Intensive Cultivation and Environment Use among the Matengo in Tanzania

This paper focuses on the agroecological background of an intensive cultivation system called *ngolo*, which has been practiced for more than 100 years among the Matengo people in southern Tanzania. The ngolo system is highly sustainable as it both conserves soil and water and matures the soil; moreover, the high productivity of this system ensures a steady food supply to the Matengo. The other cropping systems in Matengo agriculture, which are closely related to ngolo, economically support farmers. For example, coffee cultivation provides cash to support the local economy, and it also enables farmers to purchase chemical fertilizers. These fertilizers are applied to ngolo fields in the highlands, where fields cannot be left fallow because of high human population densities. Immigrants from the highlands to the woodlands practice a normal ridge system of cultivation called *mitumbila* and a slash-and-burn cultivation called *matema/malala*. These systems are the initial stages in the process of creating suitable soil conditions for ngolo cultivation, and they are major sources of income in new villages where coffee trees are too young to be harvested.

The Matengo and the origin of ngolo cultivation practice

The Matengo are a Bantu-speaking people who reside in the Mbinga District of the Ruvuma Region in southern Tanzania. They grow maize and beans as staple food crops and coffee as a cash crop. The Matengo are well known for their farming skills, and they practice a unique cultivation technique, called ngolo, in mountainous areas. Literally translated, ngolo means "pit" in the Matengo language. Since a ngolo field has many pits, the system has been referred to in the literature as "Matengo pit cultivation."

Ngolo fields are cultivated in March, toward the end of the rainy season. Men slash down the dense weeds that have grown during the rainy season and, after a week, arrange the stalks to form square grids of 1.5-2.0 m. Women then dig up the soil within the grids and use it to cover the stalks. The grid ridges produce many pits over an entire field. These pits conserve soil and water, while the buried weeds mature the soil (1) (Allan, 1965; Basehart, 1973; JICA, 1998). Older studies (Pike, 1938; Stenhouse, 1944) reported that ngolo cultivation was already in use in the early 1900s; thus the Matengo have sustained the system for over 100 years.

The origin of ngolo cultivation is related to the process of ethnic group formation. Around the middle of the 19th century, the Ngoni people invaded from southern Africa and drove the natives away. During this invasion, one party of refugees reached eastern Songea, the center of the Ruvuma Region, and became the Ndendeule; another group of refugees settled in the mountainous areas of the Mbinga District and became the Matengo (Gulliver, 1955; Ebner, 1959; Allan, 1965; Schmied, 1988). The Matengo farmers may have invented the ngolo system of cultivation in order to survive in the harsh mountainous regions while being threatened by the Ngoni (Stenhouse, 1944).

The western part of the mountainous area in the Mbinga District is called the Matengo Highlands and is characterized by steep slopes ranging from 1,300-2,000 m above sea level (asl). The indigenous vegetation of the Matengo Highlands is primarily evergreen montane forest, and this landscape differs from the woodlands found on the outskirts (JICA, 1998). Ngolo cultivation may have originated in these montane forests. Ngolo cultivation is labor-intensive, some of which are left fallow. In 1926, coffee was introduced to the Matengo Highlands and gradually spread throughout the area (Iliffe, 1979). Coffee is suited to the cool and moist conditions of Mbinga, and the cultivation of this crop may advance the sedentary lifestyle of the Matengo. According to the 1957 census, the population density of the Matengo Highlands was about 70 individuals/km^2 (Tanganyika, 1963), and in 1997 it was more than 100 individuals/km^2 (JICA, 1998). This density is considerably higher than the average 26 individuals/km^2 in Tanzania in 1988 (BOS, Tanzania, 1989).

Since the 1960s, the shortage of land has caused many farmers in the Matengo Highlands to migrate to the rolling hills in the south and east of the district. The Matengo named their original highland *itumbi* and refer to new destinations as *itutu*; they often comment on the differences in living conditions between the two areas. Aside from the shortage of land, there are also cultural and social aspects related to Matengo migration (Kato, 1996); however, this paper deals primarily with the agroecological aspect of their migration.

Basehart (1973) noted a tendency for the Matengo to maintain ngolo cultivation in densely populated villages, whereas those who migrated to sparsely populated villages adopted more extensive systems of cultivation. He interpreted this phenomenon in light of the Boserup assertion (2), which states that population density regulates the intensity of agriculture. According to Basehart, the ngolo system was formed under high population pressure; therefore, those who moved into sparsely populated areas abandoned ngolo cultivation and chose more extensive systems. However, this explanation based on the Boserup assertion does not ubiquitously fit into the context of the Matengo agricultural intensification.

In Matengo society, a patrilineally extended family or lineage generally owns one small mountainous ridge surrounded by streams. The land is called *ntambo*, which is an archetype unit of land tenure. The Matengo are polygamous and married women borrow fields in the ntambo from their fathers-in-law. Matengo men usually engage in growing the coffee, whereas women are responsible for the production of maize and beans, the daily staples. Many households raise a few goats and/or pigs, which are primarily used for rituals, in wedding and funeral ceremonies, and to supplement the income.

Ngolo cultivation

The archetype unit of the land tenure (ntambo) has influenced the unique pattern of land use in the study area (Fig. 1). The elevation ranges from 100 to 600 m and the size of the ntambo ranges from 10 to 70 ha. People build houses on any flat site, called *nnduwi*, within their ntambo and plant kitchen gardens for growing tomato, onion, amaranth, sweet potato, sunflower, pumpkin, and other vegetables. Coffee trees are planted around the kitchen garden. On the steep slopes, called *uheleu*, below the coffee gardens, ngolo fields are cultivated to grow the major food crops: maize and beans.

A narrow, flat, elongated plain along the streams, which remains wet throughout the year, is used to grow some vegetables and coffee seedlings. In these plains, locally called *kijungu* and *libindi*, fields of various perennial crops, such as sugar cane, banana, and taro are often planted, or the plains are kept in pasture during the dry season. The upper parts of the mountains are often kept covered in forest (*kitengo*). This place is used for firewood, grazing, or collecting wild plants for herbal remedies. Thus, the Matengo use the ntambo effectively to suit ecological conditions, centering the ngolo fields where the staple foods are produced. This section describes the features of the ngolo cultivation system, while paying particular attention to agroecological conditions.

Rainfall patterns

While the mountain zone has high agricultural potential that is supported by reliable rainfall, the topsoil on the slopes tends to be eroded by heavy rains. Figure 2 shows the amount of rainfall per day in the 1996/97 and 1997/98 seasons in the village of Kindimba. The annual total rainfall in the 1996/97 and 1997/98 seasons was 838 mm and 1,496 mm, respectively, and fluctuated greatly. Although there was not much difference between the two seasons in terms of number of days of rainfall, 0.5 mm (92 days in 1996/97 and 107 days in 1997/98), annual rainfall was 1.8 times higher in 1997/98 than in 1996/97. The results indicate frequent torrential downpours in years that have high rainfall. Under such severe conditions, ngolo cultivation has successfully conserved the soil for over a century.

Rainy-season tasks

A series of tasks in ngolo fields corresponds with rainfall patterns. Figure 2 shows the agricultural calendar of the ngolo system. In general, a household keeps one ngolo field for maize and one for beans, and the crops are grown in rotation. During the late rainy season, women dig pits (Fig. 3) and sow beans. After harvesting the beans in June, the field is left alone during the dry season. Maize is planted on the same ngolo ridges in December, just after the onset of the rainy season, and is harvested in August of the following year. Fields are then left without cultivation until late in the rainy season of the next cycle of ngolo preparation (i.e., a short fallow period of 7 months). Because of the two-crop rotation system with two fields, one household can always harvest both maize and beans every year.

The series of tasks performed by a household is closely related to rainfall patterns. The farmers classify the rainy season into three periods. The rain in December is called the “rain for field preparation.” Rain and clear weather alternate every few days at this time of year. Women sow maize in the ngolo fields that were cultivated during the previous season. Just before sowing, they weed with a hand hoe and re-form the grid ridges. They then use a hoe to make planting furrows on the ridges and sow maize seeds at 20-cm intervals, using their feet to cover the seeds with soil as they go. The plant

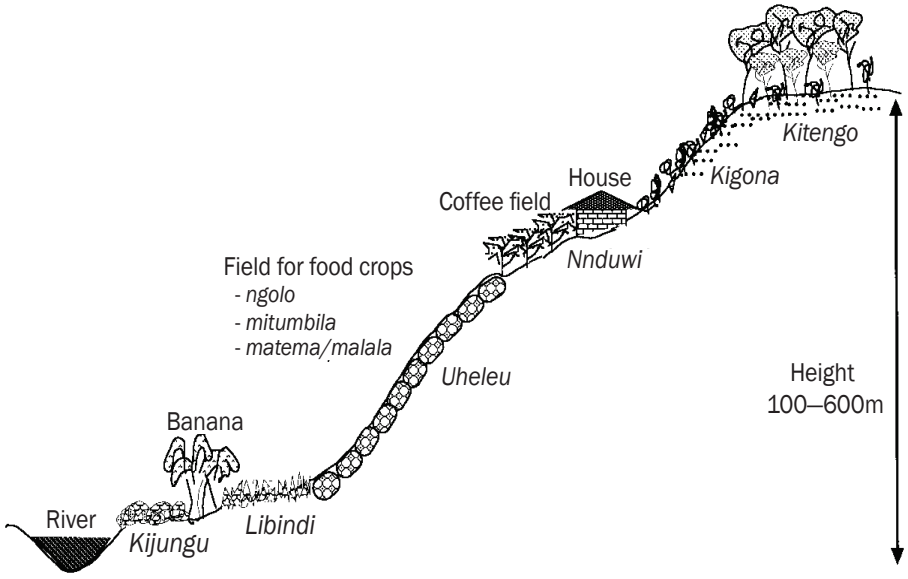

Fig. 1. *Use of ntambo (JICA 1998).*

density is about 10 plants/m^2. If the maize seeds or seedlings are damaged by pests, animals, or rain, they can be replanted.

Rainfall is usually heavy between January and February. The farmers engage in weeding (*kukulagalila*) and thinning (*kutukupila*) the maize fields; therefore, they call this rain the "rain for weeding." Women and men usually weed for several days in mid-January. By this time, the pits in the ngolo fields may be filled with soil that has been loosened from the ngolo ridges by the heavy and incessant rain. However, the soil rarely flows downhill because of the maize roots that effectively cover the soil surface.

From March to mid-April, the rains are intermittent. This corresponds to the period for cultivating another ngolo field, and this season is known as the "rain for the beans." When selecting dates for planting, women must consider the amount and intensity of rainfall because beans are sensitive to soil moisture conditions. Late in April, the rain decreases gradually, and this period is called the "last rain." Thus, the series of tasks in the ngolo fields corresponds to each type of rainfall pattern during the rainy season.

Making ngolo ridges

Ngolo fields are normally arranged on slopes of 5-30 degrees. The average size of a ngolo field is about 0.7 ha, and the average size of a square grid ridge is about 2 m. Therefore, there are more than 1,500 pits in a typical ngolo field. Preparation of the ngolo fields is based on strict gender division of labor, broadly divided into the slashing (*kukyesa*) and arranging of grasses into square matrices (*kubonga*) by men and the cultivating (*kulema ngolo*) and planting by women.

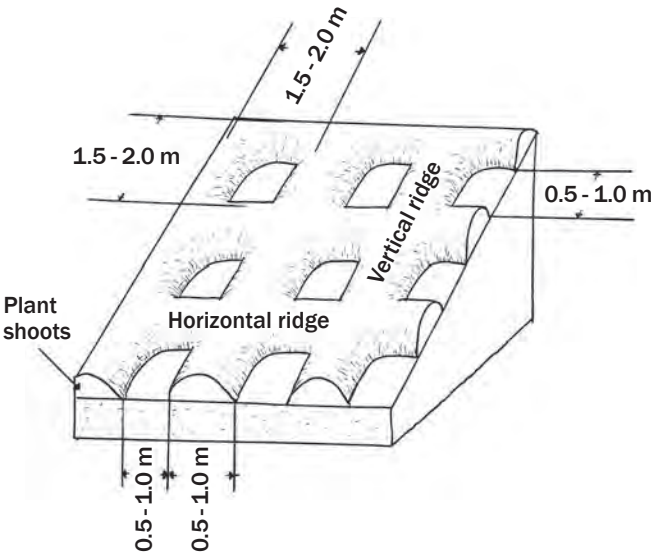

Fig. 3. *A profile of ngolo ridges (Itani, 1998).*

In February, late in the rainy season, several weeds, collectively known as *malumba* (including *Nidorella resedifolia* and *Conyza persifolia*) all flower together. At the beginning of March, men slash the malumba with a billhock (*gesela/mbopo*). In new villages, men sometimes struggle to slash *Hypharrhenia coleotricha* grass that grows about 2 m tall. Slashed grasses are left to dry in the fields for about a week, and the dry stalks are then collected and arranged into vertical and horizontal lines to form grids. The lines of grass stalks are called *mabongi*. When buried under the ridges, the mabongi have the same effect as green manure (JICA, 1998; Moritsuka *et al.*, 2000) and provide internal drainage (Itani, 1998). Men pile up excess grass in piles 2 m in diameter and 0.5 m high, which are later burned. The soil eventually deteriorates after continued cultivation for a long time, and *Pteridium aquilium* and *Imperata cylindrica* become dominant; thus, it becomes necessary to let the field lie fallow.

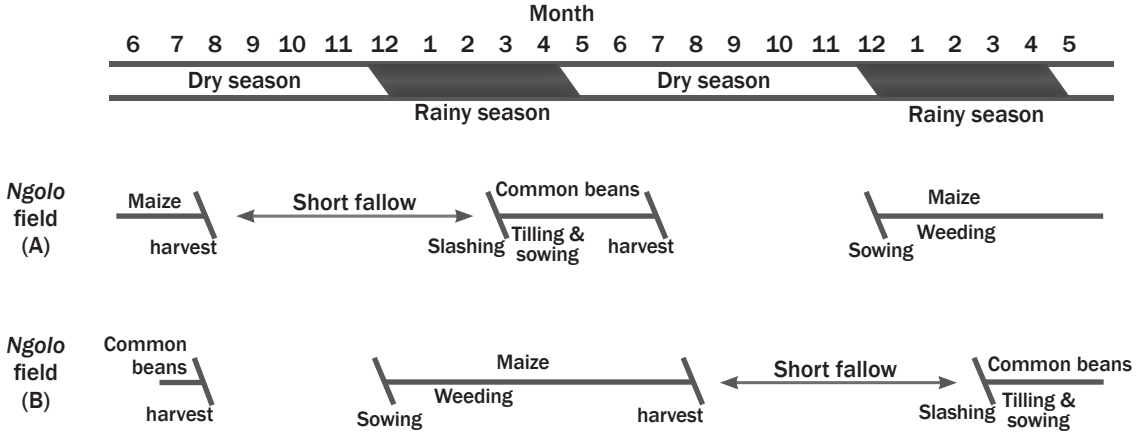

Fig. 2. *Household cropping patterns of two ngolo fields.*

After finishing kubonga, women cover the mabongi with small amounts of topsoil (about 8 cm) inside the grid (*kujalila*). Figure 4 shows the sequence of the work. Women evenly spread topsoil over the mabongi and then sow bean seeds onto them (*kukweta ngondi*). Finally, they cover the seeds with the soil in the pit (*kukulila*; Fig. 5). Kukulila looks like kujalila, but it involves deeper tillage of about 15 cm. According to the women, moving soil uphill (letters a–d and i–k in Fig. 5) is physically arduous. The women place some soil clods on a, b, and i before putting other clods on c, d, and j and the upper gaps between a, b, and i. The former clods are for ridge foundations and the latter are for linking larger clods. Thus, because the horizontal ridges are constructed more strongly, the ngolo can withstand heavy rains. Sometimes cassava cuttings are planted just after sowing the beans (point A, Fig. 5).

Soil maturing

The soil in the Mbinga District basically consists of clayey red soil, which the Matengo call *luhumbi lukeli*. Darker soil is formed in deeper layers by mixing the mabongi into the deep soil; dark soil rich in organic matter is called *luhumbi lujilo*. An important feature of the ngolo cultivation system is the formation of dark layers of luhumbi lujilo, which provides conditions favorable for high crop yields.

Although the ngolo cultivation system conserves surface soil on the slopes, by the middle of the rainy season, the pits are filled with sediment, and a small amount of soil is lost with runoff. In this system, the fertile soil from the pits is returned to the ridges every 2 years, while the subsoil that is dug up compensates for the soil losses. Therefore, some red soil (*luhumbi lukeli*) appears on the ridges, but it changes to luhumbi lujilo by being mixed with mabongi. The red soil is placed on the horizontal ridges to reinforce them (clods c, d, and j in Figure 5).

The position of the pits is shifted for each new cultivation (Fig. 6). New pits are placed where the previous ridges intersected. By changing the position of the pits during each preparation, the top and subsoils as well as dry grasses are mixed or turned over (JICA, 1998). This process matures the soil. Although the function of soil and water conservation attracts the most notice in the ngolo system, soil maturing is also quite important to maintaining high productivity levels.

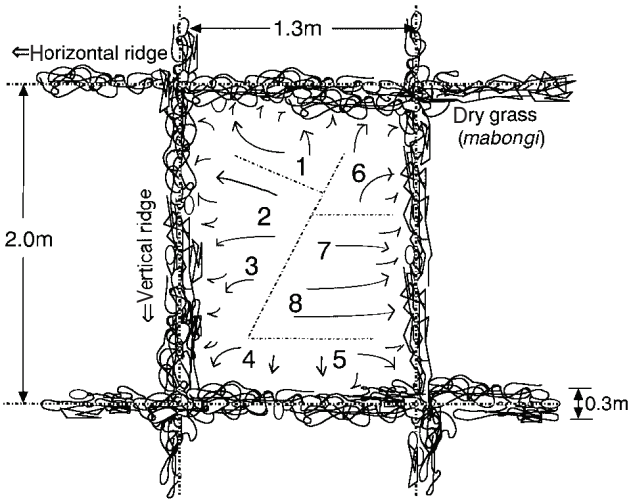

Fig. 4. *Work of* kujalila.

The change in soil nature by this cultivation is indicated at the following analysis. Topsoil of original vegetation (*miombo* woodland) and topsoil of a ngolo field were analyzed at Lupilo village, eastern side of the district (JICA, 1998). The results showed that clay occupied about 50% and 35% of the topsoil of ngolo field and the miombo woodland, respectively. This is mainly due to integrating part of the subsoil into the topsoil by ngolo cultivation. Moreover, the soil structure is stabilized through decomposing organic matter by bacteria and fungi (Russell, 1988). Topsoil forms water-stable aggregates suitable for cultivation through a process integrating organic matter.

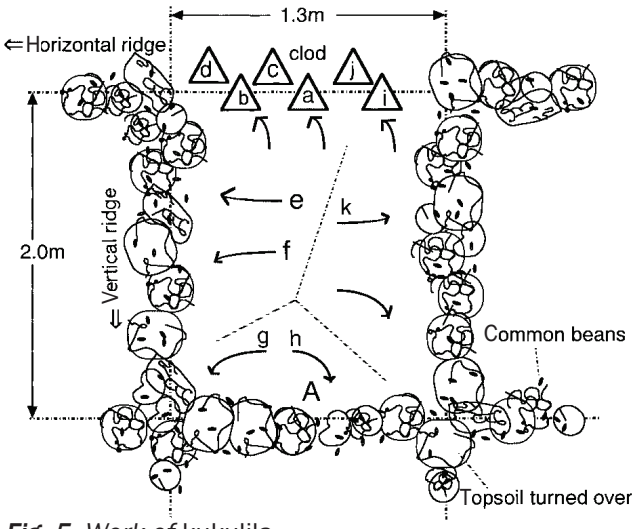

Fig. 5. *Work of* kukulila.

The Matengo define an ideal ngolo field as having pit dimensions of 3.5 m2 x 70 cm deep, with an adequate amount of buried mabongi. Under these conditions, ngolo cultivation effectively conserves

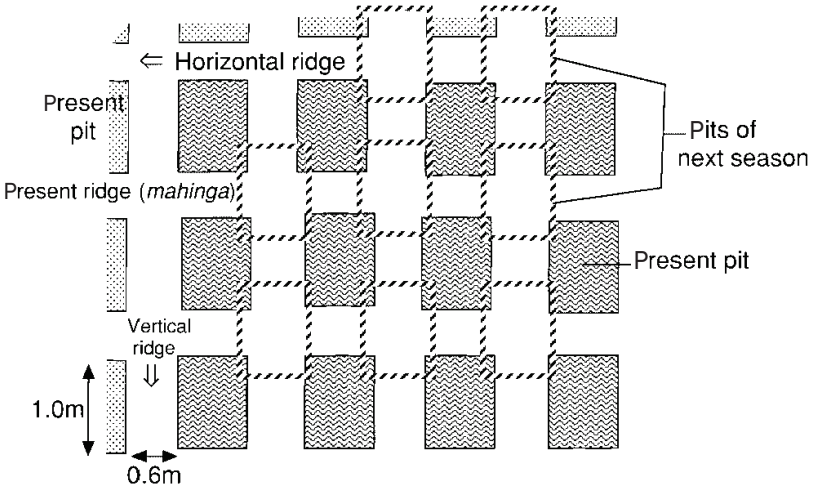

Fig. 6. *Changing positions of pits in a ngolo field.*

soil and water and maintains soil fertility. Women must master the techniques of making the ideal and perfect ngolo. They are aware that the skill of cultivating the ngolo is an index of their socio-cultural status and recognition, particularly for unmarried women. Thus, the ngolo cultivation system has also been maintained by the common recognition of women's labor and integrity.

End note

Ngolo cultivation is an intensive system that contributes to soil conservation and sustains fertility of the arable land. It is quite rare among African indigenous cultivation systems, many of which are extensive. However, Pike (1938) and Stenhouse (1944) inspected the district during the first half of the 20th century and reported that coffee cultivation and mitumbila prevailed, and that intensive ngolo cultivation was declining. Basehart (1973), quoting Boserup's assertion, pointed out that those who migrated to sparsely populated areas practiced more extensive cultivation; hence he concluded that practicing intensive ngolo could be attributed to the high population pressure.

The system of ngolo cultivation was formed under social constraints. The Matengo were placed under duress by their rival, the Ngoni, and were forced to cultivate the steep mountainsides. In those days, they needed to increase the yield per unit area in order to obtain enough food, and consequently the Matengo cultivation system was intensified.

The high population pressure might have brought about the creation of the ngolo system and the land tenure system, and the intensity of Matengo agriculture may therefore be based on population pressure. However, the severe environmental conditions in the mountainous area may also have influenced the formation of this intensive but sustainable cultivation method. The Matengo have relied on the ngolo cultivation system, which has been able to support them, and may well have been a foundation of their culture.

Notes

1. In this paper, "soil maturing" means the process of accumulating organic matter and clay in the topsoil, with repeating cultivation.

2. Boserup (1965) insists that as the population density increases, changes occur in cropping techniques such as shortening fallow periods and increasing the labor input to satisfy the higher demand for food. According to her arguments, the agricultural intensification can be spontaneously attained under the high population pressure. This paper focuses on the following part of her assertion: *...cultivation who used intensive methods in their densely settled home districts give up these methods after they have been resettled in less densely populated districts and given more land per family* (Boserup, 1965: 63).

Source

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