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ORIGINAL ARTICLE

Coexistence of multiple ethnic groups practicing different slash-and-burn cultivation systems adapted to field conditions in miombo woodlands in northwestern Zambia

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ABSTRACT This study is focused on farmers' maintenance of slash-and-burn cultivation in northwestern Zambia's miombo woodlands and elucidates their ecological knowledge and process of clearing slash-and-burn fields. It also examines farmers' coexistence in a multi-ethnic community in the context of the locations and ecological classification of fields cultivated by firstcomers and immigrants. The study area was S Ward in northwestern Zambia. It is written as S ward not to be specified the location. Northwestern Zambia is home to five ethnic groups: the Kaonde, who are considered the region's firstcomers, and the Lunda, Luvale, Chokwe, and Luchazi, who are relative newcomers to S Ward. The number of villages in S Ward increased from 11 Kaonde villages in 1960 to 23 villages in 2000, of which nine were built by non-Kaonde immigrants. The population of S Ward increased with the influx of immigrants. Accordingly, the total area of cultivated land in S Ward in 2014 was 12-times higher than in 1968. Farmers in these five ethnic groups categorized the surrounding ecological environment according to landforms, soils, and vegetation, and classified the ecology as marsh or woodland. Woodland was identified as one of two types based on the accumulated soil: the outer edge of the marsh has gray soil, whereas the upland region is characterized by red soil. According to the farmers, the gray soil was soft and rich in nutrients, whereas red soil contained little sand and hardened when dried. Farmers in S Ward recognized that the gray soil in the woodland was more suitable for cultivation. The Kaonde's cultivated fields were located at the outer edge of the marsh, as the Kaonde have lived in the area for several generations, so newcomers were forced to clear the uplands, which had remained unoccupied by the Kaonde farmers. The Kaonde and immigrants coexist in S Ward by cultivating different ecological areas and practicing different slash-and-burn cultivation systems.

Key words: cassava, ecological classification, miombo woodland, slash-and-burn cultivation, sorghum

INTRODUCTION

In Zambia, the Bantu-speaking peoples, who engage in slash-and-burn cultivation, inhabit miombo woodlands in societies that are fluid (Trapnell and Clothier 1937; Oyama 2001, 2005; Oyama and Kondo 2007; Makeya et al. 2007; Hara 2017; von Oppen n.d.). They also engage in hunting, fishing, and gathering mushrooms and caterpillars, sustaining self-sufficiency by using natural resources in the miombo woodland. Based on local people's indigenous ecological knowledge related to slash-and-burn cultivation, they select ecological sites that are conducive to the maintenance of their livelihood (Oyama 2001, 2005; von Oppen n.d.). Under the current economic and social circumstances, small-scale farmers engaging in slash-and-burn cultivation manage their lives to cope with social and economic changes by employing several agricultural methods and

various livelihood practices (Oyama and Takamura 2001; Makeya et al. 2007; Grogan et al. 2013; Hara 2017).

Labor migration from rural to urban areas and mining centers has been ongoing since the discovery of the nation's rich copper deposits during the 1920s in Zambia (Heisler 1974). However, some workers returned to their home villages upon their retirement or dismissal following the economic crisis of the 1970s (Ferguson 1999). Zambia has undergone economic liberalization and the privatization of national companies since the late 1980s. During the 2000s, the Zambian economy recovered as a result of increased prices for mineral resources on the global market. Zambia's rural areas experienced an influx of population as a result of economic fluctuation (Potts 2005).

Persistent urban-rural migration is a key topic, emerging as a significant trend in environmental change and shifts in natural resource utilization (Unruh et al. 2005). Rural

populations are increasing as a result of immigration from cities and 56 % of Zambia's population still lives in rural areas¹. These circumstances are causing land shortages. Some villagers resisted the allocation of land to immigrants for residence and cultivation (Murao 2014), with the result that migrants asserted their claims by clearing the land allocated them by the village headmen to prevent them from being seized (Unruh et al. 2005). Livelihoods in rural Zambia remain vulnerable.

When the area's population was low, the villagers interacted with one another within their communities in an effort to use woodland resources without conflict. It is feared that increasing immigration from other areas may exacerbate the shortage of land resources in the area. Land enclosure and the exclusion of immigrants has been promoted by land issues and shortages caused by the acceptance of immigrants from other areas (Unruh et al. 2005; Murao 2014). The gap between firstcomers and newcomers in terms of access to good, cultivable land was a consequence. This situation might be the cause of the instability experienced by small-scale farmers, and a trigger for conflicts over land and food, which are required to thrive in rural communities. To consider the conflicts over natural resources for livelihoods in the miombo woodlands, the actual conditions under which ecological resources are exploited by the inhabitants must be examined.

This study examines the coexistence of farmers in a multi-ethnic community in the context of the locations and ecological classification of fields cultivated by firstcomers and immigrants in northwestern Zambia. This study is focused on small-scale farmers who maintain slash-and-burn cultivation in miombo woodlands in northwestern Zambia and elucidates their ecological knowledge and actual processes of clearing slash-and-burn fields in the woodlands. In northwestern Zambia, labor migration to Copperbelt Province, which is located east of Northwestern Province, has persisted since the 1920s, when several copper mines were opened. Immigrants from several ethnic groups from urban areas live and conduct slash-and-burn cultivation in northwestern Zambia (Hara 2017).

In this study, I outline the history of immigration and population flow in the area, examining the farmers' ecological knowledge. I also examine farmer coexistence in a multi-ethnic community in the context of the locations and ecological classifications of fields cultivated by firstcomers and immigrants.

STUDY AREA

Ecological environment

The study area was S Ward, in the Mufumbwe District of the Northwestern Province in the Republic of Zambia (Fig. 1). It is written as S ward not to be specified the location in this study. Miombo woodland, which is characterized by the predominance of trees in the genera *Brachystegia* and *Julbernardia*, extends widely across the southern edge of Central Africa's Congo Basin, covering an estimated 2.7 million km² (Frost 1996). Miombo woodland is categorized into dry (mean annual rainfall less than 1,000 mm) and wet (mean annual rainfall exceeding 1,000 mm) (White 1983: 93). The study area lies approximately 1,200 m above sea level, and its annual rainfall is approximately 1,300 mm, classifying the area's miombo woodland as wet. This area slopes gently from the marsh to the main road (Fig. 2). The villages in S Ward are located along the main road and are higher in elevation than the marsh. The region experiences distinct dry and rainy seasons; the dry season lasts from April to October, and the rainy season from November to March (Fig. 3).

The soil type in S Ward is classified as Ferralsols in the Food and Agriculture Organization (FAO)/United Nations Educational, Scientific and Cultural Organization (UNESCO) soil classification system (NCSR 1983) and as Oxisols by the United States Department of Agriculture (USDA) Soil Taxonomy. Although Entisols (USDA), Arenosols (FAO/UNESCO), and Kalahari sands accumulate at the western side of S Ward (Johnson 1980). Kalahari sands are pure, coarse-grained quartz sands that accumulate to great depths and are chemically very poor (Trapnell and Clothier 1937: 6). S Ward is located at the fringe of an area of accumulated Oxisols.

Ethnic groups

S Ward is located approximately 15 km from Mufumbwe, which is the district capital. It lies within the territory of the traditional Kaonde chiefdom. A population census of Mufumbwe District conducted in 2010 revealed a population density of 2.8 people per square km, Zambia's lowest density (CSO 2012). In 2012, the population of S Ward comprised 1,320 people living in 243 households distributed among 23 villages. The Kaonde constituted 57 % of the total, followed by the Lunda at 23 %, Luvale at 8 %, Chokwe at 8 %, and Luchazi at 4 % (Hara 2017). These five ethnic groups are the Bantu-speaking people.

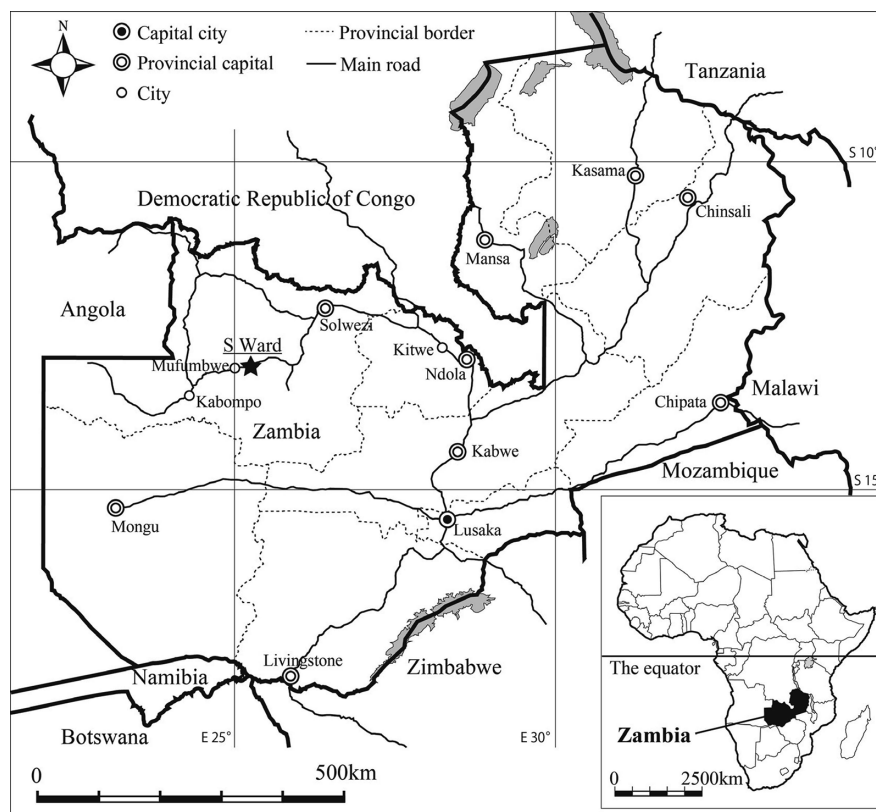


Fig. 1. Map of the research site.

The number of villages in S Ward has increased from 11 Kaonde villages in 1960 to 23 villages in 2000 (Fig. 4), of which 9 were built by non-Kaonde immigrants. There were no accurate data on the population influx in S Ward; therefore, the characteristics of population influx since 1960 could not be explored in detail in this study.

The people of these five ethnic groups have carried out slash-and-burn shifting cultivation in the miombo woodlands. All ethnic groups built small villages consisting of approximately 10 households of relatives (Turner 1996: 37–39; von Oppen 2006; Oyama and Kondo 2007). The Kaonde move their villages every few years (Oyama and Kondo 2007), and are considered the area's firstcomers. The Lunda, Luvale, Chokwe, and Luchazi, referred to as immigrants in this study, moved to S Ward from other villages and cities (Hara 2017).

Several Kaonde groups immigrated into northwestern Zambia from the Luba Empire, located in the southern Congo Basin, between the 16th and 19th centuries (Jaeger 1981: 54–56). The Lunda, Luvale, Chokwe, and Luchazi originated from the Lunda Empire in the southern Congo Basin during the 17th century (McCulloch 1951; von Oppen n.d.).

Agricultural systems

Staple crops cultivated by each household

In S Ward, the three main staple crops cultivated are maize, sorghum, and cassava. The farmers in S Ward all cultivated maize as a staple and a cash crop (Hara 2017). The Kaonde cultivated sorghum and few grew cassava. In comparison, approximately 90 % of the immigrants cultivated cassava. No immigrant farmers cultivated sorghum (Hara 2017). Crops other than maize are cultivated in slash-and-burn fields. Most farmers cultivate maize using chemical fertilizers distributed by the government, a type of maize farming known locally as *faamu*. Most people in S Ward create new fields for slash-and-burn cultivation every year. Men begin to seek out uncultivated woodland for new fields at the end of February. Richly resourced woodland consisting of large, tall trees is generally considered suitable for slash-and-burn cultivation, while woodland that consists mainly of smaller, thin trees is deemed unsuitable.

Maize cultivation

Maize is the most common staple crop in Zambia; it was initially cultivated as a staple food for mine workers in

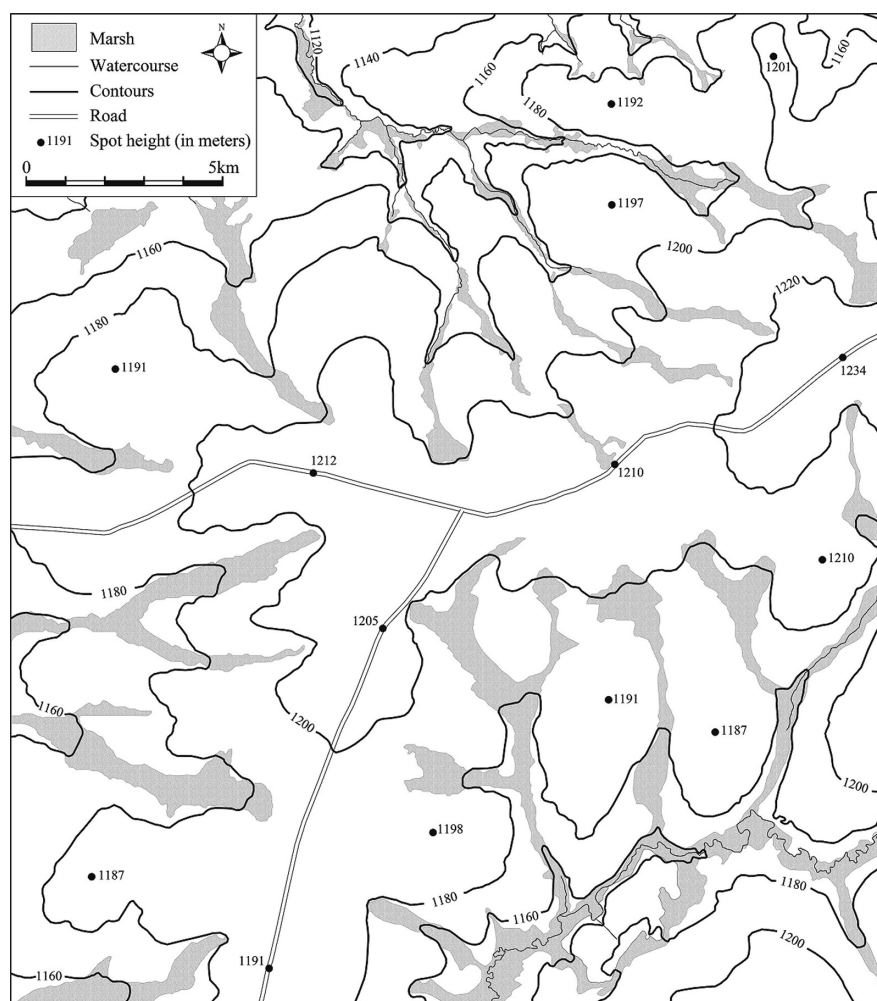


Fig. 2. Map of S Ward in Zambia.

The center of S Ward is located at the junction. This map was drawn by the author based on a 1:50,000 map (sheet no. 1325 A1; Surveyor-General, Zambia Government 1976).

Copperbelt. After independence was achieved in 1964, the government of Zambia has supported maize cultivation through agricultural credits, and reduced costs for agricultural input and for maize purchase and distribution (Chabatama 2007; Kodamaya 2011; Mason et al. 2013; Hara 2017). Maize remains an important cash crop for rural farmers.

Since 2008, farmers cultivating less than 0.5 ha of land have been able to obtain a subsidized input pack for maize cultivation. This pack contained two bags (100 kg) of D-compound, two bags (100 kg) of urea, and 10 kg of hybrid maize seed (Hara 2017). The D-compound contained 10% nitrogen, 20% phosphorous, and 10% potassium, and the urea contained 46% nitrogen. The fertilizer subsidy rate was 50% of the market price in 2002; this increased to 75% in 2010 (Mason et al. 2013). In 2018, farmers paid 400 kwacha² per pack to a government bank account; the

government subsequently added 1,600 kwacha and sent an e-voucher to the farmers via short message service (SMS). Farmers could then purchase agricultural input for 2,000 kwacha by using the e-voucher at a shop for agricultural goods in the nearest town.

Sorghum cultivation by the Kaonde

Sorghum is the most important staple food for the Kaonde (Trapnell and Clothier 1937; Crehan 1997; Oyama and Kondo 2007), who cultivated maize as a subsidiary crop of sorghum (Crehan 1997: 163–164). The Kaonde practice slash-and-burn cultivation, known as *bujimi* in the Kaonde language. They seek uncultivated richly resourced woodland in which the grass, called *kibabe* in the Kaonde language (*Hyparrhenia* spp.), is present, preferring woodland that has vigorous *kibabe* growth for sorghum cultivation (also see Oyama and Kondo 2007). Applying

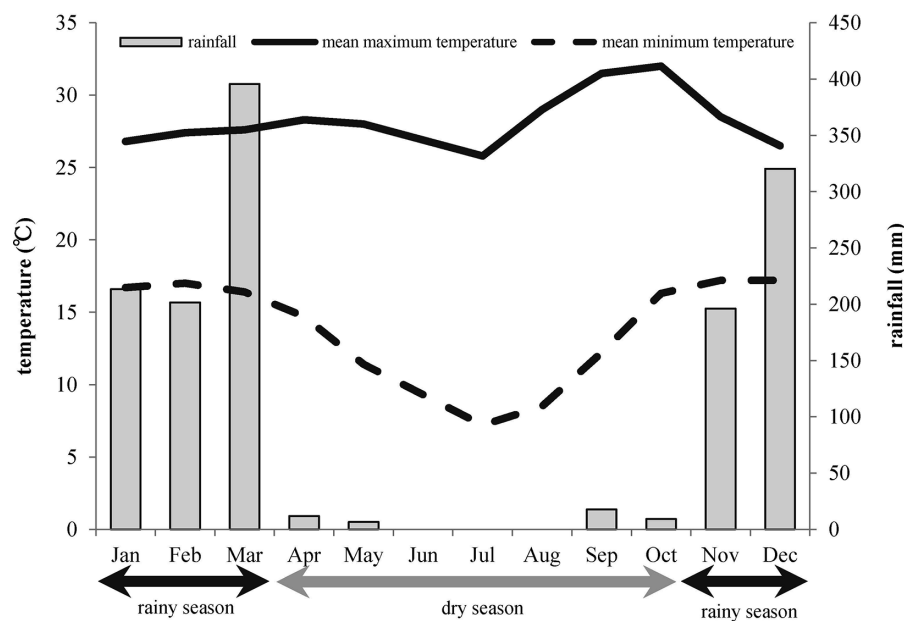


Fig. 3. Mean temperature and monthly rainfall in 2011 in Solwezi, northwestern Zambia. Based on meteorological data from Zambia Meteorological Department, Ministry of Transport and Communications. Solwezi is approximately 250 km from S Ward, and is the nearest meteorological station to S Ward.

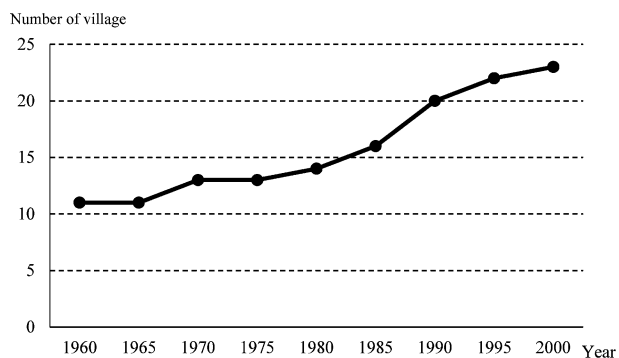


Fig. 4. Changes in the number of villages in S Ward since 1960.

bujimi, they hoe the surface soil to a depth of approximately 15 cm with *kibabe* grass, reverse the clods of soil with grass, and mix in grass to improve the soil quality before cutting down the trees. According to the Kaonde farmers, this practice improves soil humus content and drainage. After hoeing, the trees are felled, and the branches are piled up to be burned at the end of October.

The Kaonde create three types of slash-and-burn crop fields: ash patches left after burning, called *monde*; fields hoed during the dry season, called *munkulutu*; and fields of mounds called *milala*. These three types are created in a single field and adjoin each other. After burning the piled wood, farmers sow pumpkin, sesame, and finger millet in *monde*. *Munkulutu* fields are created before the beginning of the rainy season, and maize, sorghum, and sesame are

sown in November. *Milala* cultivation is done in December. At this time, the grass grows to a height of approximately 50 cm. They hoe the surface soil with grass again and reverse and pile the clods of soil with grass to make mounds. According to the Kaonde, the soil becomes more fertile after piling and mixing in the grass. After creating mounds, Kaonde farmers sow maize and transplant sorghum from *munkulutu* to *milala* fields. A few Kaonde farmers plant cassava seed stems in *milala* fields.

Sorghum produces ears in April and is harvested from June to July. The crop is vulnerable to being eaten by birds, and Kaonde women and children are responsible for deterring the birds from the ripening sorghum by banging on saucepans or cooking pots and shouting, throughout each day. Most Kaonde farmers live in huts built near their fields during the busy seasons. They cultivate sorghum in each field for 2–4 years. Afterward, they convert to *faamu* and use chemical fertilizers for maize cultivation. Some Kaonde have stopped cultivating sorghum due to the work involved in keeping birds off the crop, as well as the long distances from the field huts to schools and hospitals (Hara 2017).

Cassava cultivation by immigrants

Lunda, Luvala, Chokwe, and Luchazi immigrants mainly cultivate cassava as a staple crop (Trapnell and Clothier 1937; von Oppen n.d.). Cassava can be grown in regions where annual rainfall is as low as 500 mm or as

high as 5,000 mm. The calorie yield per acre of cassava is high. Furthermore, it is a drought-resistant crop that thrives in soils that range in texture from sandy to clay-rich, as well as in poor soil, and is productive throughout the year (Jones 1959; Nweke et al. 2002). Cassava is cultivated as a staple crop and a cash crop. Below, the agricultural systems of the Lunda are detailed, as they are representative of the systems used by all four immigrant ethnic groups.

The Lunda carry out slash-and-burn cultivation, called *muntema* in the Lunda language. Farmers seek out uncultivated woodland with large, tall trees from February to March, and begin to hoe the ground during the latter half of the rainy season. At the beginning of the dry season, the farmers cut the trees and pile up the branches, which are then burned at the end of October. After it starts to rain, they begin to make mounds approximately 40 cm high in the soil, until March. They intermittently plant cassava seed stems approximately 30 cm in length in the mounds from November to April. Maize, sweet potato, and common beans are planted alongside cassava in the mounds. The cassava's tuberous roots are generally harvested in the third and fourth year after planting. Farmers cultivate cassava in a field for 8–10 years, creating a cassava field every year and managing four cassava fields per year.

Harvesting, soaking, and cooking the cassava are performed by the women. The cassava tuberous roots are soaked in drums of water because they contain prussic acid (Jones 1959; Chiwona-Karlton et al. 2015). During the rainy season, the roots are soaked in seasonal pools. Lunda women harvest 30–40 kg of cassava roots once every 2–4 days. After harvesting, they carry the cassava roots from the fields to their homes. The harvesting, transport, soaking, and drying of the cassava roots are laborious tasks for Lunda women. Lunda, Luvala, Chokwe, and Luchazi immigrants prefer to cultivate and eat cassava, and they carry cassava seed stems when they move to other villages.

METHODS

Immigration history and land use

This study is based on intermittent fieldwork carried out over a 26-month period, from September 2011 to August 2019. I measured the positions and square measurements of 142 fields used by 89 people living in seven villages (MU, TO, and LO of the Kaonde village; SK, SB, KT, and KB of the immigrant village) in S Ward from January to February 2014 using mobile GPS (Garmin e-Trex 30J). I interviewed the farmers tending each field

concerning soil color, classification, and texture assessed by hand; I also measured the distances from the fields to the farmers' homes using GIS software (ESRI ArcGIS 10.0).

To clarify the history of northwestern Zambia, I reviewed several articles and annual reports written by government officers in the region during the colonial period, accessed at the National Archives of Zambia in Lusaka. I obtained some aerial photographs of S Ward, taken in 1968, from the Ministry of Lands and Natural Resources in Lusaka and a satellite image of S Ward taken May 1, 2014, from Google Earth. I then investigated land use around S Ward in 1968 and 2014 by interpreting these images.

Soil analysis

Soil samples were collected at eight plots in September 2012. Four of these plots were located in a field cultivated by Kaonde farmers (Fig. 5, Site 1). One composite soil sample at a depth of 0–5 cm was collected from each plot, namely: an ash patch, a hoed field, a mound field, and undisturbed woodland close to a marsh. Sample collection occurred after sorghum harvest; therefore, no sorghum remained in the fields. The remaining four plots were located in a field cultivated by Lunda farmers (Fig. 5, Site 2). In these plots also, one composite soil sample at a depth of 0–5 cm was collected from each plot, namely: an ash patch, a hoed field, a mound field, and undisturbed woodland. With the exception of cassava, the crops had already been harvested when the soil samples were taken.

The samples had been air-dried on the premises, vacuum-packed into plastic bags, and airlifted to Japan. The samples were analyzed for texture, color, pH (H_2O), electrical conductivity, total carbon, total nitrogen, soil exchangeable cations (Ca^{2+} , Na^+ , K^+ , Mg^{2+}), and available phosphate. The samples had been sifted with a 2-mm mesh sieve. Texture was determined using the hand texturing method (Japanese Society of Pedology 2010). Soil color was classified in accordance with the Standard Soil Color Charts (Fujihira Industry) by visual comparison with soil samples. Soil pH was measured in a supernatant suspension at a 1:5 soil:water ratio using the glass electrode method (DKK TOA Corporation WM-32EP). Conductivity (at a 1:5 soil:water ratio) was measured using a specific conductivity meter (DKK TOA Corporation WM-32EP). Total carbon and total nitrogen were measured using an NC Analyzer (Sumika Chemical Analysis Service, SUMIGRAPH NC-22F). Soil exchangeable cations were extracted with a 1 M ammonium acetate solution (pH 7.0); concentrations were

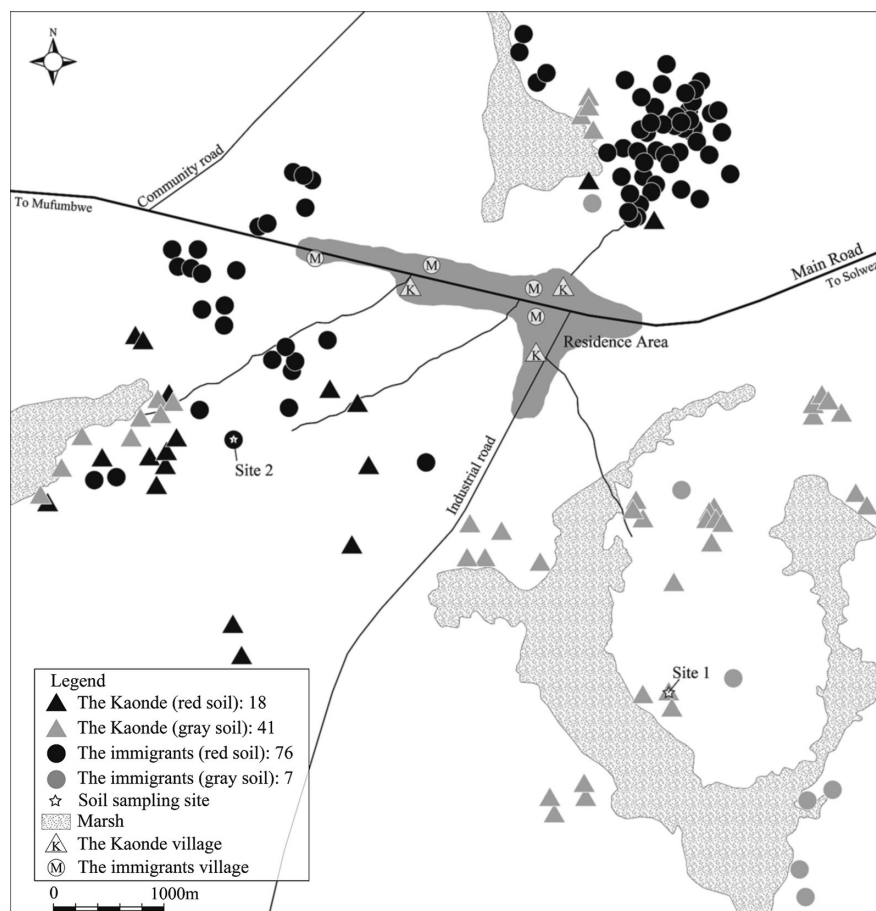


Fig. 5. Map of cultivated fields in seven villages in S Ward in 2014.

measured by inductively coupled argon plasma optical emission spectroscopy (Shimadzu AA-7000F). Available phosphate was extracted using the Bray No. 2 method with an ultraviolet spectrophotometer (Shimadzu UV mini 1240).

RESULTS

History of S Ward and immigrants

There are 73 ethnic groups in Zambia. Each ethnic group has its own society, and they differ in terms of population size. Most ethnic groups have their own traditional leader, or chief. According to official government statistics, there were 288 traditional local chiefs in Zambia in 2018³. Each chief's ruling territory is demarcated. The chiefs hold control over their territories and have the authority to permit immigration to the area, the founding of new villages, resettlement, and land allocation for new villages and fields in rural Zambia.

Zambia's 1995 Land Act recognized existing rights to customary land and reinforced the land ownership rights granted by title deeds (Oyama 2016). Zambia's government grants chiefs legal authority to oversee customary lands and to protect their community's culture and general welfare. The 1995 Land Act gave chiefs the legal power to approve requests for land tenure (Brown 2005). Thus, the traditional authorities (i.e., chiefs and village headmen) fulfill important roles in the administration of customary land in rural areas. In Kaonde society, residents cannot maintain their livelihood, open a field, or build a new village without permission from their chief. After residents obtain permission and begin cultivation, they retain this permission land even if they leave their community.

Local chief C of the Kaonde rules the area of Mufumbwe District in which S Ward is located. On its east side, chief C's territory is bounded by that of chief K, also of the Kaonde, and the territory to its west is under the ruler of chief S of the Mbunda. Immigrants other than the Kaonde have moved to chief C's territory from Portuguese West Africa (present-day Angola), the Belgian Congo

(present-day Democratic Republic of Congo), and Zambia's Kabompo District since the 1940s⁴. Most of these immigrants were Chokwe, with the remaining being from the Lunda, Luvale, and Luchazi. These immigrants established their villages separate from the Kaonde villages⁵. According to Mr. T of the Chokwe, who lives in the western part of Mufumbwe District, the first non-Kaonde immigrant reached the territory of chief C in the 1930s and he was from Angola (Portuguese West Africa at that time). Chief C granted immigration rights to non-Kaonde people and allocated them land for founding new villages and for cultivation. Chief C's territory has been a multi-ethnic community since the 1940s at least.

The colonial government and later the government of the Republic of Zambia promoted several rural development projects between the 1950s and 1970s in the northwestern region of the country (Jaeger 1981; Crehan 1997: 164). The governments promoted the resettlement of most villages in this area. The villages moved to the roadside, having formerly been within the woodlands. The government constructed agricultural centers called community centers, a primary school, and a health center in the resettlement area⁶.

In S Ward, these projects were promoted during the late 1960s after Zambia had achieved independence. Some of the Kaonde villages moved from the woodland to the

main roadside in the 1970s. In that same period, non-Kaonde immigrated into S Ward (Hara 2017). In 1968, round-shaped fields were scattered throughout woodland in S Ward (Fig. 6). The Kaonde lived in houses built near their fields. These fields and houses were located near marshlands. It is thought that most farmers, including non-Kaonde, who immigrated to S Ward, were able to create new fields without competition by obtaining permission for cultivation from chief C because most woodlands were mature or regrowing in 1968. There were few cultivated lands alongside the main road in 1968 (Fig. 6).

According to Mr. P of the Chokwe, there were no houses along the main road before 1970. Mr. M, the Kaonde village headman, reported that a few Kaonde villages were moved adjacent to the main road in 1973. The residential area of S Ward was created by the Kaonde in the 1970s.

However, in 2014, most villages were located beside the main road (Fig. 7). Most of the woodlands near the marsh had been cleared by the Kaonde farmers, who could travel on foot or by bicycle to their fields from their houses in 2014. Richly resourced woodlands near marsh remained in S Ward. However, it took two to three hours to travel on foot to the remaining richly resourced woodlands near marsh from villages along the main road. Some of the Kaonde farmers lived in the huts that had been built near their fields during the busy seasons. The total area of

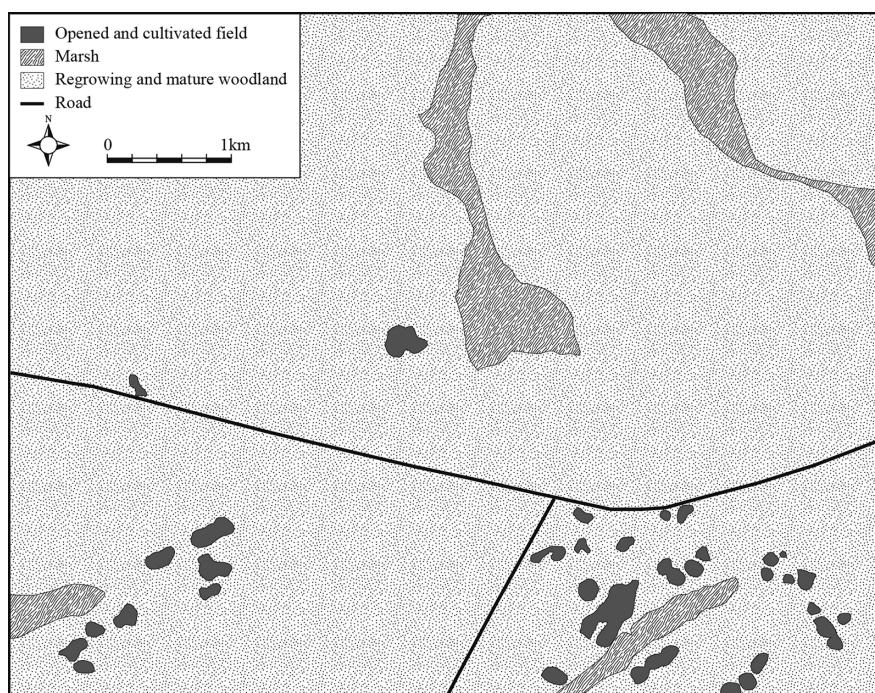


Fig. 6. Land use map of S Ward in 1968.

This map is based on an aerial photo taken by the government of the Republic of Zambia in 1968.

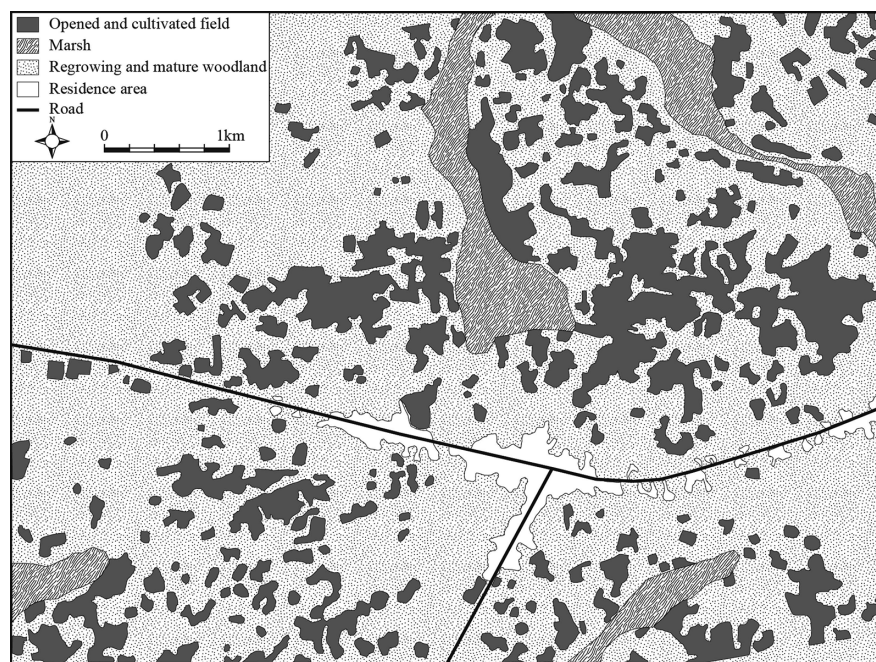


Fig. 7. Land use map of S Ward in 2014.

This map is based on a satellite image from Google Earth on May 1, 2014.

cultivated land in 2014 (Fig. 7) had increased twelve fold in comparison with that in 1968 (Fig. 6). The total area of mature and second-growth woodland was observed to have decreased in 2014.

Classification of the ecological environment based on soil type by local people

Farmers living in S Ward distinguished the surrounding ecological environment according to landforms, soils, and vegetation and divide the surrounding ecology of S Ward between marsh and miombo woodland (Fig. 8). Farmers do not clear the marsh because there are no trees in the flooded marsh; they prefer to clear miombo woodland to generate fields for cultivation. The woodland does not flood, as it is located several meters higher than the marsh. The farmers selected mature woodland with large, tall trees to create slash-and-burn fields, and never cleared poorly resourced or disturbed woodland that had small, thin trees.

Farmers in S Ward classified miombo woodland into two types according to the accumulated soil: one was gray soil, called *vusenga* in the Kaonde language and *iseki da usekulula* in the Lunda language. Mr. L of the Lunda described *iseki da usekulula* as soft (even in the dry season), nutrient rich, and dark gray, with a smooth consistency and high sand content. Ms. M of the Kaonde also reported that *vusenga* is soft and nutrient-rich (*kajo* in the Kaonde

language). Mr. S of the Lunda described *iseki da usekulula* as sandy soil. Mr. S and Mr. K of the Luchazi confirmed the softness of *iseki da usekulula* in the dry season. Farmers of the Kaonde and immigrants agreed that crops germinated well in *vusenga* in the dry season because it did not harden in the dry season. Hereafter, this study will refer to *vusenga* as gray soil.

The other soil type was red soil, called *uchimba* in the Kaonde language and *iseki da damdambo* in the Lunda language. Mr. L of the Lunda described *iseki da damdambo* as red, containing little sand, and hardening when dried. Mr. S of the Lunda and Ms. M of the Kaonde reported that *uchimba* soil was difficult to plow during the dry season because it was tightly packed. Thus, farmers must plow fields containing red soil in the rainy season, which delays sowing compared with fields containing gray soil. Mr. S described *iseki da damdambo* as clay soil. Hereafter, this study will refer to *uchimba* as red soil. Thus, farmers of all ethnic groups in S Ward recognized two types of soils: gray and red. Most farmers in S Ward reported that it is easier to plow gray soil in the dry season due to its softness; therefore, they preferred to plow and cultivate fields containing gray soil.

Both the Kaonde and immigrant farmers said that the gray soil accumulates on the gentle slope from marsh to woodland, whereas red soil accumulates at the upper part of the slope in the woodland. This study defines the slope with gray soil as the outer edge of marsh, and the upper part of

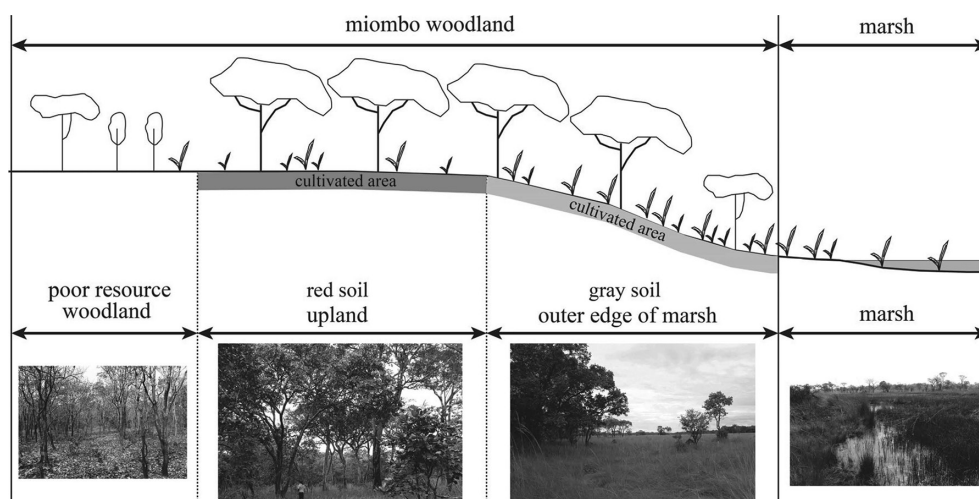


Fig. 8. Schematic diagram of ecological division by farmers in S Ward.

Table 1. Properties in the villages.

Village name	Year of immigration	Number of fields	Average of square measurement (ha)
The Kaonde village			
MU	—	28	0.89
TO	—	19	1.13
LO	—	12	1.48
The immigrant village			
SK	1970	35	0.86
SB	1990	28	0.56
KT	1993	11	1.04
KB	1996	9	0.84

the slope with red soil is defined as upland. According to the farmers in S Ward, gray soil was softer than red soil and was therefore more suitable for agriculture.

Soil type and location of cultivated fields

The Kaonde villages of MU, TO, and LO have been located in chief C's territory since the villages' resettlement along the main road in the late 1960s (Table 1). The immigrant villages SK, SB, KT, and KB were constructed in S Ward from 1970 onward. Villagers from SK moved to S Ward in 1970. SB village was built by a village headman who immigrated in 1990. The villagers of KT village immigrated in 1993, and the villagers of KB moved to S Ward in 1996. These villages' headmen were allocated land for residence and cultivation by chief C after their immigration. All seven villages surveyed in this study were located along the main road as of 2019. There was no correlation between year of immigration and average square

measurement (Table 1).

The gray soil cultivated fields were located at the outer edge of the marsh (Fig. 5), on the east side of an industrial road. Of the 59 fields farmed by Kaonde farmers, 41 (70 %) had gray soil. Most of the red soil fields were located at the upland in woodland, at the southeast and north sides of the residence area. Of the 83 fields farmed by immigrant farmers, 76 (92 %) had red soil.

The Kaonde farmers recognize woodland with a richly resourced forest floor as good ground for sorghum cultivation. *Kibabe* grass, favored by the Kaonde farmers, thrives near marshland. Kaonde farmers tend to clear and cultivate the outer edge of the marsh, which has rich *kibabe* grass and soft gray soil; they consider fields of gray soil to be rich in nutrients for crop cultivation. Immigrant farmers cultivate cassava in upland red soil.

For this study, direct distances from the cultivated fields to the farmers' homes were analyzed. The average distance from the fields to the homes of the Kaonde farmers (average direct distance \pm standard deviation) was $2,567 \pm$

Table 2. Physical and chemical properties of gray and red soils.

	Color	Texture	pH (H ₂ O)	Total C (%)	Total N (%)	C/N ratio	Exchangeable cation amount				Available phosphate (mg/kg)	Electrical conductivity (mS/m)
							Ca	Na (cmol _c /kg)	K	Mg		
Gray soil (outer edge of marsh)												
Ash patch	10YR5/3	Loam	7.25	0.83	0.06	12.9	50.13	0.03	0.82	3.64	1768.6	12.1
Mound field	10YR5/3	Loam	7.44	0.94	0.06	14.6	2.67	0.02	0.43	0.80	188.4	4.0
Hoed field	10YR5/3	Loam	6.75	1.11	0.07	15.7	4.37	0.14	0.64	0.92	322.0	7.6
Undisturbed woodland	10YR5/3	Loam	7.09	1.35	0.08	16.0	1.51	0.00	0.38	1.06	95.3	4.0
Red soil (upland)												
Ash patch	7.5YR5/6	Loam	7.16	0.55	0.04	14.5	5.37	0.06	0.89	1.52	943.0	12.5
Mound field	7.5YR5/6	Loam	6.35	1.10	0.07	15.7	0.53	0.00	0.18	0.31	59.5	1.5
Hoed field	7.5YR5/6	Loam	6.56	0.98	0.06	17.4	0.51	0.15	0.40	0.54	88.4	2.2
Undisturbed woodland	7.5YR5/6	Loam	5.94	1.09	0.07	16.4	0.64	0.11	0.32	0.67	95.7	2.2

848 m. The average distance from the fields to the immigrant farmers' homes was $1,948 \pm 994$ m. According to the Student's *t*-test results, the immigrant farmers' cultivated fields were closer to their villages than those of the Kaonde ($t = 3.9$, $p < 0.001$). Fig. 5 shows several paths to the cultivated fields from the residential areas; each is nearly the same distance as a direct path from the main road to the fields. Thus, farmers are able to access their fields without walking long distances.

Soil physical and chemical properties

Farmers in S Ward recognize different soil types in their fields. I analyzed physical and chemical properties of gray soil on the outer edge of the marsh and of red soil on the uplands (Table 2).

Gray soil from the outer edge of the marsh

All four gray soil samples from the marsh edge had a loam texture and were dull yellowish brown in color (10YR5/3), with pH ranging from 6.75 (hoed field) to 7.44 (mound field) (Table 2). Total C content ranged from 0.83 % (ash patch) to 1.35 %. Total N content ranged from 0.06 % to 0.08 %. The C/N ratio ranged from 12.9 (ash patch) to 16.0 (undisturbed woodland). Ca content ranged from 1.51 to 50.13 cmol_c/kg (ash patch). The ranges of soil Na, K, and Mg content were 0.00–0.14, 0.38–0.82, and 0.80–3.64 cmol_c/kg, respectively. Available phosphate content ranged from 95.3 to 1768.6 mg/kg (ash patch). Electrical conductivity was 4.0–12.1 mS/m, reaching a maximum in the ash patch.

Upland red soil

All four red soil samples from upland fields had a

loam texture and were bright brown in color (7.5YR5/6), with pH values ranging from 5.94 (undisturbed woodland) to 7.16 (Table 2). Total C content ranged from 0.55 % (ash patch) to 1.10 %. The ranges of total N content and the C/N ratio were 0.04–0.07 % and 14.5–17.4, respectively. Red soil in the hoed field had the highest C/N ratio among all eight plots. Values of Ca, Na, K, and Mg content were 0.51–5.37, 0.00–0.11, 0.18–0.89, and 0.31–1.52 cmol_c/kg, respectively. Available phosphate content ranged from 59.5 to 943.0 mg/kg (ash patch). Electrical conductivity ranged from 1.5 to 12.5 mS/m. The highest electrical conductivity value among all eight soil samples was found in red soil from the ash patch.

DISCUSSION

Ecological classification according to soil properties and farmer evaluations in S Ward

Mufumbwe District is a remote area. The district's population density is the lowest in Zambia. Richly resourced woodlands remain in this area. All farmers in the S Ward differentiated between the outer edge of the marsh, which had soft gray soil, and the uplands, characterized by red soil.

Trapnell and Clothier (1937) surveyed the vegetation, soil, and agricultural systems in northwestern Rhodesia between 1932 and 1934. They reported on and classified the ecology of northwestern Rhodesia using vegetation and soil types. They also recorded "native" agricultural systems in the 1930s. Trapnell and Clothier (1937) reported that gray and black soil accumulated near marshes and that gray soil contained water and was good for sorghum cultivation. Red and brown soil accumulated on the plateau above the marsh

in northwestern Rhodesia in the 1930s (Trapnell and Clothier 1937).

The first non-Kaonde immigrants reached the western part of Kaonde territory from the late 1930s to the early 1940s. Several ethnic groups, including the Kaonde, already lived together in the western part of Mufumbwe District in the 1940s. It is suggested that farmers in this region appeared to have recognized and classified the surrounding environment in terms of soil type and landforms.

Farmers of all ethnic groups in S Ward considered gray soil suitable for crop cultivation because it was soft and nutrient-rich. Farmers described gray soil as sandy and red soil as clayey. In the current study, both gray and red soil were classified as loam by hand; no differences in soil texture between red and gray soil were detected. Red soil samples were bright brown (7.5YR5/6), whereas gray soil samples were dull yellowish-brown (10YR5/3), suggesting that gray soil was in a reduced state due to accumulation near the marsh. Farmers' preference for gray soil might be due to moisture content as well as softness.

Location of different ethnic groups' cultivated fields

All farmers in S Ward considered richly resourced woodland with large, tall trees to be good, cultivable land. Small, thin trees grow in abandoned fields following cultivation. Farmers avoided clearing and cultivating abandoned woodland because it was poorly resourced. This trend was also discernible among other shifting cultivators in miombo woodlands (McGregor 1994; Oyama 2005). The Bemba, who engage in shifting cultivation, examined above-ground woody biomass in miombo woodland as a means of selecting new sites for slash-and-burn cultivation (Oyama 2005).

To obtain water for sustenance, farmers who conducted slash-and-burn cultivation in miombo woodland lived and farmed close to the marsh (Oyama 2001; Oyama and Kondo 2007). Corroborating previous studies, this study confirmed that Kaonde farmers created new fields at the outer edge of the marsh, seeking good woodland and soil for cultivation. As is clear from 1968 land use patterns (Fig. 6), Kaonde farmers selected sites for cultivation at the outer edge of the marsh when the area was more sparsely populated. The miombo woodland within walking distance from the roadside villages, both in the upland and at the outer edge of the marsh, includes fields cleared for cultivation due to resettlement projects undertaken by the government and the population increase due to the influx of immigrants to the area from the 1970s. The sphere within which slash-and-

burn fields could be created was restricted due to resettlement to the roadside and population growth.

After immigration to S Ward, the non-Kaonde immigrants began to create fields in the uplands. The local chief allocates land for cultivation to each village in the Kaonde community. Chief C allocated land at the outer edge of the marsh to the Kaonde farmers, as the Kaonde villagers had lived in the area for several generations. The immigrants who were newcomers to the area had to clear and cultivate the uplands, which were not occupied by the Kaonde farmers. The red soil in the upland hardened during the dry season, so the Kaonde tended not to cultivate the upland, as ploughing the red soil was particularly labor intensive. Therefore, vast and richly resourced woodland was available in the upland area, as the Kaonde had not cleared it. There was sufficient aboveground woody biomass for slash-and-burn cultivation in the uplands, and immigrant farmers were obliged to create new fields in the upland area and began to cultivate cassava.

Coexistence of the Kaonde and immigrants through the cultivation of different ecologies

In S Ward, the Kaonde cultivate mainly sorghum and maize, whereas immigrants cultivate cassava and maize. All farmers in S Ward create maize farms in abandoned slash-and-burn fields, sow hybrid maize seed, and use chemical fertilizer distributed by the government. These chemical fertilizers allow farmers to ignore ecological differences between locations.

However, the farmers showed preferences when choosing the location of a new slash-and-burn field. According to Trapnell and Clothier (1937), Kaonde farmers had created new fields for sorghum cultivation in woodland areas with gray loamy sands. In S Ward, the Kaonde cultivated crops at the outer edge of the marsh, which was characterized by vigorous *kibabe* grass and gray soil. Kaonde farmers sought new gray soil fields by searching for *kibabe* grass, which formed root mats at the outer edge of the marsh. The Kaonde considered hoeing the surface, and reversed soil with grass, important for sorghum cultivation, as it mixed grass into the soil. Kaonde farmers found it easy to create *munkulutu* and *milala* fields for sorghum using *kibabe* root mats. Thus, *kibabe* root mats play an important role in Kaonde sorghum cultivation.

By contrast, the Lunda, Luvale, Luchazi, and Chokwe, who cultivated cassava, created new cassava fields in red woodland soil (Trapnell and Clothier 1937). The results of the current study indicate that the Kaonde cultivate sorghum

in gray soil fields at the outer edge of the marsh, whereas immigrant farmers create cassava fields in red woodland soil in the uplands; this finding is consistent with that of Trapnell and Clothier (1937).

However, immigrant farmers in S Ward value gray soil for cultivation. It is difficult for farmers to hoe red soil in the dry season. Cassava, which is cultivated by immigrant farmers, can grow under severe soil and rainfall conditions (Jones 1959); therefore, immigrant farmers are able to plant cassava in upland red soil. Thus, both the Kaonde and immigrant farmers prefer to cultivate fields at the outer edge of the marsh in S Ward.

Mr. L of the Lunda stated that 'we (immigrants) want to plant cassava seed stems into mounds of gray soil in the dry season because gray soil is soft in the dry season. We can plant seed stems and harvest cassava roots easily. But the Kaonde have already opened the woodland at the outer edge of the marsh. We cannot create new fields at the outer edge of the marsh.' Immigrant farmers in S Ward assessed gray soil as good for cultivation because it was soft in the dry season. The Kaonde farmers did not discuss their cultivation at the outer edge of the marsh because it seems that they had already opened the land there. In comparison, most immigrants reported a desire to have gray soil fields. This preference and desire for gray soil by immigrant farmers is likely to have been influenced by living with the Kaonde.

The location of the upland area was convenient for the immigrants' daily lives. The main road was built on the uplands to prevent flooding. Thus, the upland fields were closer to the roadside villages than was the outer edge of the marsh. Therefore, the immigrants could easily carry heavy loads of cassava tuberous roots after harvesting and soaking. The women in the immigrant community carry heavy cassava roots on a daily basis, so the distance between the village and the fields is a key consideration.

Farmers in S Ward selected new sites for slash-and-burn cultivation by ascertaining the soil type, tree heights and sizes, and distance between the field and home. In addition, the Kaonde farmers focus on *kibabe* grass. In northwestern Zambia, the Kaonde continue to cultivate sorghum, and the immigrants continue to cultivate cassava. These trends have been sustained throughout the communities' coexistence (Hara 2017). The Kaonde and the immigrants have never shared agricultural practices; it is crucial that all farmers select slash-and-burn sites that are appropriate for their livelihoods.

Local farmers' ecological knowledge and national agricultural policy

The government of Zambia has designed agricultural policy to support maize cultivation throughout Zambia since the colonial period. The government of Zambia supports maize cultivation through agricultural credits and reduced costs for agricultural input, maize purchases, and distribution (Chabatama 2007; Kodamaya 2011; Mason et al. 2013). Small-scale farmers in rural Zambia must cultivate maize by relying on government support so as to obtain a cash income. However, shortages of agricultural input and delays in the supply of subsidized fertilizers have had large impacts on maize production (Mason et al. 2013; Hara 2017).

The government of Zambia has long discussed the adoption of other staple crops to replace maize (Marter 1978). However, maize cultivation for cash income and staple food using subsidized fertilizers continues among local farmers in Zambia. As this study shows, local farmers recognized the surrounding ecology and practiced slash-and-burn cultivation. The government should consider the situations of local farmers and establish agricultural policies or guidelines that utilize the ecological knowledge that is peculiar to the locality to achieve sustainable national agriculture in rural Zambia.

CONCLUSION

In miombo woodland, people maintain several types of livelihood (e.g., slash-and-burn cultivation, fishing, and hunting) in their efforts to withstand ecological, social, economic, and political changes (Oyama and Takamura 2001; Kakeya et al. 2007; Oyama and Kondo 2007; Grogan et al. 2013; Hara 2017; Kilawe et al. 2018). This study elucidated the ecological classifications applied by farmers to miombo woodland and examined the different conditions of slash-and-burn fields among different ethnic groups. Kaonde farmers created fields in the woodland close to the marsh, which was suitable for slash-and-burn cultivation. After most of the woodland area at the outer edge of the marsh was cleared, immigrant farmers began to clear woodlands in the upland area. Therefore, cultivated woodland was expanding from that which is suitable for slash-and-burn cultivation (i.e., in the outer edge of the marsh) to the woodland in the area (i.e., in the upland) of S Ward. This trend of woodland use was based on farmers' ecological knowledge and classificatory systems.

Farmers' site-selection practices for slash-and-burn cultivation are influenced by both macro (e.g., rural

development projects implemented by the government and population increases) and micro factors that are peculiar to the locality (e.g., ecological classification and agricultural methods). The Kaonde and the immigrants have similar ecological classification systems; they coexist in this area by practicing different farming systems and using fields in different ecological settings. This study examined current land use in the multi-ethnic community in northwestern Zambia using limited data from fieldwork and laboratory analysis. Further studies need to conduct more detailed quantitative analyses, including the collection of soil samples from all cultivated land, soil analyses, especially particle size, land-use history surveys, and crop yields.

NOTES

- 1 Rural Population (% of total population) Zambia, The World Bank. <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ZM> (Accessed November 17, 2019).
- 2 1 USD = 12.75 Kwacha on August 5, 2019 in Lusaka.
- 3 House of Chiefs, Ministry of Chiefs and Traditional Affairs, Government of the Republic of Zambia. <http://www.mocta.gov.zm/index.php/house-of-chiefs> (Accessed November 12, 2018).
- 4 *Kasempa tour reports 1956* (file no. NWP1/2/80) and *Kasempa tour reports 1957* (file no. NWP1/2/89) in National Archives of Zambia in Lusaka.
- 5 *District travelling reports: Kasempa 1949–50* (file no. NWP1/2/25) in National Archives of Zambia in Lusaka.
- 6 *Kasempa tour reports (1954–55)* (file no. NWP1/2/69), *Kasempa tour reports (1955)* (file no. NWP1/2/73) and *Kasempa tour reports (1947–48)* (file no. SEC 2/937) in National Archives of Zambia in Lusaka.

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