by-products from palm oil production, 3) charred organic by-products from the production of potash; along with diverse organic materials left over from cooking, domestic refuse processing, crop processing and house construction. As we examine each of these sources in turn it becomes evident that each depends centrally on women's work and contributions within prevailing gender divisions of labour and household provisioning responsibility. Age cross-cuts gender however, and the contributions of children (both girls and boys under about 13 years of age) are central, reflecting both women's childcare responsibilities and the expectation that children will assist their female relatives in day-to-day productive and reproductive tasks.

In spatial terms, many of these activities are located on the edge of the town, in or behind the ring of kitchens that typically encircles the settlement's residential houses. In the region this is conceptually and practically identified as a feminised gender domain (Leach, 1994; Ferme, 2001), a focus for women's work and socialising in contrast with the more male-dominated house verandas and central public meeting places. While not strictly adhered to, these spatial gender boundaries reinforce everyday associations between gendered subjectivities and AfDE formation on settlement edges. Where these activities take place in the bush outside town, as they sometimes do near farm kitchens or to be close to water sources, their sites become temporary feminised spaces for the duration of the work, yet also leave a lasting legacy in the creation of dumpsites and AfDE.

Making fires

Women and children make fires every day for many different purposes: for cooking, palm oil, soap, and potash production, drying meat and children's games. Cooking fires are lit in kitchens in town and in farm kitchens in the bush. Men, on the other hand, light fires to clear land for agriculture and make cooking fires to boil palm seeds during water oil processing (see below); in addition, specialist blacksmiths make fires in their forges on the edge of town. Fire is also used in the bush to clear fallow land for agriculture; a task managed by men in shifting cultivation systems that rely on the deposition of ash and small amounts of char to create a year or two of fertility in otherwise nutrient-poor upland soils. However this field-scale burning is distinct from the localised, intense deposition of char that contributes to AfDE formation.

Fires for different kinds of cooking and food processing require different burn intensities, so particular firewood species are preferred. In Loma, Borwolor (Funtumia elastica) and Diacolegee (Macaranga heudelotii) softwoods are known as "women's stick" and frequently used for cooking, as they are easy to break and fast burning, and said to be "dry". The Mende equivalents are Ndeway and Belle that are said to burn smoothly but do not last long. These are the most easily available wood, gathered as dead wood from bush fallows and cleared fields. Longer burning species that are said to be "wet" and produce the most charcoal (especially Tizae (Margaritaria discoidea), but also Yardyan (Diospyros mespiliformis) and Kudee (Uapaca heudelotii)) are preferred but less easily available so tend to be reserved for activities which require long hot fires, such as oil palm processing. In Mende areas, Tijue and Mambui (commonly known as black tumbler tree) burn for long hours and produce more coal but are less easily available (See table 3).

Producing palm oil

Oil Palm (Elaeis guineensis) is fundamental to subsistence in the region, and by-products from processing technologies contribute large amounts of material to AfDE formation. Oil palm has long been a valuable source of oil, food, drink, medicine, construction materials and bridges, and a major export (Irvine, 1969; Hartley, 1977). Archaeological evidence suggests that oil palm use is ancient, stretching back 5000 years or more (D'Andrea et al., 2006; Logan et al., 2012). Today, palm oil is still an essential ingredient in soups and sauces that are consumed daily, while it is used to make soap for bathing and cleaning kitchen utensils. People consume the fruits raw in the dry season, and also cook them in water to make palm butter soup. Women generally control these subsistence uses of oil palm products, which are put towards meeting their gendered food provisioning and domestic responsibilities. However palm oil sold to regional and national markets in Zolowo and Monrovia in Liberia and Koindu, Bamoi and Freetown in Sierra Leone is also a major source of household income; men also exert control over such income and how it is spent. E. guineensis is abundant in the bush fallow landscape of NW Liberia and SE Sierra; both locations are within the oil palm belt of West Africa (Hartley, 1977). The majority of palms are volunteers, but palm dispersal and germination are encouraged by shifting cultivation. Oil palms are sometimes planted however, in particular new genetically modified varieties that are much shorter and easier to climb. These are often grown in AfDE nurseries in town, before being planted in the bush.

Oil palm processing involves a sequence of gender and age-divided tasks. Men climb the palms with a harness and cut bunches of palm fruits; a task that is strictly forbidden to women. The act of harvesting, negotiated in relation to tenure over the palm tree, gives the man rights over the palm fruit and their resulting oil. Women and children carry the palm heads to the farm kitchen or a pit in the bush near to a water source, and separate the seeds. Subsequent gendered tasks depend on which of three types of oil are being made: Torboguie in Loma (or Glogboi or Tuweeloie in Mende) or water oil from the palm fruit mesocarp, and Canna in Loma and Ndangleie in Mende oil from the kernel. Oil palm is harvested in the dry season and might extend to the early rainy season. Water oil is produced during this time, while palm kernel oil production increases in the rainy season.

In Loma and Mende areas, both processes produce by-products: palm straw from palm heads (often recycled to make potash); mesocarp fibres (often dried to use in lighting fires or as chicken bedding), and char from boiling the seeds – in much larger quantities for water oil due to its repeated boiling. This char is dumped near the pit. Sometimes, kitchen and pit are combined in the same space. Waste from cooking for the workgroup also contributes to AfDE formation. An edible leafy plant called "Toluagulii" (Portulaca oleracea) in Loma, which means "grass of the kernel trash," colonises areas of palm trash. Because certain places in the landscape are best suited to oil palm production, people often reutilise spaces that were first used by grandparents, leading to a considerable build-up of waste deposition over time. Palm fruit endocarps left over after making (palm) water oil in pits in the bush are brought into town or to (new) farm kitchens by women and particularly girls, who dry and crack them to reveal the kernel and then boil these to make kernel oil. The woman who processed the palm fruit oil is considered to have exclusive rights to the kernels and their oil, as a reward for her labour – though she may of course share or exchange them with others. Women value kernel oil for cooking in the rainy season when palm fruit oil is scarce, use it as a moisturizer, to plait their hair, as well as to make soap and sell for their own income. In NW Liberia, Canna oil is considered a powerful medicine that is forbidden to make inside the town. Women therefore process it just outside the town margins. The large amounts of waste produced – wood char from the boiling, and cracked kernel endocarps – it is used as fertiliser applied directly to plants (such as banana) and contributes substantially to AfDE formation. An elderly Mende man (Vandi Moiwo) in Yanihun, SE Sierra Leone explained that soil improvement includes use of: 'palm kernel shells ... that is burned in fire before being deposited on the soil'.

Producing potash

"Potash" (potassium carbonate) refers to salts containing potassium in water-soluble form. Its production from plant remains has ancient origins in the region, and prior to industrial salt production it was produced and traded in large quantities (Jones, 1983). Even though industrial salt and sodium bicarbonate are now widely available, potash production continues; people often lack the money to purchase salt and soda, and use potash to make soap, added to sauces that are consumed with every meal, to soften leaves, and to improve digestion. Women are exclusively responsible for the tasks involved in potash production, and control the product for their own use, exchange, or sale.

In both country case study sites, the most common materials used to make potash are the seed pods from Pentaclethra macrophylla, Cola nitida, Ceiba Pentandra, and Elaeis guineensis palm fruit heads after the fruits have been removed - although we observed 20 different species being used (Table 4). Potash is made by drying and then burning tree and plant remains. The resulting ash and char are placed on a filter made with rice stalks; water is poured through the filter and then boiled until it is dry. This process is lengthy, taking 6 to 9 hours, and the trash goes straight into AfDE production. Where potash is produced depends on seasonality and materials used – sometimes beside farm kitchens, sometimes near oil palm processing pits, and sometimes on the town edge.

Adding organic materials

During participant observation and transect walks, we observed a large variety of organic materials being added to dump piles. They fall into three main categories, each associated with gender-differentiated tasks and responsibilities. First, there are wastes from crop processing both for subsistence and for the market. Women, bearing main responsibility for day-to-day food provisioning, process and dispose of the stalks from rice, banana and plantain, the staple foods; the skin of cassava, plantain and banana, eddoe (Colocasia esculenta), sweet potato, yam (Dioscorea spp.), pumpkin, oranges, coconut, kola nuts (Cola nitida), avocado, papaya and breadfruit, as well as the roots, stems, pedicels and flowers of plants (e.g. Pepper, cassava, potato, a vast variety of greens, garden eggs) used to make the sauces eaten with rice. Children, particularly girls, often help their female relatives with food processing and so also contribute their labour to such waste dumping. Men and women both work in processing peanuts, beans, oil palm, kola and cocoa – the principal cash crop – and dispose of their pods and kernels on dump sites. Second are wastes from insects and animals consumed for food – including bones from fish, mammals and snakes; shells from crabs and prawns; the guts of fish and animals, and the hair and scales of mammals, fish and pangolins. Local chicken and cattle faeces are deposited in association with ashes and charcoal swept from household kitchen in settled case study sites. Hunting and trapping are men's work, while women, girls, boys and men fish in local streams and rivers, using gender-specific technologies. The task of processing such animal sources, and dumping their wastes, tends to be divided relatively flexibly between genders. Children contribute to these processes by seasonally collecting insects such as termites and grasshoppers to snack on, disposing of their leftover heads and wings, and also in their use of diverse insect and animal species as toys, which are subsequently disposed of in the dump piles. In Mende areas boys and men use insects they find in developing AfDE as bait for fishing. Human faeces, especially of children under eleven, are also added to dump sites either after cleaning up mess made by the younger ones or during open defecation by the older ones – although some parents, as well as NGOs promoting hygiene and sanitation, discourage this. A third category of organic wastes is from construction and the manufacture of local technologies. Thus men and women often work together to collect and roof houses and kitchens with the fronds of Raphia vinifera; when a roof is replaced, the old roof materials are dumped. Women and children make brooms, nets and baskets from Raphia vinifera and other local fibres, while children often make dolls and other toys, as well as nests for chickens and birds. Again, worn-out tools and toys including those made with clothes and ropes are dumped on the town or kitchen edge. Weeded plants around compounds in towns and farms sometimes form part of the added organic materials.

Thus a wide range of gender and age-differentiated practices is involved in producing the char and wastes that, added to dumpsites, become the 'dirt' that contributes to the creation of fertile AfDE. The work of women – as wives and mothers – is paramount in these processes, not least because of their central responsibilities for household food provisioning, and the expectation that they will contribute labour to household cash enterprises such as processing palm oil or cocoa for sale. In these instances, women's labour contributes to products whose income will generally be controlled by their husbands or male relatives. Nonetheless, the wastes themselves are a key by-product; not thrown away but put to use in building up fertile patches that women as well as men value for further productive activities. In effect, these practices draw plant and tree products from the agricultural and forest hinterland into the feminised domestic milieu of the kitchen and its surroundings, whether kitchens on the town edge or farm kitchens. How these AfDE production sites are used, and their changing distribution in the landscape, depends however on further dimensions of gender relations.

Gendered dynamics of AfDE use and distribution

The immediate surroundings of the kitchen are thus the primary locus of AfDE production in both the town and the bush. Town kitchens are as permanent as the town itself. The close positioning, high density and temporal continuity of kitchens in towns means that soil transformations in towns will be more significant, longer lasting than those in the bush. Farm kitchens are more temporary, there are two kinds (Loma and Mende respectively): Balailah or Kpowee, a longer-term rice kitchen, with an upper storey to store rice and space for sleeping during periods of semi-residence at the farm, built in a central place around which the annual rice can rotate. Only after 5 years or more may the kitchen need to move if no fallow of adequate age for cultivation is located close-by. Bocoplegii or Kpoelah, by contrast, are temporary shelters that tend to change location every one or two years when rice farming moves to another location, so the production of AfDE is intermittent.

Viewed at the landscape level, AfDE thus form a tripartite typology: type I forming in rings around current towns, villages and hamlets; type II forming in the soils underneath and around rice kitchens and palm oil production pits, and type III constituting relic anthrosols at the site of former settlements (old town spots) - by kitchens historically, which today no longer exist. In Wenwuta, types I and III (current and former settlements) are typically between 0.5 and 2 ha in size, though two outliers were 5ha and 14ha respectively. Type II (rice kitchens) are usually from 100-500m^2 in extent, but are much more abundant. These AfDE types are used in different, gendered ways.

Whether in town or farm, kitchen-edge dumpsites are, after several years of waste deposition on a spot, initially used to plant garden crops. All households make and use dump piles this way, but exact management practices vary. Dumping may continue in one place from one up to ten years, before a different place is used for dumping. The original dump-spot may or may not be burnt before the waste is spread out and used for planting. In Wenwuta, Liberia, people generally described dumpsites and their soils unproblematically as a household resource; as one woman spoke of herself and her husband, ‘this place is for us’. In the study villages in Sierra Leone, however, villagers were clear that tenure over dumpsites (kawei) formally rested with the (usually male, occasionally an elder woman) head of household, who had overseen its establishment or inherited the place from an older relative. Male heads of household assisted by their sons carefully demarcate kawei sites with sticks tied with ropes obtained from the bush. Often prayers are offered and sometimes rituals performed there under the direction of the male head of household before waste deposition starts by the wives. These actions are intended to ensure good fortune there, but they also instantiate men’s ultimate authority over sites that are, as we have seen, located within female-dominated kitchen-edge spaces and which women’s work will subsequently render fertile.

There is also gender differentiation in planting, ownership and control of the garden crops planted. Men cultivate bananas, plantain, bush yams, oil palm, cocoa and coconut; longer-term cultivars that both confirm household tenure over the dumpsite, and which contribute to men's responsibilities, as household heads, to provide staple foods for their families. Women of the household cultivate annual plants such as careless greens (Amaranthus spp.), palaver sauce (Corchorus olitorius), pepper, garden eggs and bitter ball or long term greens as fever leaves (Ocimum viride), onions, peppers, aubergine, okra (Abelmoschus esculentus) and sweet potato and cassava (used mainly for their leaves). These crops are valued and used by women in their responsibilities to provide daily sauce ingredients, and in networks of exchange amongst their female neighbors and relatives. Women also sell small amounts of pepper, leafy plants (for soup), seeds of greens or eddoe and aubergine as a source of own-account income – and in towns with good road and market access, may do so periodically in larger quantity. As men in Mapuma, Sierra Leone explained, they encourage their wives in such cultivation, aware that whatever is produced in the kaweis is ultimately consummed by the household as food or generates money used to buy other food condiments, pay school bills, for medicines, clothing and other non-food items – assisting the head of the household to meet his responsibilities. Women do normally use and dispose of the products as described, but where marital relations are tense, value an independent source of income; conversely they might purchase cigarettes and underwear to sweeten their relationship with their spouse.

This gardening on developing AfDE around the town, and its micro-economy of gendered resource use, is replicated in the dumpsites around farm kitchens (type II AfDE), although around temporary shelters only annual crops are grown. Type II AfDE homegardens can be more diverse, as women prefer to move pepper, aubergine and other sauce crops that seed in town dumpsites to their farm kitchens to avoid damage by the small ruminants that roam the town edge. Town-edge Type I AfDE, with their longer-term, deeper and more fertile dark earths, tend to be dominated by plantain, sweet potato, eddoe and leafy plants used for soup. AfDE is an important source of greens for soups for people who lack access to lowland soils in dry season "when the soup business is hard." The species they exploit are mainly volunteers such as bush pepper leaves (Piper guianense) from the old town spots and around town, Pelevelegii (Indet.) from the roads around towns, Bitter leaves (Solanum incanum), Careless greens (Amaranthus spp.), Pompondai (Piper umbellatum), Kebeah uwi (Boerhaavia diffusa) or Toulaguli (Portulaca oleracea).

In some cases, farm kitchens are re-established at locations that have been used for a long time. In one case in Wenwuta, for example, a woman and her family occupied the kitchen space of her grandmother, with noticeable areas of AfDE. When asked why she had planted eddoes in that specific place she explained that:

"Because my grandmother used to have that specific place as dumping site and she planted eddoes there too, I know it is rich, but before planting them I throw kernel trash, rice stalks, charcoal, old banana leaves and ash to make it better".

Women also intentionally create small areas of AfDE more rapidly in other parts of the landscape, charring piles of trash (mainly a children's task) a few months old and then repeatedly adding ash and charcoal to this charred patch, to cultivate condiments such as peppers, onions and leafy plants usually surrounded by a fence made from Raphia vinifera leaves. Thus women in Mapuma and Buma, Sierra Leone, explained how they do so near the inland valley rice swamps where they often work in order to plant peppers for sale. Both here and in Wenwuta they describe how this 'speeded up' process mimics the longer-term creation of AfDE around kitchens. Thus, a woman in Wenwuta claimed that she learned to make black soil in this way by observing the effects of her mother's burning of dumped waste around the town.

After a period of cultivation with (women's and household) garden crops, town-edge (type I) AfDE is typically turned over to tree crops, which are usually controlled by men. Men plant cocoa – a regionally important cash crop that does not grow well in red upland soils, but flourishes in AfDE, along with kola (Cola nitida), widely used for social and ritual purposes. The agroforests that form sometimes also include oil palm and non-domesticated trees such as silk cotton (Terminalia superba) and Albizia spp. Women must move their gardens onto new dumpsites and areas of forming AfDE, around farm kitchens or in the bush. Villagers describe this succession, whereby AfDE created and cultivated as kitchen gardens by women become men's agroforests, as an accepted aspect of gendered dynamics, and tensions appear rare. Tree crops, people agree, generate more income than garden crops and this income is valuable to meet joint household needs. Nevertheless women have less say in how larger, rare 'lumpier' tree crop revenues are spent than over the more frequent small incomes from garden crops that they control themselves, and have little recourse should their husband squander the money (see also Leach 1994). The most income generated by AfDE comes from cocoa planted on old spots (type III AfDE) and comes during the cocoa harvest in (September and October). This money is invested by men in valuable assets such as sheep, goats, metal roofing material, cement, and secondary / further education for children. Income that is generated from type I and II AfDE on a daily basis, year round, is controlled primarily by women and used to sustain the family.

Whether or not tree crops are planted or AfDE continue to be used for kitchen gardens is also shaped by the population dynamics, topography and land availability of particular towns. Wenwuta, for example, does not currently have much cocoa in the AfDE around the town; much was cleared as the town expanded after the recent war, and replaced with plantain, which requires less space. In some expanding towns the chiefs even forbid the planting of cocoa, since it takes a long time to mature and problems may arise with its owner if land is required for building. Plantain and garden crops are maintained instead since these short-term crops can easily be moved.

Villagers also 'mine' the richest, town-edge, type I AfDE to create nurseries for tree seedlings, particularly oil palm (Elaeis guineensis). While, in locations closer to the market, AfDE is sometimes bagged and sold to agricultural extension agencies, more often than not it is given away free. In Mapuma and Buma in Sierra Leone, it is common for men to scoop up AfDE and put it in polythene bags for nursing cocoa and coffee seeds, normally at the kawei site. When the seedlings mature, they are assisted by their wives and children, particularly boys, to transport the seedlings and AfDE pockets to sites where the tree crop plantation is being established. Sometimes men also scoop transformed type I AfDE for their wives, who transport it to their vegetable gardens in the bush where they apply it to enrich the soils further.

Through the course of time, the resulting agro-forest 'island' may result in a town becoming "too cold". This is one reason for town abandonment; others might relate to flooding, disease, shifts in political allegiance or to move closer to a road or politically-allied settlement. As inhabitants shift settlement sites, the old settlement (old town spot in Liberian English, tomboi in Mende) is often planted over with tree crops, assisted with seed dispersal by crop raiding animals such as chimpanzees. The enriched, abandoned soils of the town-edge, along with those enriched by roofing and organic materials of the houses themselves, become type III AfDE. Tenure over these old town spots is controlled by the patrilineages who owned each particular 'quarter' within the original town. Men generally secure access to their type III AfDE for tree planting either by being a member of this land-holding lineage, or through marriage to one of its daughters.

Crop cultivation in Upland, Lowland, and Anthropogenic Soils

The results of our cultural domain analysis provide quantitative confirmation of issues already discussed above regarding who plants what in AfDE, now comparing this with other upland and lowland soils. There was a strong divergence in terms of the most salient crops planted in each soil category (Figure 2), and men and women gave almost identical answers. This is unsurprising, since knowledge of what is appropriately or 'normally' planted in different soils is definitely shared. Still, the fact that men's and women's answers were so similar points to a strong degree of cultural consensus on which crops are appropriate in different types of soil.

Unsurprisingly, as the main, culturally valued staple food crop - rice (Oryza spp.) is most salient in upland and lowland soils, but Loma farmers emphasized rice intercrops in upland soils, such as beans (Vigna spp.) groundnut (Arachis hypogaea) and okra (Abelmoschus esculentus) along with cassava (Manihot esculenta). In lowland soils however, after rice the most salient crops were Musa spp. (mainly plantain), cocoa (Theobroma cacao), followed by pepper (Capsicum spp.) and okra. This emphasis on plantain and cocoa is probably related the higher nutrient requirements of these crops. In non-anthropogenic soils, cocoa can only be planted successfully in the richer soils of the lowlands, while plantain also requires better soils to yield well. In AfDE, the most salient crop was plantain followed by eddoe, cocoa and pepper. This reflects the fact that these soils are preferred for more nutrient demanding crops that cannot be grown successfully in the upland soils. The freelisting exercise thus confirms our qualitative findings that Loma (and indeed Mende) people prefer to use spatially restricted patches of AfDE to cultivate crops that would otherwise only normally grow well in more fertile lowland soils – and yet are at risk of flooding there.

Conclusions

While the phrase "God made the soil, but we made it fertile" is repeated by women and men alike, women's practices are particularly important to this soil 'upgrading', yet it is often men and their tree cash crops that ultimately profit from the resulting AfDE. As we have shown, both the formation of AfDE and its use depend centrally on women's labour, yet women do not necessarily control the products or income either from activities that contribute char and organic waste, such as palm oil production, of from its use; women's garden crops are often a temporary stage in AfDE cultivation, ceding eventually to agroforests controlled by their husbands and male relatives. It could be argued that the gender relations within which AfDE is produced and used thus involve subordination of women's labour and decision-making power to men's authority, as well as areas of female autonomy – such as when women create and cultivate patches of AfDE for their own pepper gardens. In the region, such gender differences are also cross-cut by age, with older women sometimes acquiring similar status and authority to men, subjugating and controlling the labour of younger women and male youth.

Yet looked at another way, and as generally described and understood by Loma and Mende villagers themselves, AfDE production and use is part of the relegated interdependence between genders that pervades and is central to social and economic life. The sequencing and combination of specific tasks and activities performed and controlled respectively by women and men towards outputs that are ultimately for joint, household sustenance is characteristic of many dimensions of livelihoods, including the central activity of upland rice production. AfDE production and use, viewed in sum, is no different. Indeed

AfDE processes, and presence in the landscape as a reminder of those processes, powerfully represents and symbolises patterns of gender interdependence in the generation of fertility and prosperity that pervade social life in the region more generally, from productive and reproductive domains to those of secret societies and politics. In all of these, feminine and masculine knowledge(s) and attributes are seen as distinct and different, but both valuable; and it is in their combination and mixing that the greatest power and efficacy lies (Ferme 2001, Leach 1994). The subjective experience of being a Loma or a Mende woman or man is strongly shaped by being part of such gender-specific, yet interdependent, domains of life, and the experiences of producing and using AfDE provide an everyday context in which such subjectivities are affirmed and reaffirmed. Processes of soil transformation are part and parcel of this; they render visible and durable the ancestral alliances through which current kinship has been made manifest. The way in which male and female individuals responded to the freelisting would support a high degree of gender inter-dependence: respondents of both genders gave almost identical ranking to the same species, irrespective of whether they were "men's" or "womens's" crops.

At a landscape scale, the spatial and temporal patterning of AfDE patches and their different types also reproduces and represents gender relations: here those of the marriage and wife giver-receiver relationships that allowed strangers to settle land through creating kinship with those already there (Leopold, 1991), and which still govern tenurial access to AfDE. At a general level these social relationships, and the politics of settlement processes with which they interact, represent strong continuities in the region within which AfDE formation is deeply embedded. Nevertheless, external political and economic changes, from war to commerce and cash cropping have, as we have seen, altered the micro-politics of gendered resource use, with impacts on the distribution of AfDE in the landscape. This case of AfDE in West Africa illustrates the mutual production of gendered environments and gendered subjectivities. In this political ecology, gender relations both shape the materiality of the landscape, and are reproduced as people live and work within that landscape, and use its resources. How gendered work and use patterns impact on the environment, however, is mediated by 'ecosystem engineers' (Jones et al., 1994) at multiple scales: the actions of microbial life in soils, ants, termites, earthworms, plants and trees - that create, maintain, or modify physical or chemical features of the landscape, and respond in particular ways to disturbance by human agency. Loma and Mende women and men are themselves aware of these ecological characteristics, and express – through indigenous concepts and categories of colour and 'dirt' – everyday yet finely-tuned knowledge of how soil transformations take place in different 'background' soils. Some aspects of ethnopedological knowledge are matters of local debate – such as i) whether superficial burning in fields should be considered as producing black soil or not, ii) the precise stage and processes through which 'black soil' becomes, as Mende put it; 'very black' porleilei, and iii) the precise mix of human and biophysical action (or God) at work. Conversely, others are shared – most importantly the recognition that fertility lies in the application of "dirt" to soil, and that the everyday dumping of wastes over time transforms 'ordinary' soils into 'chief' AfDE in which garden and tree crops can flourish, are basic precepts in local knowledge and experience in this region. National policy makers and NGOs, such as Care and Rainforest Alliance, planning or managing agricultural carbon projects in West Africa (see Lee, 2012), should attend to the knowledge and practices of Loma and Mende women and men who have made and cultivated carbon-rich anthropogenic soils in the region for generations.

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Figure 1 Fieldwork locations (counties, districts, and village locations) in Sierra Leone (left hand side of the map, yellow), and Liberia (right hand side of the map, green). Counties/districts that we worked in are coloured darker and close-ups are inset to the bottom left and top right of the figure. Map by Victoria Frausin.

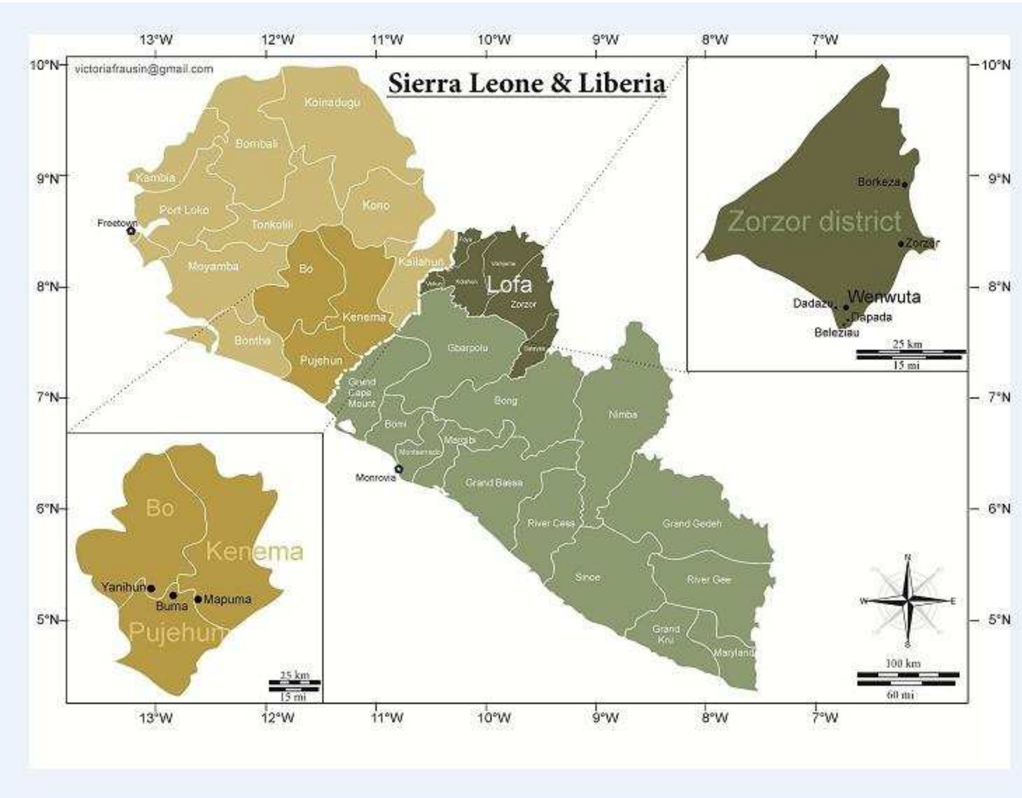
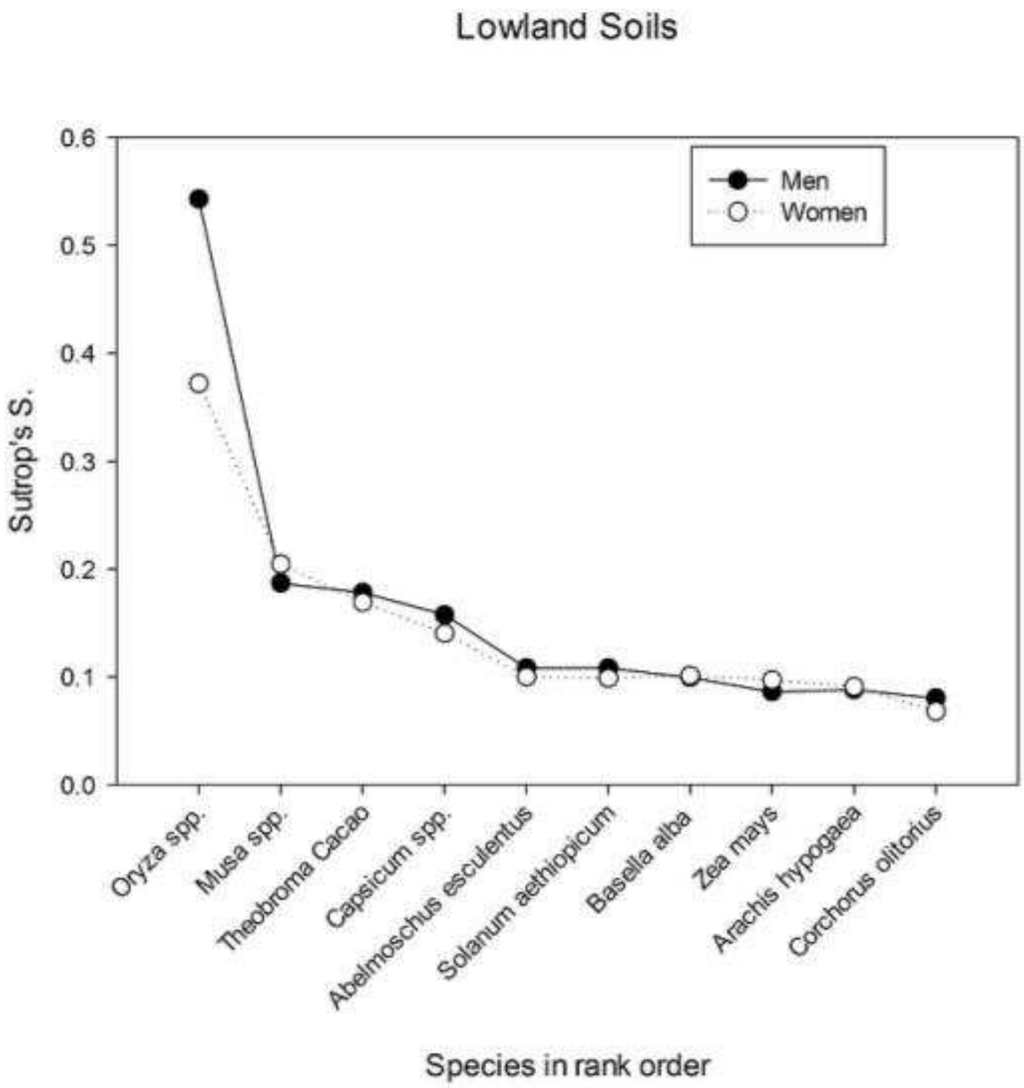
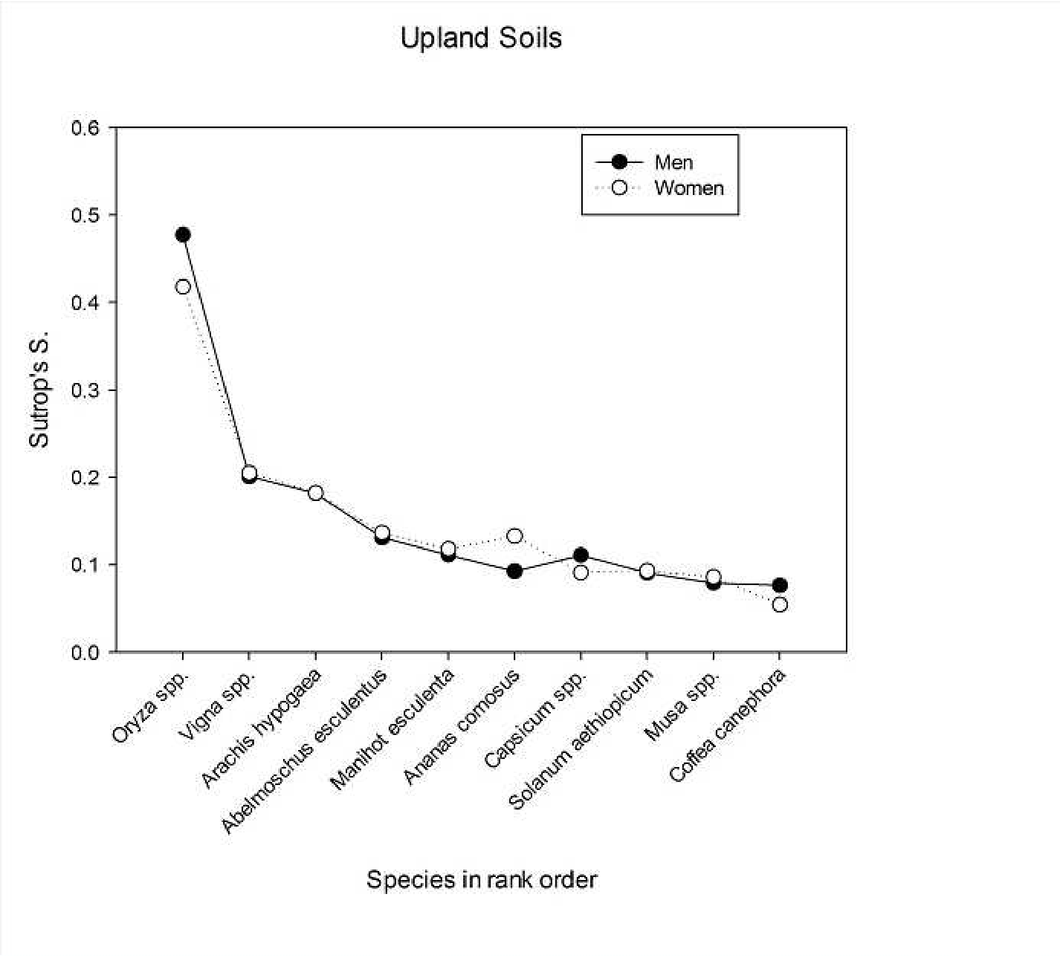


Figure 2 Most Salient Species (calculated with Sutrop's S) planted in 3 kinds of soil A) lowland, B) upland, C) anthropogenic, amongst Loma speaking farmers (m=64, w=51) in Zorzor district, NW Liberia.


Lowland Soils
Men
Women
Sutrop's S.
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Oryza spp.
Musa spp.
Theobroma Cacao
Capsicum spp.
Abelmoschus esculentus
Solanum aethiopicum
Basella alba
Zea mays
Arachis hypogaea
Corchorus olitorius
Species in rank order


Upland Soils
Men
Women
Sutrop's S.
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Oryza spp.
Vigna spp.
Arachis hypogaea
Abelmoschus esculentus
Manihot esculenta
Ananas comosus
Capsicum spp.
Solanum aethiopicum
Musa spp.
Coffea canephora
Species in rank order

Country	Researcher	Activity	Location(s) & No. Informants if more than one location	Total Gender Balance Male:Female

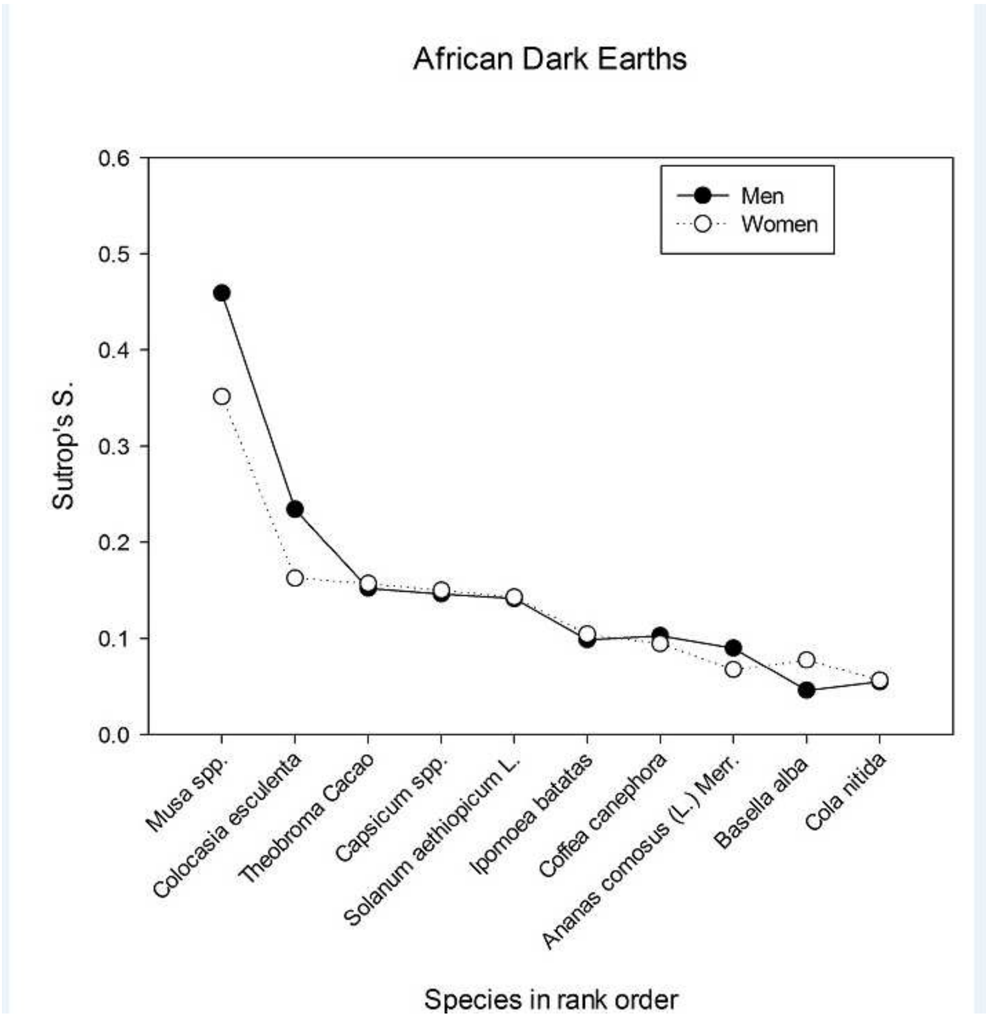


Table 1. Sampling frame for researcher roles, activities examined and methods used, locations, number and gender of informants for fieldwork in Liberia and Sierra Leone

Liberia	Fraser, Frausin & Narmah	*Participant observation and open interviews*	Wenwuta	**43:52**
	Fraser, Frausin & Narmah	*Key Informants, (Transect walks, Local Soil and ecology info)*	Wenwuta	**7:4**
	Frausin	*Participant observation on use of plants leafy edible plants and types of vegetation used for potash production*	Wenwuta	**6:20**
	Narmah & Fraser	Crop freelisting	Wenwuta (44), Borkeza (29), Beleziau (18), Dadazu (13), Dapada (11)	**64:51**
	Narmah & Fraser	Firewood freelisting	Wenwuta	**6:9**
Sierra Leone				

Table 2 Loma and Mende soil categories based on colour, name, location and characteristics.

Colour(s)	Name(s), Loma	Name(s), Mende	Sites where found	Characteristics	Comments
Black	Plolege	Porlei	Lowland, Swamp	Clay sand, mud.	
Black	Plolege[1]	Porlei	Upland (non-ADE, shallow top layer or transitional state)	Dirt, no sand or rock, loose, relatively fine-grained	Not all informants agreed on this category
Black	Plolege Tulupole	Porleilei Kawei	Around towns, farm camps, old spots	loose, smooth, fine-grained, fertile, retains water	ADE
Red	Korteyage	Porgboi	Hilltop or valley bottom	Rock, sand, mud. Muddy in wet season	
Red	Na-vie, Penai	Porgboi	Lower slopes of the hill and Lowland	Clayey. Holds water. Slippery	Low areas of rice fields

				in wet season, cracks in dry season	can be this soil. Oil production pits often located in these soils
Red	Plogba-gee	Porgboi	Upland	Loose, no sand, coarse-grained, can be stony, doesn't hold water	These are the typical rice farming soils
White	Yanziszu	Porgwee	Upland and Lowland	Sandy	Sun can burn plants on it. Used to rub houses
White/Yellow	Bazi	Partay	Swamp subsoil	Clayey, thick slippery	Used to make pots
White	Coborgee	Worgee	Swamp subsoil	Chalky	Used to rub houses

Table 3 Most salient species used for firewood by Loma women

Species	Loma Name	Times mentioned	Salience
Funtumia elastica (Preuss) Stapf	Bowolor	15	0.60
Macaranga heudelotii Baill.	Diacolegee	13	0.35
Diospyros mespiliformis Hochst. Ex A. DC.	Yardyam	10	0.23
Margaritaria discoidea (Baill.) G.L Webster	Tizae	9	0.21
Uapaca heudelotii Baill.	Kudee	7	0.14
Canarium schweinfurtii Engl.	Savagee	3	0.05
Harungana madagascariensis Lam. Ex Poir.	Kpodogee	3	0.05
Albizia zygia (DC.) J.F Macbr.	Kpakpa	3	0.05
Allanblackia floribunda Olv.	Narmue	3	0.04
Myrianthus serratus (Trécul) Benth. & Hook.f.	Gbalue	2	0.03
?	Gbaneh	1	0.02
?	Ceaceawogee	1	0.02

Table 4 Plant species used in potash production at Wenwuta Town, Lofa County, Liberia.

Loma name	English name	Scientific name	Part used
Kovelee	Oil bean tree	Pentaclethra macrophylla Benth.	Seed pod
Kpebelee	N/A	Bussea occidentalis Hutch.	Bark
Guo	Cotton tree / Kapok	Ceiba pentandra (L.) Gaertn.	Seed pod
Koigii	African tragacanth	Sterculia Tragacantha Lindl.	Trunk
Kpolue	African nut tree	Ricinodendron heudelotii (Baill.) Heckel	Bark
Yanlai	Fig	Ficus Mucuso Welw. Ex Ficalho	Trunk
Voi	East African Satinwood	Fagara Macrophylla Engl.	Seed pot
Mázáágìì	Plantain / Banana	Musa spp.	Trunk
Cɔcɔlɛgìì	Cocoa	Theobroma cacao L.	Seed pod
Wùìtolìì	Coconut	Cocos nucifera L.	Seed pod
Cofegii	Coffee	Coffea canephora Pierre ex A. Froehner	Dry skin
Gúléí	African oil palm	Elaeis guineensis Jacq.	Rachis
Koizee	N/A	Amphimas pterocarpoides Harms	Bark
Wùìkpìlì	Papaya	Carica papaya L.	Trunk
Táyangíí	Peanut	Arachis hypogaea L.	Seed pod
Tówó	Beans	Phaseolus spp.	Seed pod
Tulìì	Kola	Cola nitida (Vent.) Schott & Endl.	Seed pod
Molan	Rice	Oryza spp.	Panicle
Gbangee	Hogplum	Spondias mombin L.	Bark
Kpazie	Maize	Zea mays	Skin