DEVELOPMENT OF A MAJOR RICE CULTIVATION AREA IN THE KILOMBERO VALLEY, TANZANIA

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ABSTRACT After economic liberalisation in Tanzania, rice cultivation rapidly expanded as a source of income, and several production areas formed. The Kilombero Valley, located in central southern Tanzania, is a major rice production area. The people residing in the valley had already developed the original rice paddy cultivation system for subsistence farming by the mid nineteenth century. The system depends on run-off from a flooded tributary of the Kilombero River. Recently, production using the indigenous cultivation system has increased and has produced a surplus for sale. However, suitable lands for the flood cultivation system are limited to narrow riversides. One reason why rice production has successfully increased is the introduction of modern technologies, such as tractors and trucks, into the indigenous system. Tractors and trucks have enabled the expansion of paddy fields to remote areas, and as a result, rice production has increased. At the same time, abundant production has accelerated the trading of rice and has increased opportunities for trading. Thus, increased rice production in the Kilombero Valley based on the established indigenous cultivation system has led to activation of the rice market.

Key Words: Economic liberalisation; Endogenous development; Flood; Indigenous cultivation; Tractor and truck.

INTRODUCTION

In the Arusha Declaration of 1967, the Tanzanian government advocated "African socialism," which promoted economic development without external assistance, and it began villagisation based on the *ujamaa* policy that brought together scattered villages in 1967. The *ujamaa* policy aimed to increase agricultural production by introducing modern agricultural technologies to collective farms (Yoshida, 1997). However, the *ujamaa* policy came to a deadlock due to an international oil crisis, declining export crop prices, increasing expenditures for new infrastructure caused by the collapse of the East African Union and increasing costs of a war against Uganda. Additionally, villagisation itself was unsuitable to the realities of Tanzanian rural communities. As a result of these problems, the national economy became sluggish and accumulated an enormous debt by the 1980s (Oda, 1989).

In 1986, the Tanzanian government implemented the Structural Adjustment Program (SAP), supervised by the International Monetary Fund (IMF) and the World Bank, and the economy converted from socialism to capitalism. As a result of SAP, the government curtailed the marketing board of the National Milling Corporation (NMC) that had previously monopolised Tanzanian food marketing. The participation of private traders in agricultural marketing was

legalised in 1990, and the NMC collapsed in 1991.

The purchase of crops by private traders established new commercial networks between urban and rural communities against a background of increasing food demand from a growing urban population. It also provided new opportunities for farmers to sell their agricultural products. Although economic liberalisation extended the economic connection between urban and rural communities, it also increased the risks of farming management because it increased the price of agricultural inputs, in particular agro-chemicals, and enhanced the fluctuation of crop prices in rural areas (Isinika et al., 2003).

As is the tendency after African countries gain independence, rural households engaged in several different activities for increased security or profitability (Seppala, 1998). There was also a trend of income diversification, and de-agrarianisation was considered a coping strategy for the economic crisis (Bryceson, 1997). In the Kilombero Valley, where most people have cultivated paddy rice as a staple food, rice cultivation expanded rapidly, as it was the only income generator after economic liberalisation. Currently, the valley is a major rice production area, supplying about 9% of all rice produced in Tanzania (United Republic of Tanzania, 2004).

Sakamoto (1998) argued that rural areas in Africa have the potential for endogenous development, in which agricultural productivity and welfare, based on traditional values, can be enhanced. Meertens et al. (1999) described changes in the Sukumalands of Tanzania after economic liberalisation; a combination of ecological, economic, technological and population density factors stimulated the cultivation of rice, and farmers quickly adapted their farming systems according to changes in markets, available technologies and population density, and intensified land use as a way to ensure the sustainability of farming systems. Moreover, endogenous development has occurred through technological innovations and the creativity of people indigenous to rural areas (Kondo, 2003; Kanda, 2006; Shimomura, 2007). In the case of the Kilombero Valley, however, the expansion of rice production was established by the integration of the indigenous cultivation system and some external technologies, such as tractors and trucks, without any major innovations to the system.

In this study, I clarify the development process in the rice production area associated with the ecological environment of the Kilombero Valley and the people's responses to economic liberalisation. Moreover, by analysing the factors used to establish the new farming system, I evaluate the case of the Kilombero Valley as a new pattern of endogenous development in a rural area after economic liberalisation.

OVERVIEW OF THE STUDY AREA

The Kilombero Valley, part of the Rufiji Basin of southern Tanzania, is located in the Ulanga and Kilombero Districts, Morogoro Region (Figs. 1 & 2). The Kilombero Valley lies at the foot of the Great Escarpment of East

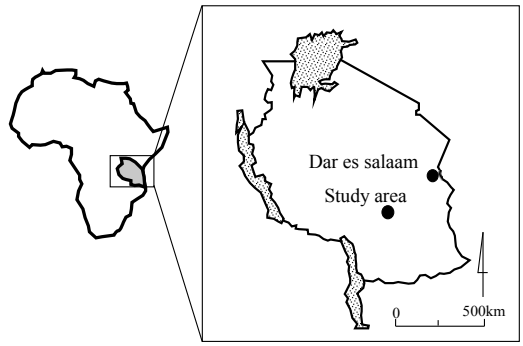

Fig. 1. Study area

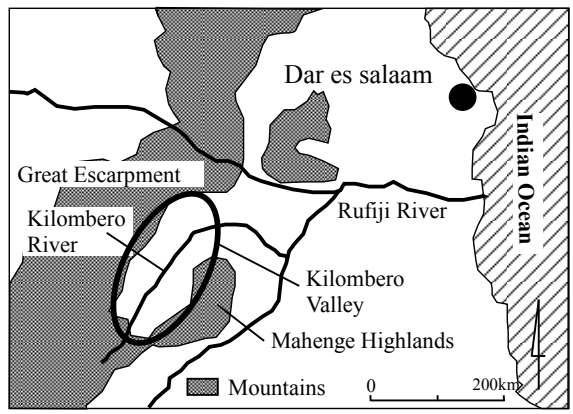

Fig. 2. The Kilombero Valley

Africa in the southern half of Tanzania, about 300 km from the coast (Jatzold & Baum, 1968). With a total length of 250 km and width of up to 65 km, it covers an area of about 11,600 km^2 (including the marginal hills). The Valley is roughly divided into inner and outer valleys: the inner valley is the actual basin, and the outer valley contains marginal strips and hills (Baum, 1968). The elevation of the inner valley is about 300 m above sea level, and the climate is hot and humid throughout the year. A high humid monsoon from the Indian Ocean causes abundant rains on the windward side of the Escarpment; the annual precipitation in the Kilombero Basin is between 1,000 and 2,000 mm from November to April.

The Kilombero River is flooded for many months during the rainy season by the rainwater gathered from the large catchment because the river has a bottle-neck at its lower reaches. A large floodplain has developed on both sides of the river. Although Jatzold & Baum (1968) divided the Kilombero Valley into eight subdivisions based on physiography and vegetation, in this paper I classified the research site, the southern part of the Kilombero Valley, into three agro-ecological zones: the braided river zone, the alluvial fan zone and the marginal *miombo* woodland zone.

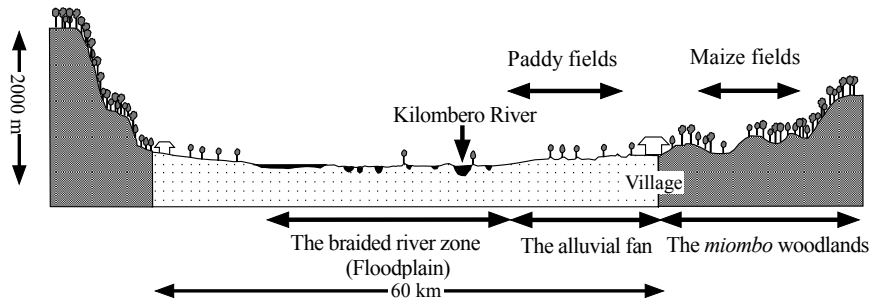

Fig. 3. Typical profile of the Kilombero Valley

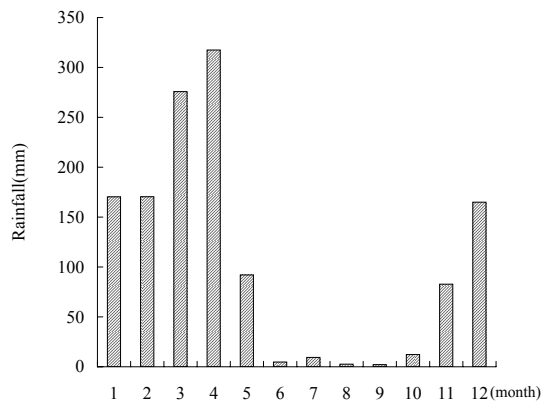

Fig. 4. Annual rainfall pattern in the alluvial fan zone

Fig. 3 shows a typical profile of the Kilombero Valley. The main streams of the Kilombero River lie in the centre of the valley and form braided streams in the riverside (the braided river zone). This zone is mainly covered with tall grasses such as elephant grass (*Penisetum purpureum*), guinea grass (*Panicum maximum*), *Hyparrhenia* spp. and reed (*Phragmites mauritianus*), but no trees occur due to the long-term flooding.

Many tributaries flow into the floodplain from the Mahenge Highlands located in the south of the valley and have deposited sediments in alluvial fans at the margin of the floodplain. The floodwater of the main stream does not enter the alluvial fans; thus, some trees such as borassus palm, *Ficus* spp. and sausage tree (*Kigelia africana*) appear on anthills scattered over the alluvial fans, which are covered with *Hyparrhenia* spp. In the alluvial fan zone, much rain falls toward the end of the rainy season, in March and April (Fig. 4). The rain sometimes causes temporary overflows of the tributaries, and relatively narrow areas along the tributaries are flooded for several days. Paddy rice is mainly cultivated in the alluvial fan zone, depending on the short-term overflows of the tributaries.

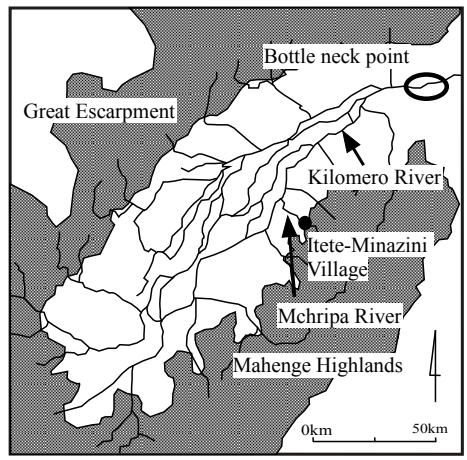

Fig. 5. Location of Itete-Minazini Village

The southern edge of the Kilombero Plain is edged by *miombo* woodlands, mainly consisting of *Brachystegia* spp., at the foot of the Mahenge Highlands. Villages are located along a road that runs along the transition between the plain and hilly woodlands. The people cultivate maize in semi-permanent fields created in the *miombo* woodlands.

I conducted fieldwork from September 2003 to August 2004 and from September 2005 to October 2006 in Itete-Minazini Village, Mtimbira Division, Ulanga District, located on the hillside edge of the alluvial fan zone (Fig. 5). This village comprises a population of about 7,000 in 1,200 households. Major ethnic groups residing in the village are the Pogoro, Ndamba, Ngindo, Ngoni and Sukuma. Most of the villagers cultivate rice in the alluvial fans and maize in the hills. In this paper, I focus on their livelihoods. Only the Sukuma live in the grasslands of the plain as agro-pastoralists.

SUBSISTENCE AND FLOODS IN ITETE-MINAZINI VILLAGE

I. Subsistence Activities

Rice (*Oryza sativa*) and maize (*Zea mays*) cultivation are the main livelihoods in Itete-Minazini. A household survey of 50 randomly sampled households in the village showed that rice and maize are grown by 100 and 95% of households, respectively. The average area of paddy and maize fields per household is approximately 1.2 and 0.4 ha, respectively. Families also grow cassava (*Manihot esculenta*) in kitchen gardens as an emergent crop and usually use it as a leafy vegetable. Only a few okra (*Abelmoschus esculentus*) and pumpkin (*Cucurbita maxima*) plants are grown on anthills near the paddy fields. Except

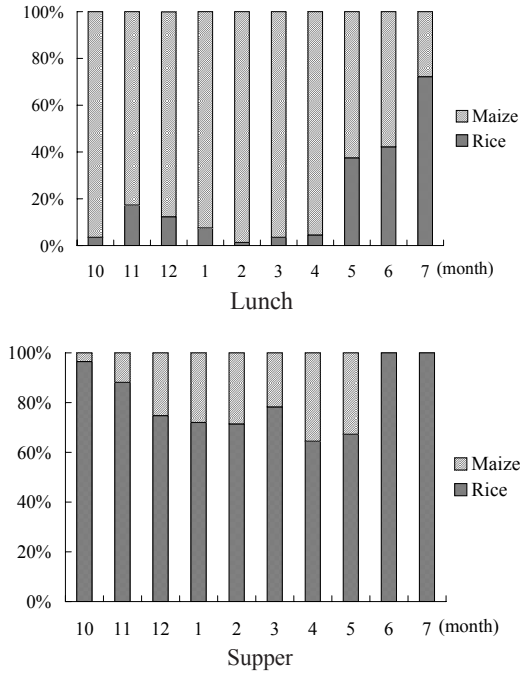

Fig. 6. Usage frequency of staple foods for meals

for the Sukuma, villagers do not customarily raise any livestock, probably because they traditionally depended on bush meat obtained from the mountains and floodplains. Only one household within the 50 sampled households kept goats, and 43% of households kept chickens (on average 3.6 chickens/household). Fig. 6 shows the frequency of materials used as staple foods for meals each month; maize and rice are staple foods for lunch and supper, respectively. Thus, villagers supply their staple subsistence foods by themselves and then purchase most of their other food materials.

II. Cropping Calendar

Fig. 7 shows the cropping calendar of Itete-Minazini. In November, before the rains commence, the villagers begin to prepare the upland fields on the mountains and sow maize seeds immediately after the rains. Due to the early preparation of the upland fields, rice and maize do not compete for cultivation labour. With adequate moisture in the paddy fields, the villagers begin to plow with tractors and broadcast rice seeds. In some areas of Tanzania, paddy fields are surrounded by ridges for water harvesting. However, in the alluvial fans in the marginal areas of the Kilombero Valley, the ridging technique is not used because surface water easily leaks underground due to a deep sandy soil layer. Plowing must occur during the early rainy season. Weeding occurs throughout the growing season. In the case of broadcasting seeding, weeding is particularly

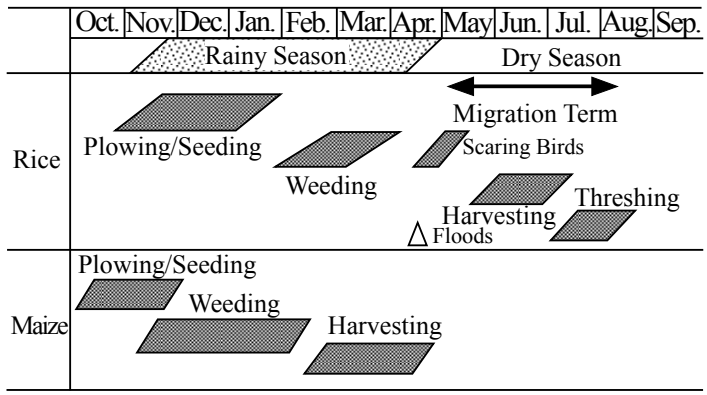

Fig. 7. Clopping calender of Itete-Minazini

important in the early stages of growth. Weeding requires much time, leading many farmers to use herbicides such as 2-4 D. Farmers begin harvesting ripe maize in early March and continue until May. At the end of the rainy season, the rain becomes heavier but more irregular and rice plants are often exposed to a soil water deficit, although in this season rice plants are in the booting stage and require high soil moisture for heading. A heavy rain often causes overflows in the tributaries, and the paddy fields arranged along the tributaries can be flooded for several days. The flooding of tributaries occurs occasionally in the late rainy season. Rice plants supplied with water can head immediately and ripen using soil moisture toward the dry season. The floodwater is remarkably effective for rice growing; the yield strongly depends on the timing and scale of flooding. Therefore, the cropping system and selection of rice variety are determined by flooding.

After rice heading, the farmers must constantly deter wild birds throughout the ripening stage. Harvesting and threshing follow. The harvested rice plants are gathered and threshed with sticks. Threshing is the hardest work in rice cultivation, and farmers usually employ wage labourers. After threshing, the farmers hire trucks to carry rice bags from the paddy fields to their homesteads in the village. For harvesting and threshing, adults migrate to the paddy fields with all their necessities and live in small huts (*lingo*) built on anthills, for 2 or 3 months until all of the work is completed. Because the paddy fields are remote, children remain in the village to attend school and live by themselves during this time.

The rice cropping system in this area is characterised by broadcasting, flooding and use of tractors and trucks. The farmers have integrated modern agricultural technologies into their indigenous cultivation system, which depends on the ecological environment, especially floods and topography.

EXPANSION AND DISTANCING OF PADDY FIELDS

In 1983, the Tanzanian government created the National Agricultural Policy, aimed at raising the self-sufficiency rate of major staple foods through market improvement, introduction of new agricultural technologies and creation of new fields (Mlambiti, 1992). In the following year, the "National Food Strategy Development" plan was publicized, including nutritional improvement and the construction of infrastructure supporting food distribution (Isinika et al., 2003). Without implementing the policy, however, in 1986 the government accepted the SAP supervised by IMF and the World Bank; African socialism was shifting to capitalism. After the SAP, the government gradually relaxed regulations concerning food marketing. In 1991, the government abolished the marketing board section of the NMC, which had monopolised food trading, and the domestic food market became fully controlled by private traders. Increasing food demand in growing urban populations advanced commercial activities by private traders in rural areas. In contrast, medical and educational services provided by the government were curtailed in the process of the economic liberalisation. Villagers in rural areas also became deeply involved in the money economy. Thus, commercial farming spread throughout Tanzania.

In sub-Saharan Africa, rice consumption increased by 5.3% from 1995 to 2001, while the production increased by only about 2% during that period (Africa Rice Center, 2006). The increase in urban populations probably increased rice consumption. Since the late 1990s, the Tanzanian government has recommended rice cultivation for cash generation and has accelerated the activity of private traders in rural areas. Consequently, after economic liberalisation, production rapidly increased as rice became an important cash crop in Tanzania, especially in regions with large marshlands or swamps (Isinika et al., 2003).

In the Kilombero Valley, people had developed rice cultivation system by the mid-19th century. The tractor, which was probably introduced by missionaries or Indian cotton merchants, was already used in the Kilombero Valley in 1968 (Jatzold & Baum, 1968). Before the tractor was introduced, farmers had cultivated paddy fields by hand hoeing. Tractor cultivation gradually spread, and currently almost all farmers use tractors. The traditional settlements scattered in the *miombo* woodlands and plain grasslands were forced to gather into new villages along the road during villagisation in the mid-1970s. The compulsory settlement policy was curtailed within several years, but people did not return to their native settlements and the population in villages has grown.

Before economic liberalisation, maize was not only a staple food but also a source of income in the Kilombero Valley, and rice was cultivated around villages as a crop for home consumption. It was difficult for the Kilombero Valley farmers to establish income generation because maize and rice cultivation required much labour. After economic liberalisation, farmers expanded rice cultivation for income generation. In Itete-Minazini, however, there were some problems with increasing rice production. First, the increasing population led to a lack of paddy fields. Second, old paddy fields were less productive due to a

change in the direction of natural run-off and increased drying. Therefore, farmers had to search for solutions to maintain rice production.

As mentioned above, rice cultivation on alluvial fans depends on the floods of tributaries. For farmers to improve rice productivity in old paddy fields, it is necessary to control the ecological environment, especially the floods of the tributary. In 1961, the Food and Agriculture Organisation (FAO) examined the construction of modern irrigation systems but found it difficult to control floods in this area, where the rainfall pattern and flood level are very irregular; consequently, the irrigation plan was suspended (Jatzold & Baum, 1968).

The Sukuma people, who began migrating into the Kilombero Valley in the mid 1980s, also cultivated rice. Their cultivation method differed from that of native villagers of this area. The Sukuma do not use flooding areas along tributaries for their paddy fields; instead, they use natural swamps scattered in open spaces and cultivate by ox plowing. They sometimes enclose a field with ridges for water harvesting and then transplant rice seedlings. They can freely use the fertile swamps where heavy clay sediments are deposited because the native villagers never use the swamps.

The technique of enclosing paddy fields with ridges is not suitable for rice cultivation alongside tributaries because the impounded water easily leaks through the deep sandy soil layer. The Sukuma occupied almost all swamps around the village by the early 1990s. As a result, native villagers had no way to maintain their rice production except by expanding paddy fields along the flooded tributary.

By 1985, the villagers of Itete-Minazini cultivated rice in flooding areas along the Mchripa River and in other grasslands with floodwater, about 2–3 km away from the village. As noted before, the production of rice decreased because the old paddy fields around the village dried up. The villagers abandoned the fields and exploited new fields in 1986, downstream along the Mchiripa River, about 8 km away from the village. In 1994, they expanded their fields further downstream of the areas opened in 1986, about 10 km away from the village. With a third expansion in 2003, the paddy fields reached the floodplain of the Kilombero River, more than 15 km from the village (Fig. 8).

These intermittent expansions of paddy fields are related to the rice cultivation system. In this area, because farmers other than the Sukuma depend on tractor cultivation, they cannot cultivate rice in remote and large paddy fields without agreements with tractor owners. In other words, decision-making by tractor owners enabled the expansion of paddy fields in Itete-Minazini. According to the customary land tenure system in this area, an exploiter is granted ownership by opening unused lands. If a farmer convinces a tractor owner to plow grassland with the tractor, the farmer acquires ownership of the new field. Therefore, many farmers follow a tractor owner when he agrees to expand a rice cultivation zone.

Before 1986, when the paddy fields were small and near the village, rice growers could bring the product from the fields to their homesteads by themselves. Now, however, the average size of a paddy is 1.2 ha, and the average

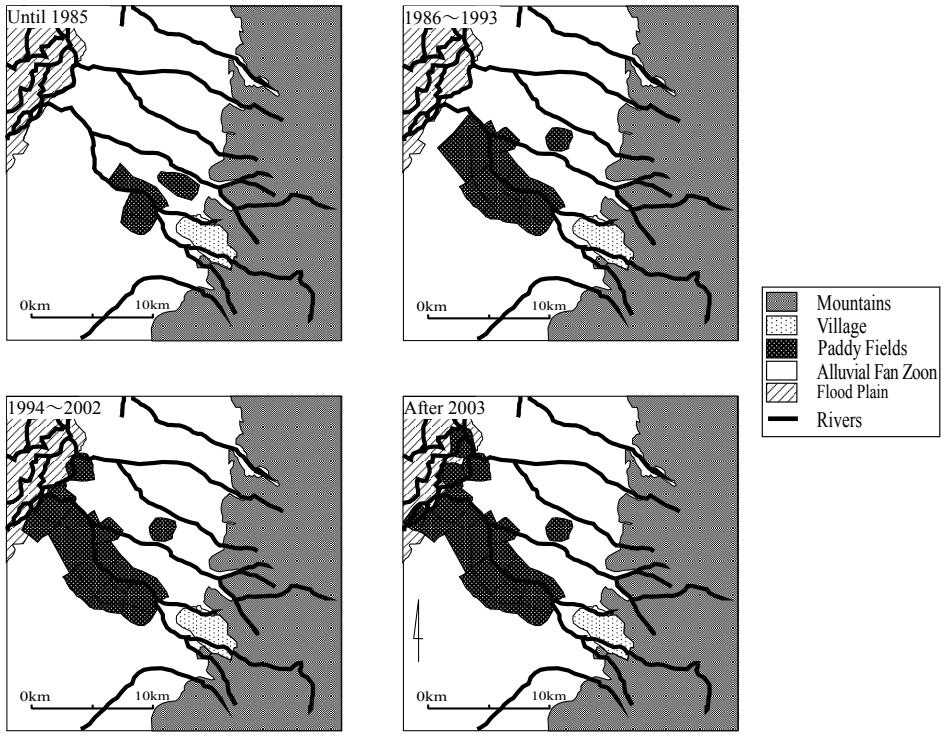

Fig. 8. Location and creation year of paddy fields

rice yield per hectare is approximately 3.5–4.0 tons (2005/06); thus, the average yield per household is approximately 4–5 tons. Therefore, trucks are necessary to transport the harvested rice. The interaction between the expansion of rice cultivation and the activation of rice marketing attracted many trucks to Itete-Minazini and resulted in the expansion of paddy fields in more remote areas.

The expansion of rice cultivation is also related to the subsistence system. In this area, many birds such as the red-billed firefinch (*Logonostica senegala*), red-cheeked cordon bleu (*Uraeginthus bengalus*) and southern cordon bleu (*U. angolensis*) frequently forage on ripening rice grains. Farmers must scare birds away from the rice heads. Because these birds forage from dawn to dusk, during the ripening season the farmers migrate to small huts built in the paddy fields and live there for several months until all of the work in paddy fields has been completed. They have maintained their traditional lifestyle, including migration to the fields for rice cultivation. I assume that this custom has also made it easier to adapt the current cultivation system in more remote paddy fields.

Furthermore, in this area, villagers traditionally kept very few livestock and cultivated only a few vegetables because they acquired additional food by hunting, fishing and gathering in the vast woodlands and grasslands. I hypothesise

that having no livestock or vegetable gardens made the villagers flexible, which was advantageous for concentrating on staple food cultivation. Today, it is difficult to obtain sufficient bush meat or fish because hunting and fishing require licences. Moreover, villagers cannot afford to grow any vegetables because they spend so much time cultivating rice in more remote areas. However, in the 1990s, farmers in other villages began to migrate into the valley to cultivate vegetables. Currently, seven farmers grow vegetables in the village and supply them to rice growers. Thus, this division of labour also contributes to the maintenance of the remote rice cultivation system.

HOUSEHOLD ECONOMY OF RICE GROWERS

The expansion of rice cultivation to remote areas was supported by various internal and external factors. As rice is a staple food and cash crop in this area, rice growers produce four times the amount required for self-consumption and maintain their household economy by selling the surplus. Tables 1 & 2 show the gross profits, production costs and net profits with a breakdown of expenses, on average, of three households. As the villagers do not usually sell maize, the gross profits are gained from rice. The gross profits, which are almost equal to the lowest annual salary of a Tanzanian official, is higher than the general income of farmers in rural areas. However, the expansion of rice cultivation increased the gross profits as well as the expenses; production costs, such as hiring a tractor and truck and purchasing herbicide, account for about 25% of the gross profits, and food accounts for about 60% of the net profits. Thus, the surplus income is not large.

Table 3 shows the timing of rice sales and the reasons for selling in three households in Itete-Minizini. The growers can sell a small amount of rice throughout the year. Two households sold rice in July to hire trucks for product transport and three households sold in October to hire tractors. Families can sell rice whenever they need cash for daily necessities, school and medical fees, or ceremonial occasions. The free access marketing reflects the current short supply of rice in the market and also indicates the advantage of major production areas where a trader can collect a large amount of rice at once from many growers, even if each farmer sells only a small amount.

One of the reasons that farmers frequently sell a small amount of rice is related to the annual fluctuation of rice prices. Fig. 9 shows the change in the price of rice between July 2005 and June 2006 in Itete-Minazini. The price was lowest just after harvesting in July and did not change through December, but rose rapidly after January, peaked from March to May (before harvesting) and dropped sharply after harvesting. The steep price increase relates to the annual rainfall pattern in Tanzania; rain usually begins in November or December. To sell rice at a higher price, farmers must store it in their house even during the rainy season. Rice packed in 120 kg nylon-net bags is usually kept in a storeroom.

In rural areas of Tanzania, however, only about 30% of houses have gal-

Table 1. Gross income of household

Gross profits	441,035
Production costs	101,250
Net profits	339,785

(Tsh)
1$=about 1,000 Tsh
Average of 3 households

Table 2. Household expenses

Food	230,000
Milling/Polishing	23,606
Others (Including savings and investments)	86,179
Total	339,785

(Tsh)
1$=about 1,000 Tsh
Average of 3 households

Table 3. Timing, reason and amount of rice sold

Farmer \ Month		7	8	9	10	11	12	1	2	3	4	5	6
A	Amounts (kg)	480		1,560	600	240		480		480	120		
	Reason	Truck, Daily life		School, Daily life	Tractor	Medical treatment		Funeral		Weeding, Daily life	Childbirth		
B	Amounts (kg)	360			480	120	840	240		360			
	Reason	Daily life			Tractor	Medical treatment	Daily life	Funeral		Daily life, Savings			
C	Amounts (kg)	600			600		720			240			
	Reason	Truck, Daily life			Tractor		Daily life			Daily life, Savings			

Data collected in 2005–2006
Amounts are weights of husked rice

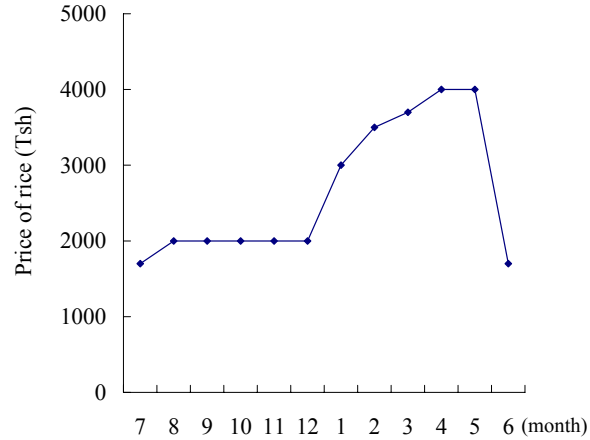

Fig. 9. Fluctuation in rice prices

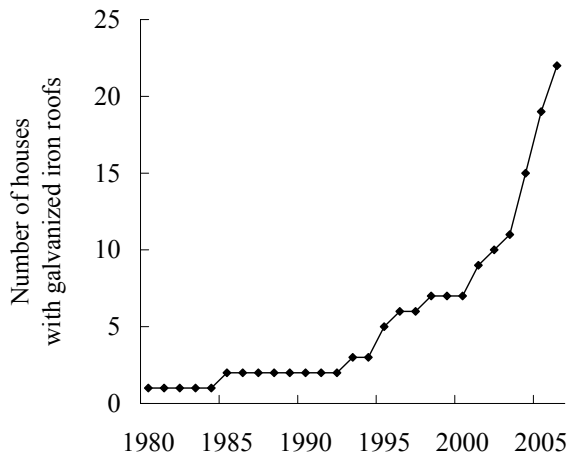

Fig. 10. Number of houses with a galvanised iron roofs

vanised iron roofs; the remaining 70% are still roofed with straw (National Bureau of Statistics, 2002). If rice gets wet from a leaky roof, the price and quality decreases. In the worst case, if the rice germinates, its commercial value is completely lost. Rice growers therefore tend to sell their entire harvest by the beginning of the rainy season. As a result, rice becomes scarce as the rainy season advances and the price rises after January. Therefore, many farmers in the Kilombero Valley wish to build houses with a galvanised iron roof to safely store their product. As indicated in Fig. 10, the number of houses with a galvanised iron roof began to increase early in the 1990s and rapidly increased after 2000.

Thus, the household economy of rice growers in this area is characterised by high production, as well as high production and food costs. Although the

surplus income is not large, farmers are investing it in assets such as bricks or galvanised iron roofs that enable them to store rice safely, even during the rainy season. Farmers attempt to cope with the socio-economic changes in Tanzania through monetary management. However, the current situation is such that even farmers who build a house with a galvanised iron roof must nevertheless sell most of the stored rice during the dry season, due to production costs and the need for money for subsistence, and so far the investment does not pay off.

CONCLUSIONS

Through studies of the development process of green gram production areas in Myanmar, Okamoto (2003) demonstrated the importance of establishing a cash crop production system while maintaining the subsistence system, preparing capital for the introduction of cash crops, raising productivity of cash crops and establishing a market. In the case of rice cultivation in the Kilombero Valley, rice is a cash crop as well as a staple food crop. If rice growers produce a surplus, they can sell it and earn an income. At this time, they need no capital or risks to create a new income. Furthermore, the indigenous rice cultivation system was established in a peculiar ecological environment, where land drains well and tributaries often flood in the late rainy season, and this has ensured stable yields. To produce a surplus, rice farmers have expanded paddy fields to remote areas using the indigenous cultivation system, with no innovation in the system. The simple expansion of fields based on their background, indigenous knowledge and technology may be a steady way to ensure subsistence, increase surplus and avoid several risks without capital.

In Tanzania, rice markets have developed since pre-economic liberalisation. Areas located in large wetlands have the potential to become income generators. The expansion of paddy fields increased rice production and the availability of tractors and trucks; consequently, a major rice production area has formed in the Kilombero Valley under the liberalising economy.

Tsurumi (1996) emphasised that the solutions to issues faced by rural peoples should be found within their indigenous culture to create endogenous development. Recently, the Mbozi District in the Mbeya Region of southern Tanzania developed a major rice production area. Kanda (2006) and Shimomura (2007), who surveyed processes of the spreading of rice cultivation in the district, found that some external technologies were introduced to societies and then in the process spread to the farming systems. New cultivation systems and technologies have been created for coping with the liberalised economy. They concluded that the innovation processes of indigenous cultivators, which were induced by an external impetus, may represent a case of endogenous development in Africa.

In the Kilombero Valley, the internal cultivation system depended on the ecological environment, and external technologies such as tractors and trucks were integrated to expand rice cultivation. However, a substantial difference between

the two cases is that there was no technological innovation in the Kilombero Valley, and the current cultivation system was caused by activating external factors. This process can also be regarded as a type of endogenous development in Africa.

Finally, forecasting the future situation in the Kilombero Valley, rice cultivation is not sustainable because paddy fields have already reached the floodplain of the Kilombero River and there is no additional land suitable for rice cultivation. Moreover, the demarcation of the Kilombero Game Controlled Area around the centre of the valley by the Tanzanian government, the enlargement of teak plantations by a foreign company and conflict with pastoralists will prevent expansion of paddy fields. The dissemination of galvanised iron roofs may be a coping strategy in fully saturated areas, and some farmers are attempting to modify their rice cultivation systems to exploit new arable land. In the near future, further development may occur through an interaction between internal and external factors.

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