INTENSIVE CULTIVATION AND ENVIRONMENT USE AMONG THE MATENGO IN TANZANIA

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ABSTRACT This study focuses on the agro-ecological background of an intensive cultivation system called *ngolo*, which has been practiced for over 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 allows for 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.

Emigrants have succeeded in maintaining *ngolo* cultivation, even in underpopulated villages, although the cultivation system was originally conceived and sustained under conditions of high population pressure. The system is able to conserve land in new villages that experience similar natural conditions, such as hilly landscapes and intense rainfall. However, social constraints and agricultural effects are not the only reasons why the Matengo have successively used *ngolo*; they have trusted in *ngolo* cultivation based on past experience, and it might therefore be a foundation of their culture.

Key Words: Coffee; Intensive cultivation; Matengo; *Ngolo* system; Soil maturing.

INTRODUCTION

The Matengo are a Bantu-speaking people who reside in the Mbinga District of the Ruvuma Region in southern Tanzania (Fig. 1). 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 up during the rainy season, and after a week, they 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

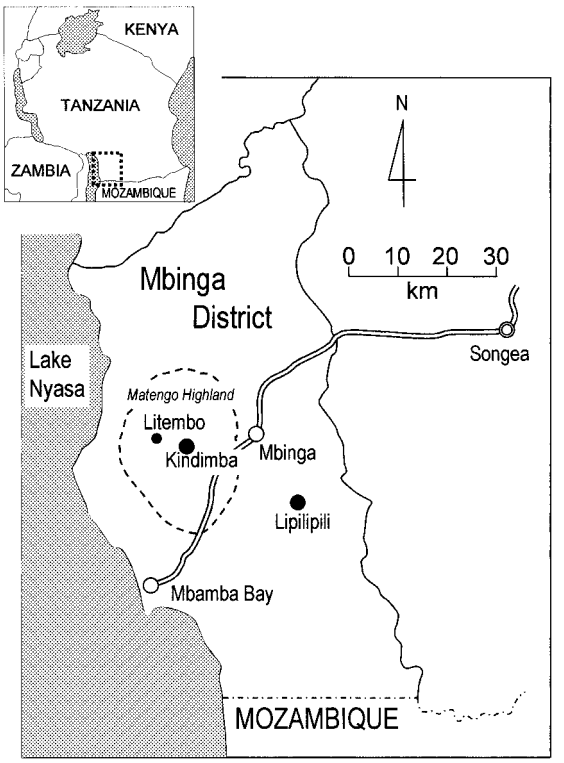

Fig. 1. Study area.

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 individulals/km^2 (JICA, 1998). This density is considerably higher than the average 26 individuals/km^2 in Tanzania in 1988 (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, in this paper I deal primarily with the agro-ecological aspect of their migration.

Basehart (1973) noted a tendency for the Matengo to maintain *ngolo* cultivation in densely populated villages, whereas those who immigrated into 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's assertion does not ubiquitously fit into the context of the Matengo agricultural intensification. In this paper I will discuss the dynamic aspect of the intensive Matengo agriculture by comparing overpopulated areas to sparsely populated areas.

RESEARCH AREA AND ETHNIC GROUPS

The Mbinga District is located to the northeast of Lake Nyasa (Fig. 1). The District is characterized by steep mountains and rolling hills, ranging from 600-2000 m asl. The climate of the study area is temperate tropical with a reliable unimodal rainfall pattern, starting in November and ending in May of the following year. The rest of the year is virtually dry. Annual rainfall averages about 1200 mm. The mean maximum temperature ranges from 19-27°C, and the mean minimum temperature lies between 7 and 16°C (JICA, 1998). The area is characterized by intense and erratic rainfall events of about 20 mm/hr (Itani, 1998).

Natural vegetation under 1500 m asl occurs in woodlands called *miombo*, which are composed mainly of *Brachystegia* spp. and *Julbernardia* spp. (both Caesalpiniaceae). This vegetation covers a wide range from southern to central Africa. *Miombo* is open woodland, with a mean overstory height of about 15 m. The forest floor is covered with short grasses. In contrast, the native vegetation of the west central District above 1500 m asl is mainly composed of evergreen montane trees such as *Chrysophyllum gorungosanum*, *Macaranga capensis*, *Albizia schimperiana*, and *Schrebera alata* (JICA, 1998). However, to date almost all of these forests have been cleared, with the exception of a few isolated forest reserves.

Traditionally, Matengo society was primarily non-hierarchical. In the late 19th century, however, a Matengo kingdom was formed, during conflicts with the Ngoni

(Basehart, 1972). The colonial rule by Germany, which began at the end of the 19th century, weakened the royal reign, although the Matengo initially resisted the colonial government. During the Maji Maji Rebellion of 1905-07, which spread to the southern Tanzania, the Matengo were not so influenced by it because they dwelled relatively remote (Ndunguru, 1972; Iliffe, 1979; Schmied, 1988). *Arabica* coffee was introduced into this District from the Kilimanjaro Region, and cultivation of the crop has since spread to the entire Matengo Highlands area. Since the 1980s, Mbinga has become one of the major coffee production districts in Tanzania because its conditions, i.e., a cool and wet climate, are well suited to cultivating coffee (ICRA, 1991). The introduction of coffee strengthened sedentary behavior among farmers. Today, some households are fairly wealthy because of their income from coffee.

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.

This study was conducted in association with the activities of the JICA Research Project entitled, "Integrated Agro-ecological Research of the *Miombo* Woodlands in Tanzania". I conducted field surveys 3 times: from October 1993 to March 1995, September-December 1996, and July-August 1998, for a total of 20 months. I conducted my research using the Swahili language and, when necessary, I used the Matengo language. In this paper, italicized words are from the Matengo language. The principal villages studied were Kindimba, located in the Matengo Highlands, and Lipilipili, in rolling hills (Fig. 1).

Older villagers reported that around the 1900s, people began to settle in Kindimba village, 8 km east of Litembo, which is the historical center of the Matengo Highlands. The altitude here ranges from 1300-1800 m asl. In 1997, the village had 548 households with 2525 inhabitants in an area of 22 km^2, or 115 individuals/km^2 (JICA, 1998). Coffee cultivation began in the village of Myangayanga, near Kindimba (Schmied, 1988). The average coffee production per household in 1994 reached 225 kg (MBICU, 1995). This village is relatively well-off, such that a few households can purchase a milling machine or a used car.

In contrast, the village of Lipilipili is located 20 km southeast of Kindimba. The altitude ranges from 1000-1400 m asl, and the dominant native vegetation is the *miombo* woodland. According to my census in 1996, 1735 villagers inhabited an area of 66 km^2, i.e., a population density of 26 individuals/km^2. In the 1970s and '80s, this village became one of the destinations for the many people migrating from the highlands, where capacity had been saturated. The immigrants began by clearing the *miombo* forests, and expanded their farm fields to grow food and coffee. The average coffee production per household in 1994 was 79 kg (MBICU, 1995). Many villagers cannot get adequate cash income, partly because many of the coffee trees are still young.

NGOLO CULTIVATION

The archetype unit of the land tenure (*ntambo*) has influenced the unique pattern of land use in the study area (Fig. 2). The elevation ranges from 100-600 m and the size of the *ntambo* ranges from 10-70 ha. People build houses on any flat site, called *nnduwi*, within their *ntambo* and plant kitchen gardens for growing tomatoes, onions, amaranth, sweet potatoes, sunflowers, pumpkins, 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 chapter describes the features of the *ngolo* cultivation system, while paying particular attention to agro-ecological conditions.

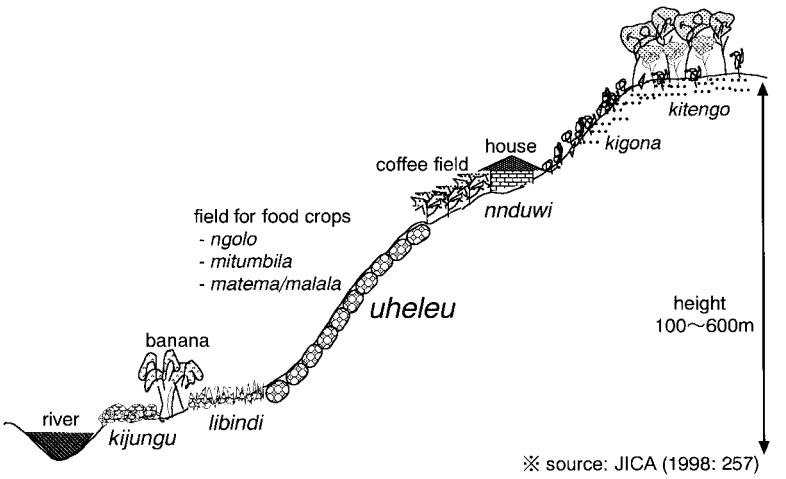

Fig. 2. Use of *ntambo.*

I. 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. Fig. 3 shows the amount of rainfall per day in the 96/97 and 97/98 seasons in the village of Kindimba. The annual total rainfall in the 96/97 and 97/98 seasons was 838 mm and 1496 mm, respectively, and fluctuated greatly. Although there was not much difference between the two seasons in the number of days of rainfall $>$ 0.5 mm (92 days

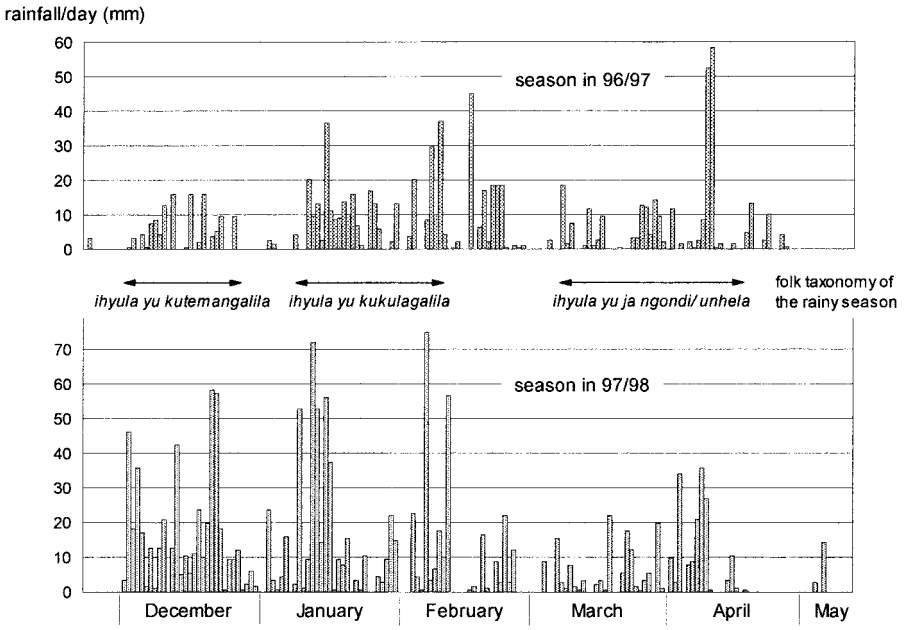

Fig. 3. Daily rainfall pattern at Kindimba village (source: JICA, 1998).

in 96/97 and 107 days in 97/98), the annual rainfall was 1.8 times higher in 97/98 than in 96/97. The results indicate that there are frequent torrential downpours in years that have high rainfall. Under such severe conditions, *ngolo* cultivation has successfully conserved the soil for over a century.

II. Rainy Season Tasks

A series of tasks in *ngolo* fields corresponds with rainfall patterns. Fig. 4 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. 5) 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.

A series of tasks performed by a household are closely related to rainfall patterns (Fig. 3). 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

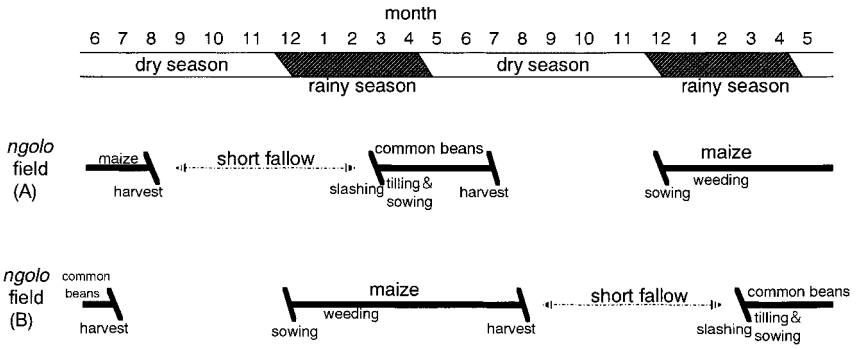

Fig. 4. Household cropping pattern of two *ngolo* fields.

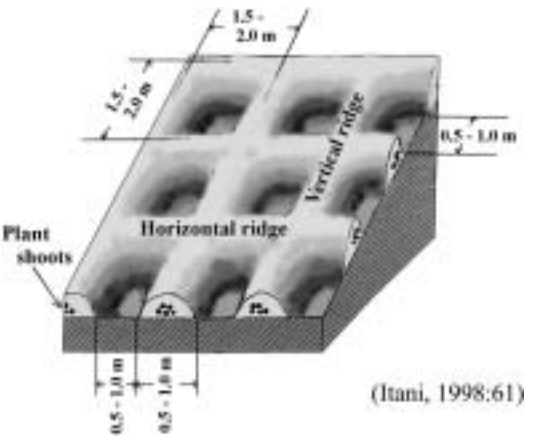

Fig. 5. A profile of *ngolo* ridges.

with soil as they go. The plant 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 take into consideration 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.

III. 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 cultivating (*kulema ngolo*) and planting by women.

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.

After finishing *kubonga*, women cover the *mabongi* with small amounts of topsoil (about 8 cm) inside the grid (*kujalila*). Fig. 6 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. 7). *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. 7) 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

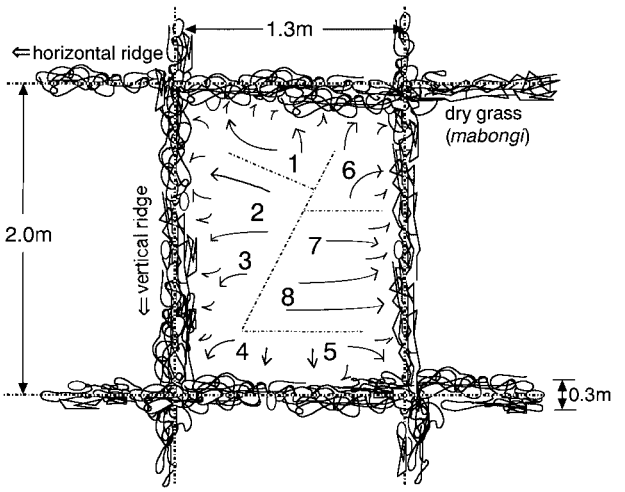

Fig. 6. Work of *kujalila*.

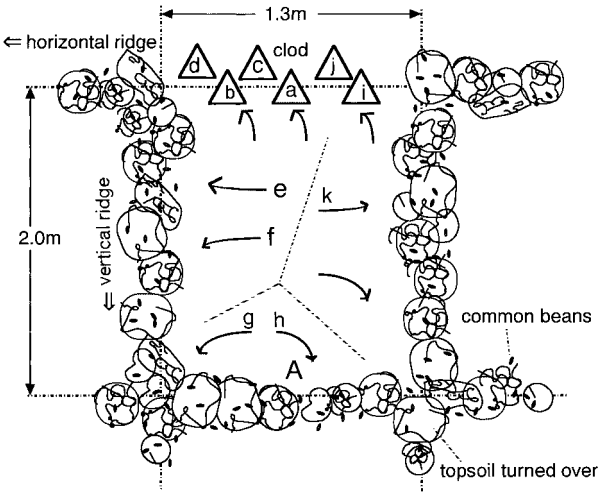

Fig. 7. Work of *kukulila.*

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. 7).

IV. 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 run-off. In this system, the fertile soil from the pits is returned to the ridges every two years, while the sub-soil 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 Fig. 7).

The position of the pits is shifted for each new cultivation (Fig. 8). New pits are placed where the previous ridges intersected. By changing the position of the pits during each preparation, the top and sub-soils 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.

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

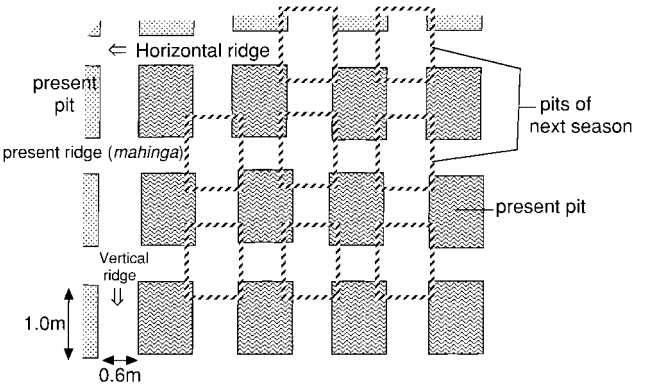

Fig. 8. Changing positions of pits in *ngolo* field.

miombo woodland, respectively. This is mainly due to integrating part of sub-soil into 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 of integrating organic matter.

The Matengo define an ideal *ngolo* field as having pit dimensions of 3.5 $m^2 \times 70$ cm deep, with an adequate amount of buried *mabongi*. Under these conditions, *ngolo* cultivation effectively conserves 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.

RELATIONSHIPS BETWEEN *NGOLO* AND OTHER SYSTEMS OF CULTIVATION

Aside from the *ngolo* system of cultivation, people also practice other cultivation techniques. In this chapter, *ngolo* is viewed in the context of a holistic Matengo agricultural system that includes other cultivation practices by comparing land use in the old village of Kindimba and in the new village of Lipilipili. Differences in the extent of agricultural intensification between the villages is also analyzed, based on the level of soil maturing.

I. Land Use in an Old Village

Table 1 shows the land use patterns of an extended family in the old village of Kindimba in 1997/98. The Mbaya lineage includes 8 households and occupies a part of the "Walanzi", one of the *ntambo* in Kindimba. They are descendants of the late Mbaya who settled there about 1920. The Mbaya lineage holds 25.2 ha of land and

borrows 2 fields (totaling 1.0 ha) from unrelated persons.

Table 1 shows that farmland areas are used mainly as *ngolo* and coffee fields, and there are small plots of *kijungu* and *libindi* in wet areas and in *mitumbila* fields. *Mitumbila* refers to a type of cultivation that is characterized by linear ridges (30 cm high, 1 m wide) that follow contour lines. *Mitumbila* is assumed to have spread from neighboring ethnic groups several decades ago, possibly through migration and intermarriages. *Mitumbila* can often be seen in kitchen gardens near homes where slopes are gentle. In the *mitumbila* fields, farmers sometimes plant maize and beans by mixed cropping; they also plant sweet potatoes for snacks.

Creating the *mitumbila* begins just after the rainy season and takes about one week to complete. The first step is to collect crop remains or grasses with a hoe and arrange them in a line. These lines are then covered with a layer of topsoil, much like the *kujalila* in *ngolo* fields. Farmers sow maize or beans on the lines and cover them with another 30-40 cm of soil. In the next section, I will compare *ngolo* and *mitumbila*.

Table 1. Land use pattern in extended families at Kindimba and Lipilipili villages.

	household	age[*1]	area (ha)								
			house and lot	coffee field	*ngolo* field	*mitumbila* field	*matema /malala* field	*libindi & kijungu*	grazing area	original vegetation	afforested area
Kindimba	1(2)	60	0.1	1.0	1.4	0.0	0.0	0.2	1.3	0.0	0.0
	2	31	0.1	0.4	1.0	0.0	0.0	0.1	-[*2]	0.0	0.4[*3]
lineage of	3(2)	50	0.1	1.3	2.8	0.2	0.0	0.2	-	0.0	0.0
Mbaya	4	66	0.1	1.2	1.2	0.1	0.0	0.1	-	0.0	0.0
	5(3)	38	0.1	1.2	3.1	0.2	0.0	0.2	-	0.0	0.0
	6	30	0.1	0.6	1.3	0.1	0.0	0.5	-	0.0	0.0
	7f	62	0.1	0.6	1.0	0.1	0.0	0.0	1.2	0.0	0.0
	8f	52	0.1	0.7	0.6	0.1	0.0	0.0	-	0.0	0.0
		average	0.10	0.88	1.55	0.10	0.00	0.16	0.31	0.00	0.05
Lipilipili	1(2)	60	0.2	0.6	4.6	0.7	0.7	0.3	3.7	12.0	0.0
	2	38	0.1	0.5	2.2	0.3	0.0	0.2	1.8	8.2	0.0
lineage of	3	26	0.1	0.2	1.6	0.3	0.0	0.1	-	-	0.0
Limka	4	22	0.1	0.1	1.8	0.2	0.0	0.1	-	-	0.0
		average	0.13	0.35	2.55	0.38	0.18	0.18	1.38	5.05	0.00

[*1] Number in parentheses indicates the number of wives in a polygamous household, and "f" means the householder is woman.
[*2] The sign "-" means that the household does not have a priority over using grazing area and original vegetation.
[*3] This household borrows the fallow area of household 1 and planted eucalyptus for firewood.

II. *Ngolo* and *Mitumbila*

Table 2 estimates the amount of labor required for each type of tillage. The figures express the average time that an adult farmer spends cultivating a 1-are (100 m^2) field of *ngolo* or *mitumbila*. Data were obtained from 9 individuals (man-days) in *ngolo* and 20 individuals (man-days) in *mitumbila*. It took 2.33 hours in *ngolo* and 1.24 hours in *mitumbila* to cultivate the entire field; thus, *ngolo* requires approximately twice as much labor as *mitumbila*.

Table 2. Time distribution of each work for *ngolo* and *mitumbila*.

type of work	cultivation method (hour/are) *ngolo* (n=9)	*mitumbila* (n=20)
kukyesa (slashing)	0.28	———
kubonga (arranging grasses)	0.18	0.75*1
kujalila	0.76	
kukweta imbeju (covering with soil and sowing)	0.19	0.49*2
kukulila	0.92	
total	2.33	1.24

*1 Including weeding just before covering with soil.
*2 Including sowing.

With regard to the quality of labor, women commented that *ngolo* is more difficult than *mitumbila*, because it requires digging a pit approximately 70 cm deep; hence a weak woman who has just recovered from illness usually opts to cultivate with *mitumbila* instead of *ngolo*. However, although her illness prevents her from completing the *ngolo* field before the dry season begins, she must cultivate the *ngolo* field without sowing beans during the dry season following her recovery, so that she can use it during the next cropping season.

Recently, the wage for cultivating *ngolo* was approximately 10 Tanzanian shillings (Tsh) per pit; thus, it costs about 15,000 Tsh to employ labor in *ngolo* fields. Since the wage is paid on the basis of the number of pits dug, the pits are often shallow, and the *ngolo* field becomes susceptible to soil erosion. Because of this, many people refrain from using hired labor for the *ngolo*. Even a wealthy household is reluctant to hire labor. Despite the hard work involved in *ngolo*, women willingly cultivate their *ngolo* fields by themselves without using hired labor.

There is also a distinction between *ngolo* and *mitumbila* in the gender division of labor. Although the *ngolo* cultivation system is based on a strict gender division of labor, there is no division in the *mitumbila*. In *ngolo* fields, men usually slash and women tend to the crops. If either gender fails to perform its duty, the cultivation of *ngolo* may commence late or be abandoned altogether. It is almost impossible to exchange labor between sexes in *ngolo* cultivation, because men and women have mastered only one technique. Compared with *ngolo*, *mitumbila* is a more convenient method, as no special skill is allocated to sex.

Based on a field experiment in the one of the old villages in the Matengo Highlands, maize yields in *ngolo* fields were 1.3 times higher than those of *mitumbila* fields on steep slopes (JICA, 1998). A similar experiment conducted at Mt. Kilimanjaro (Allan, 1965) indicated that maize yields in *ngolo* were 2.3 times higher those of *mitumbila* in wetter years, and that maize yields of *ngolo* were about 3 times as high as those of a bench-terracing system. It can be inferred from these results that the *ngolo* system has a high productivity, particularly under wetter conditions. This may be because heavy rain causes loss of soil and nutrients in *mitumbila* or bench-terraced fields, while it does not affect *ngolo* fields as much. The *ngolo* system secures more stable yields under changing rainfall conditions. The high yields from *ngolo* fields may be one of the reasons that the system has persisted despite the intense labor requirement, and may be ascribed to the deep dark soil,

luhumbi lujilo, in *ngolo* fields. In the following section, the process of soil maturing is agro-ecologically analyzed, showing land use patterns in a new village.

III. Land Use in a New Village

Table 1 shows the land use patterns of an extended family living in the new village of Lipilpili. The Limka lineage includes 4 households and occupies a part of the "Lizabon", one of the *ntambo* of Lipilipili village. The *miombo* woodland covers 20.2 ha (50%) of their total land area (40.7 ha). The fallow and grazing areas, including the woodland, amount to 25.7 ha (63%).

New villages are often characterized by large *mitumbila* fields, and in addition, *matema/malala* is also practiced. *Matema/malala* is a kind of slash-and-burn cultivation that involves clearing primary/secondary forest or bush. In these fields, farmers grow finger millet, sunflowers, sesame, and maize by mixed cropping. A major crop is finger millet, which is used as an ingredient for local beer brewing. During the dry season men cut down trees and women turn over topsoil using handheld hoes. Men burn the felled trees and piles of slash just before the rainy season. Soon after the onset of the rainy season, women plant maize and sunflowers, and they sow the finger millet in January as they weed the maize or other crops. The literal meaning of *matema* is a heap of trunks and branches cut to less than 2 m with a hatchet. On the other hand, the meaning of *malala* is a heap of grass and shrubs cut with a sickle. While *matema* is created in the process of clearing woodlands, *malala* is made in the bush in fallow fields covered in grass.

In new villages, people practice the more extensive cultivation method of *matema/malala* and *mitumbila* along with *ngolo*. This is discussed in the context of the soil maturing process by *ngolo*, and by analyzing the sequences of the cultivation systems.

IV. A Series of Cultivation and Soil Maturing Processes

In a new village, *ngolo* fields can be observed together with *matema/malala* and *mitumbila* fields (Table 1). The area from which a farmer has cleared primary forest initially becomes a *matema* field. Then, *mitumbila* is practiced in the field for a few years before starting *ngolo* cultivation. In the case of *malala*, i.e., clearing fallow land, *ngolo* is often applied directly without *mitumbila*. It has been noted that *matema* fields, in which large tree roots and hard topsoil remain, require a large amount of labor to make *ngolo*. Farmers also claim that the productivity of maize or beans is low even though they cultivate the *ngolo*. This may explain why soil organic matter is not abundant just after clearing. Therefore, the farmers cultivate *mitumbila* to soften the soil while increasing the organic matter.

While the *mitumbila* is cultivated, weeds invade the field and establish a dense grassland. These weeds later become the green manure in the *ngolo* fields. The process of cultivating the *mitumbila* is important in order to change the field from woodland to grassland. Adequate conditions for *ngolo* cultivation can be prepared throughout the period of the *mitumbila*.

The farmers renew the ridges in *ngolo* fields every two years, and each time cut

weeds are added to the new ridges to sustain the fertility of the *ngolo* field. This process in *ngolo* fields is soil maturing, and it includes the sequential process from the *matema/malala* through the *mitumbila* to the *ngolo*, which change the nature of the soil.

FOOD PRODUCTION AND INCOME

In recent years the need to acquire cash has increased, even in rural areas of Tanzania. The *ngolo* system is the most important way for the Matengo to acquire food, and many of the farmers do not sell products from their *ngolo* fields. The agricultural products from other cultivation systems support their economy. This chapter deals with the economy of the Matengo society.

I. Coffee Cultivation and Maize Production

Coffee cultivation is a major source of income for the Matengo, and it justifies the intensity of *ngolo* cultivation to a greater extent. Here, the relationships between coffee and food production are examined in detail.

Normally, a young man begins planting coffee trees after he builds his house to get married. Coffee is usually cultivated in bench terraces on the slopes. The farmer grows coffee seedlings in a shaded nursery at *kijungu*, and transplants 30 cm tall seedlings to the coffee garden around his home. Under good weather conditions and with proper husbandry and management, it takes three or four years to bear the first fruits. The amount of dry coffee berry produced per tree increases with age, and by age 20, the coffee tree attains the maximum production of 4 kg per tree. With the application of agrochemicals and compost, and with adequate pruning and other necessary handling, the coffee tree can continue to produce berries over the next 50 years. Activities in a coffee field during the rainy season include weeding and spraying agrochemicals, 1-3 times each. The farmers pick coffee berries from July to September, and then pulp and dry them. Usually, the men spray chemicals and prune trees, and both women and men cooperate in the other activities. The busiest months for coffee cultivation are January, February, August, and September, whereas those for food crop cultivation are December, March and April; thus, there is no competition for labor.

I will examine the relationships between coffee cultivation and food production from the view of the productivity of the *ngolo* fields. The farmers typically allow a *ngolo* field to remain fallow for several years when they observe low maize yields. The fertility of a *ngolo* field can be sustained by long fallow periods, as well as by short fallow periods every two years. A field that has been fallow for some years is called *lipusa*. However, because of the high population density, the old villages have no extra fields that can remain fallow, so the farmers must continue to cultivate their fields for a long time without allowing them to lie fallow. Many farmers in Kindimba now say that the exhaustion of their fields is serious, and that without applying chemical fertilizers, they would harvest less than half of the amount of maize necessary for household consumption. In this village, farmers have used

nitrogen fertilizers (e.g., calcium nitrate and/or urea) since the 1980s to grow maize. They use 50-100 kg (1-2 bags) of fertilizer in one *ngolo* field (about 0.6 ha). Because one bag (50 kg) of the fertilizer is equal to the producer price of 100-200 kg of maize, it is a large expense for the farmers. On the other hand, people in the new villages rarely use fertilizers because they have extra fields. For example, while 25 (74%) out of the 34 fields that I researched in Kindimba received chemical fertilizers, none of 28 fields in Lipilipili were fertilized. This discrepancy may be attributed not to differences in potential fertility between the two areas, but rather to the availability of fallow fields.

To estimate the productivity (kg/ha) of maize in the *ngolo* fields, I obtained data of maize yields (kg) from 10 households in Kindimba and 10 households in Lipilipili (Fig. 9). The sizes of their *ngolo* fields were consecutively measured from 1990 to 1998. Lower productivity in 96/97 and 97/98 was ascribed to an epidemic of plant diseases (maize leaf rust) and excess rain (El Niño effect), respectively. Data from Kindimba between 1990 and 1994 suggest that the yield of fertilized fields was greater than that of unfertilized fields. However, the yield of unfertilized fields in Lipilipili was as high as the yield of fertilized fields in Kindimba. These results suggest that the fertility of *ngolo* fields is supported by suitable fallow periods, and that farmers who are unable to fallow their fields must use chemical fertilizers to maintain soil productivity. However, they do not use chemical fertilizers for the purpose

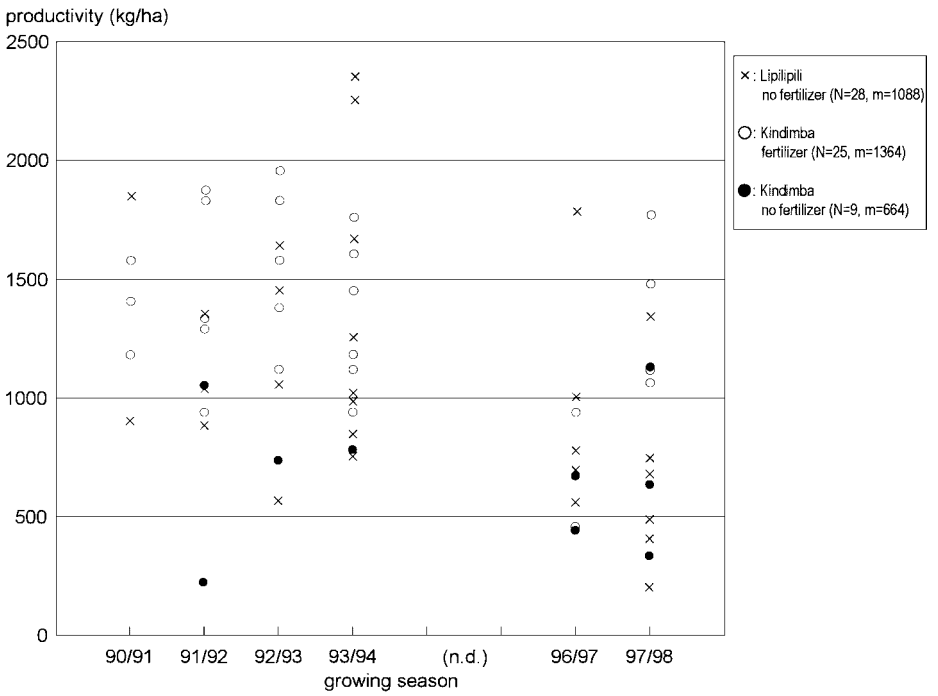

Fig. 9. Productivity of maize and the effect of chemical fertilizer.

of selling surplus crops; they use fertilizers to secure food for their own consumption. Households that have extra fertilizer apply it to their coffee gardens.

Six of 9 farmers who did not use any chemical fertilizer in Kindimba during the research period could not afford it because of low coffee yields or because of relatives' illness or other misfortunes. Another farmer could not have transported the fertilizers to their fields, due to bad road conditions during the rainy season. These are circumstances that often do not allow farmers to apply chemical fertilizers to their fields. Most of the income in the Matengo economy is acquired through coffee production. Therefore, many households use the cash obtained from coffee to buy the chemical fertilizers used in the *ngolo* fields. Even households with lower incomes apply fertilizers to the *ngolo* fields rather than to the coffee gardens. Thus, in the old villages, maize productivity is strongly supported by the income from coffee production.

II. Commercial Production in *Mitumbila*

Coffee production is the main source of income among the Matengo in the old villages. In the new villages to which many people are migrating, however, the economical background is unstable, because the young coffee trees result in low yields. The immigrants open vast areas of woodland and grow maize or beans to compensate for the loss of income. In this case, the farmers usually cultivate normal ridges, called *mitumbila*. As mentioned above, extensive *mitumbila* fields are cultivated as the initial stages in the process of creating *ngolo* fields, and in this case, they are also used as a convenient means of cultivating a large area. Therefore, many *mitumbila* fields are observed in the new villages (Table 1). For instance, household number 1 in Lipilipili had a *mitumbila* field of 0.7 ha, of which they used 0.4 ha to cultivate maize to sell. On the other hand, there is little possibility that the products from the *ngolo* field are sold, because it would impose a burden on the women who cultivate these fields.

Many farmers in the new villages cultivate food crops for sale. However, with increasing coffee production, they are reluctant to grow cash crops in the *mitumbila* fields. Thus, the *mitumbila* field has three functions: first, it matures the soil; second, it is an alternative in cases of emergency (such as illness); and third, it can be used instead of coffee to make money. Each function is quite important to the support of the *ngolo* cultivation system.

DISCUSSION

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 the 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. In the colonial period, the menace of the Ngoni weakened and some of the Matengo began to migrate to sparsely populated areas on the outskirts of the mountains. There, they adopted the convenient and extensive *mitumbila* cultivation system instead of the intensive *ngolo*. Thus, the Boserup's assertion may apply to Matengo society.

However, according to my long-term investigations, the people who migrated to the sparsely populated areas have no intentions of returning to more extensive cultivation systems, and are willing to reproduce the *ngolo* fields in their new lands after clearing forests and maturing the soil. Slash-and-burn cultivation is a temporary method for the Matengo to clear the forests, and the *mitumbila* cultivation is part of the process of preparing soil conditions, so that the weeds necessary for the *ngolo* cultivation system cover the land. Moreover, *mitumbila* is an alternative method in emergencies, and can temporarily contribute to income in place of coffee cultivation. Thus, the various kinds of extensive cultivation seen in a new village are the early stages of agro-ecology in the process of establishing the *ngolo* system. Matengo agriculture is not becoming extensive at all.

The Matengo practice of applying the *ngolo* cultivation system even in sparsely populated areas is rooted in their peculiar land tenure system and severe natural environment. A *ntambo* is customarily an archetype unit of land, owned by a lineage, and it is divided among the households belonging to the lineage. Immigrants to the woodlands must purchase a *ntambo*, or land, prior to their migration. This land tenure system was likely established in the days of the Ngoni conflict, and its significance is to restrict the shifting cultivation that is widely practiced in Africa. Because of this land tenure system, the Matengo were forced to change their arable land and create soil conservation measures to survive in the mountains.

Allan (1965) reported that in the area around Mt. Kilimanjaro only the *ngolo* fields produced good yields in a wet year, while almost nothing was produced in other cultivation systems because of soil degradation. This suggests that *ngolo* fields have excellent resistance to heavy rain, and that the system is suitable for steep mountains with frequent erratic rainfall. There are similar environmental conditions, such as heavy rain and steep slopes, in both old and new villages. When the Matengo, who recognize the significance of the *ngolo* system, migrate from an old village to a new one, they must naturally consider continuing *ngolo* cultivation. Because *ngolo* cultivation is laborious, the size of a *ngolo* field is often limited. Therefore, the Matengo work hard to mature the soil to obtain enough yields per area.

Thus, 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.

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NOTES

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

(2) Boserup (1965) insists that as the population density increases, changes occur in cropping techniques such as shorting 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:
...cultivators 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).

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