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# THE TRADITIONAL AGROSILVIPASTORAL COMPLEX SYSTEM IN THE KILIMANJARO REGION, AND ITS IMPLICATIONS FOR THE JAPANESE-ASSISTED LOWER MOSHI IRRIGATION PROJECT

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ABSTRACT There are many farming systems in the Kilimanjaro Region of Tanzania. This paper examines two farming systems: the traditional farming of the Chagga people on the slopes of Mt. Kilimanjaro, and the modern paddy farming introduced by Japanese foreign aid.

The Chagga practice intensive land use by intercropping coffee and banana. They also combine farming, forestry and livestock in a sophisticated homestead farm, the "kihamba," which I call an "agrosilvipastoral complex" system.

Japanese style modern paddy farming started from 1985 in the semi-arid lower zone. Its economic performance varies greatly among farmers.

It is thus important to grasp the significance of, and limits to, both traditional and modern farming in this area.

Key Words: Farming systems research; the Chagga; Agrosilvipastoral complex; Paddy farming; Kilimanjaro Project in Tanzania.

## INTRODUCTION

There are several farming systems in the Kilimanjaro Region. In this paper I will focus on the traditional "agrosilvipastoral complex" practiced by the Chagga people on the slopes of Mt. Kilimanjaro, to assess the potential and limitation for the modern paddy irrigation farming in Lower Moshi.

The food shortage among many Sub-Saharan countries in the middle of 1980s was so severe that Sub-Saharan Africa was called the "starvation continent."

Therefore, the role of agriculture is more and more important, and many developed countries extended Overseas Development Aid (ODA) to African agriculture. The Japanese government has concentrated its assistance to Tanzania and Kenya (The Ministry of Foreign Affairs of Japan, 1990). Within Tanzania, the Kilimanjaro Region is the major area of Japan's ODA to agricultural projects. One has been the Lower Moshi Irrigation Project.

Currently in Japan, criticism of ODA as regards to its philosophy and significance has been voiced (Sumi, 1989). One criticism is the lack of the consideration for indigenous traditions and specific environments of the countries to which Japan gives aid.

Although ODA fundamentally intends to amiliorate the underdevelopment of agriculture, in the short run, it may not be very successful. One reason is the gap be-

tween the structure of agriculture as a whole in the targeted country and the ODA-introduced technology.

I approach this problem by comparing the traditional agrosilvipastoral complex and the modern paddy farming in the Lower Moshi area. This paper is based on field research mainly involving data collection from various institutions and interviews with farmers. Interviews were conducted in Maua village (20 persons) on the slopes of Mt. Kilimanjaro and in Chekereni (25 persons) and Mabogini (15 persons) villages in Lower Moshi. The study was carried out intermittently from 1989 to 1992.(1)

## OUTLINE OF THE KILIMANJARO ZONE

The Kilimanjaro Region consists of the Kilimanjaro zone in the north and the Pare zone in the south. This paper will focus on the former. The inhabited area is divided into three zones, according to the altitude and annual rainfall. The mountain slopes, ranging from about 1,100 m to 1,800 m, belong to the humid zone with annual rainfall of 1,250 mm and above. The foot hills of the mountain, 800 m to 1,100 m, is semi-humid, where rainfall ranges from 750 mm to 1,250 mm. The flat

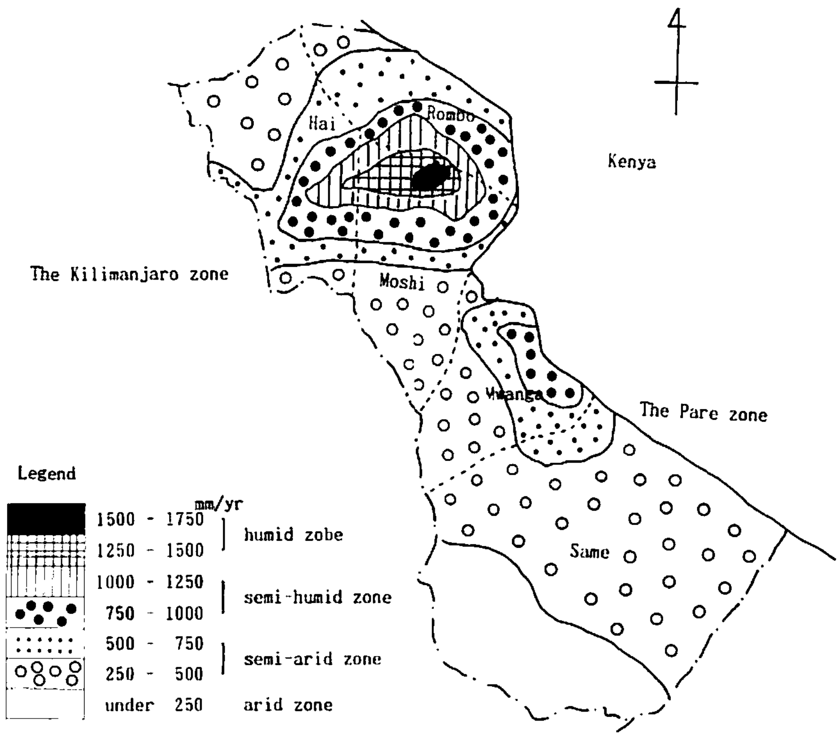


Fig. 1. Regional distribution of rainfall.
Source: Mlambiti, 1985.

plains, below 800 m, are semi-arid, where rainfall is less than 750 mm. At the edge of the Kilimanjaro zone, rainfall ranges from only 250 mm to 500 mm (Fig. 1).

One of the research areas, Maua village is within the semi-humid zone where annual rainfall is about 1,000 mm. The other research area is the so-called Lower Moshi near Moshi town, the administrative center of the Kilimanjaro Region, where rainfall is about 700 mm.

There are two rainfall peaks: a long rainy season which usually starts in March and ends in May, and a short rainy season between October and December. However, rainfall varies greatly according to the location of villages. From July to August in 1989, Moshi town had rain showers every morning, while there was no rain in Lower Moshi from the end of May. Production in rainfed agriculture, especially maize culture in the lower plains, is very unstable, as it is subject to this annual pattern of uncertain rainfall.

The soils around Mt. Kilimanjaro are generally alluvial or colluvial volcanic soils and said to have of considerable agricultural potential under irrigation (Mlambiti, 1985). Soil type is Ferruginous Tropical Soil, of which texture varies between clay loam, silt loam and coarse sand. This soil type is susceptible to erosion and so makes soil conservation important.

The Kilimanjaro zone, especially the mountain area, was settled early by the Chagga who tried to escape raiding by pastoralists (Allan, 1965). In the colonial period, coffee cultivation was introduced and supported a rapid population increase. According to Moore (1986), at the start of coffee cultivation, only 110,000 persons lived in the mountain area in 1900. But 28 years later, population increased to 289,000 persons, and coffee cultivation spread to 22,400 acres. The population continued to increase rapidly to about 476,000 in 1967, when about 33,500 acres were devoted to coffee.

Table 1. Supply and demand of food by Districts (1985/86) (tons).

| District | food | yield | amounts required | surplus |
|---|---|---|---|---|
| MOSHI urban | | — | 5,460 | −5,460 |
| MOSHI rural | maize | 46,374 | 23,393 | 22,981 |
| | rice | 6,399 | 7,209 | −810 |
| | banana | 322,800 | 335,560 | −12,760 |
| HAI | maize | 55,362 | 13,752 | 41,610 |
| | rice | 600 | 4,245 | −3,645 |
| | banana | 210,000 | 197,156 | 12,844 |
| ROMBO | maize | 12,649 | 12,224 | 425 |
| | rice | | 3,781 | −3,781 |
| | banana | 107,260 | 175,108 | −67,848 |
| MWANGA | maize | 4,090 | 5,775 | −1,685 |
| | rice | 495 | 1,778 | −1,283 |
| | banana | 66,240 | 82,827 | −16,587 |
| SAME | maize | 4,000 | 12,731 | −8,731 |
| | rice | 9,600 | 3,940 | 5,660 |
| | banana | 3,250 | 182,617 | −179,367 |

Source: Regional Agriculture Development Office, 1987.

Coffee cultivation fostered Moshi. From the colonial era, Moshi has been a trading center for agricultural products, for farmer-grown coffee and estate-grown sisal and sugar. Soon, there arose small industries and service activities related to agriculture, which included coffee curing, sugar refining, bottling soft drinks, flour milling and bars (Moore, 1986).

People seeking jobs have migrated from other regions to Moshi town. This situation has hastened social population growth rather than natural growth. In 1988 the population density of the Kilimanjaro Region was 83.3 persons per sq.km, which is the second highest after Dar es Salaam, where as the national population density remained at 25.6 persons per sq.km (Bureau of Statistics of Tanzania, 1988).

A large number of immigrants were supported by the region's ability to supply the necessary food. At present, the supply and demand of food is growing due to population increase. Table 1 demonstrates this situation as regards the major foodstuffs by each District in 1985/86, and can see that bananas were the most insufficient, followed by maize, while the shortage of rice was relatively small at the regional level.

The land use pattern is one major factor in a farming system (Fresco, 1986). Various farming systems were grouped into the following seven types(2) by land use patterns: (1) permanent upland farming with miscellaneous cereals, (2) shifting cultivation with grassland burning, (3) traditional paddy farming, (4) traditional agrosilvipastoral complex, (5) modern paddy farming, (6) modern agroforestry, (7) national estates of sisal, sugarcane and wheat.

Figure 2 shows general land use patterns in the Kilimanjaro Region. Types (1),

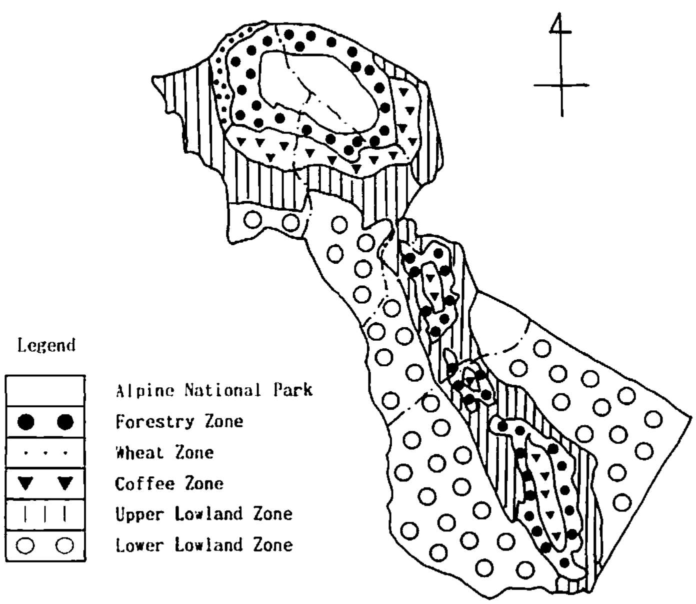


Fig. 2. Land use in the Kilimanjaro Region.
Source: Mlambiti, 1985.
Original source is compiled from RIDEP, Kilimanjaro.

(2) and (7) with the exception of wheat are generally seen in the upper lowland zone, while wheat estates are distributed on the west side of the Kilimanjaro area. In the forestry zone, type (6) is practiced with Food and Agriculture Organization (FAO) assistance, while type (5) mainly under Japan's ODA is carried out in Lower Moshi and in Mkomazi valley of Pare District, in the upper lowland zone. Type (4) is dominant in the coffee zone, while type (3) is restricted to the side of swamp mainly in Mkomazi valley.

In the following sections, types (4) and (5) are examined in detail.

## THE AGROSILVIPASTORAL COMPLEX ON THE SLOPES OF MT. KILIMANJARO

### I. "Kihamba" Farming as an Aspect of the "Agrosilvi-Complex"

The Chagga around Mt. Kilimanjaro practice a farming system which combines mixed cropping with forestry and live stock-raising (Fig. 3). I call this farming system, an agrosilvipastoral complex.

The Chagga depend on two kinds of farms for their livelihood. One is the "kihamba," and the other is the "shamba." The former is a kind of a homestead farm surrounding their houses, where the Chagga practice agrosilvipasture. The latter is a field which lies in the lower zone between 500 and 750 m, where mainly maize and sunflower are grown.

The "kihamba" basically belongs to the clan and is used within the area distributed according to the number of members in the extended family including the paternal kin. Although the farming area varies as time passes, in 1989, the median

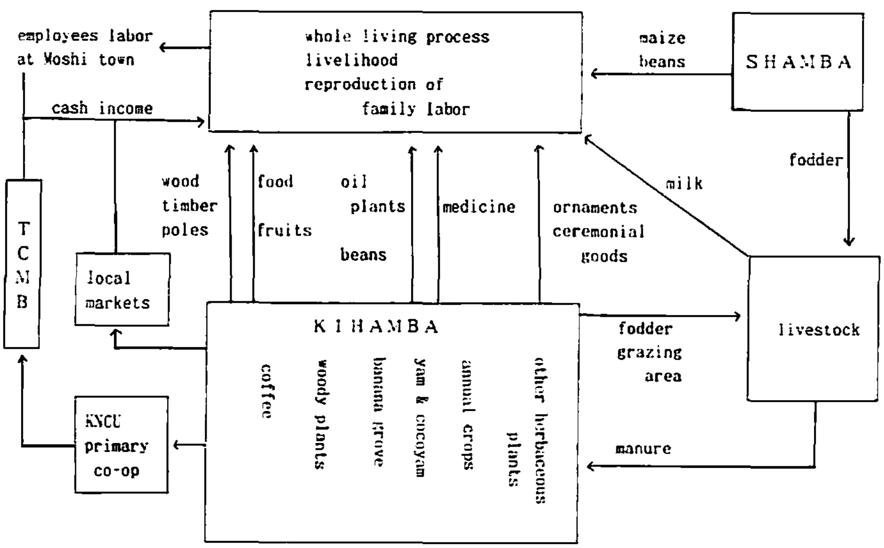


Fig. 3. Agrosilvipastoral complex method of living.

kihamba ranged from 0.53ha to 1.0 ha at Maua village. On the contrary, the "shamba" was exploited in relatively recent years, where the new land belonged to persons who exploited it, and this caused large differences in land ownership. The size of shamba per family ranged from 0.8 ha to 2.5 ha.

Agriculture on the slopes of Mt. Kilimanjaro was only understood as cropping of banana with coffee trees (Hickman & Dickins, 1969). However, such descriptions are insufficient to understand the farming system of this area as a whole. In particular, the significance of growing a combination of crops and plants as well as the interrelationship among farming, forestry and stock-raising has been disregarded by the researchers. Thus, I feel it is necessary to investigate the unique mode of production of the agrosilvipastoral complex, "kihamba."

In the "kihamba," many kinds of herbaceous and woody plants are either grown or semi-domesticated in the small plots. The villagers indicated to me that they planted up to 40 varieties. According to O'Kting'ati et al. (1984), the plants observed in the "kihamba" on the slopes of Mt. Kilimanjaro amounted to 42 families, and 111 species. Not every farmer grows them all, but the diversity of plant species in the "kihamba" is very large.

The mixed cropping of many plants is possible by planting crops of different heights. Vertical space is differentiated into five levels by species and height. The bottom layer on the surface is covered with beans, cocoyam, potatoes and a variety of leaf vegetables, such as "loshuci" and "nafu." The lower layers between 1 and 2.5 meters are filled with arabica coffee, traditional medicine trees, such as the "iwonu," and shrubs, such as "kweme." The middle layer is mainly banana trees, yam called "nduu" or "iko," fruit trees, such as avocado, and wood for fuel, such as "mduka." The top layer consists of rather large trees for fuel wood, and the highest are timber wood. I propose to call this spatial use the multi-storied sharing system.

Banana is the most important plant for the daily production of the family. It is one of the main staple foods, and made into local beer by mixing it with finger millet. The local brew has an important role in marriage and other social ceremonies. The seed of "kweme" is also important for cooking oil, and "bilingani" is often cooked together with beans, peas, cowpeas and fruits. Another component plant, "isale," seen everywhere, is a very important plant for the Chagga as a boundary marker, as a symbol to identify lineage and to warn non-members not to trespass on their land. No one will pass through the places where "isale" is grown without permission of a lineage member. Furthermore, "isale" is used as a medicine to care stomach aches.

Many component plants have multiple uses. For example, leaves of herbs and arbor plants are indispensable as fodder for livestock as well as food and medicine. Fodder for livestock tends to run short and leaves in the "kihamba" are seldom thrown away.

Therefore, the multi-storied sharing system supplies diversity not only among plants but also materials for living. This diversity ensures the self-sufficiency in food, clothes, fuel wood, medicine, and timber. In this complex, it is worthy to note, food crops and cash crops are well combined.

There are other advantages in this multi-storied sharing system. First, it is possi-

ble to utilize solar energy efficiently. Second, bananas and other tall trees provide shelter for coffee trees. Third, it helps to yield good arabica coffee by keeping adequate moisture and a mild climate (Fernandes et al., 1989). This also gives the people shelter from heat in the hot tropics.

This system is also advantageous for labor allocation. Beans and maize are annual seed crops, while tubers, stem vegetables, root vegetables and fruit trees are perenial crops with different periods of growth. The former needs to be cared for at every growing stage, requiring a specific pattern of labor allocation in a year, while the care for perenial crops is relatively less specified. Therefore, labor demand is distributed throughout the year in this system.

This multiple cropping system, of combining annuals and biennials with perenial herbs and arbor plants, enables farmers to produce the necessary living materials with the least labor input. This system is labor extensive despite using land intensively.

Generally, intensive land use requires intensive labor and a great deal of agricultural inputs. In the "kihamba" farming, however, labor extensiveness supplements intensive land use. This is made possible by the multi-storied sharing system, the multiple cropping system with non-seed crops, which multiply by vegetative propagation, and also by the traditional small-scale irrigation system, as well as good climate and soil.

Furrows have been developed to flow along contour lines. Administrative rights of the furrows system were based on ownership of canals and furrows constructed by communal or personal efforts. Allan (1965) noted that the remarkable water distribution system, formerly used for finger millet, was put to use for domestic needs and coffee pulping, and so "remnants of this organisation (Water Users Association, in effect) survive, but the responsibility for the water system is now largely in the hands of the modern Native Authority" (p. 166). In Maua village, water distribution and management, including maintenance of the furrows, are presently carried out by communal cooperation.

## II. "Kihamba" Farming as an Aspect of "Agrosilvipastoral" Complex

Most of the Chagga keep livestock, mainly cattle, goats and poultry. Cattle are fed in the hut or tethered outside the hut. But, occasionally, the animals graze out in a field or in a common space. Among the Chagga, cattle seem to occupy an important position in their value system. Above all, cattle are valued as the source of manure. Cattle supply enought milk for daily use, and the Chagga can also acquire cash through the sale of milk. Even presently, cattle are sometimes used as dowry, though the importance of this custom is dimishing.

The source of feed for the animals lies in both the "shamba" and the "kihamba." From the low semi-arid area "shamba," women collect annual grasses and herbs, or crop residues after harvesting, carrying big bundles of fodder and bedding weighing about 60–70 pounds for several kilometers to their village through the steep and sometimes slippery road. This work has been one of the heaviest in the women's labor budget, but now, a few persons and co-operatives own some trucks and tractors, available for transportation of heavy burdens at the cost of several

shillings. Although transportation has improved greatly, the supply of fodder remains women's work. However, sexual division of labor is rarely seen in other aspects of farming.

Fodder is carried up from the "shamba," but farmers are likely to run short of fodder. Therefore, the role of the "kihamba" is also important in keeping animals, especially because animals are usually stall-fed in the hut and grasses or grazing areas are insufficient. So the Chagga, for example, plant various kinds of forage crops, such as guatemala grass, *Tripsacum laxum*, and "torontoro," *Commelina latifolia*. And usually, all the remains of food crops and other plants are put to use. The Chagga cut down leaves of some trees and banana pseudostems, and use them as forage.

Livestock manure is spread over on the "kihamba." The Chagga have used manure traditionally (Dundas, 1924), while it is generally believed that use of manure is rare in Sub-Saharan countries, due to shifting cultivation with fire, in which soil fertility is mainly preserved from wood ashes and recovered after fallow. Housing livestock makes manure collection easy. By contrast, collecting manure from free grazing livestock is difficult.

One of the main problems of farming systems with intensive land use lies in the preservation of soil fertility. The spread of manure contributes greatly to the solution of this problem. The Chagga use manure over the entire surface of the "kihamba," especially at the base of banana groves and coffee trees. The leaves of bananas and other trees as well as remains of some crops are spread as well. This practice has mulching effects, to conserve soil moisture and control weeds on the fields.

As described above, the Chagga combine livestock raising with farming and forestry in a sophisticated way. This is the reason I call the farming system in the "kihamba," an "agrosilvipastoral" complex.

Compared with farming systems in Southeast Asia, the Chagga limit the interdependence between livestock and the other two sectors in this system to the exchange of manure and fodder, and lack the use of animal power, for example, ox-drawn plough. Therefore, the extent of agrosilvipastoral interdependence is less than in Asia. But it should be remembered that the main farming areas of the Chagga are located on steep slopes, while the Asian peoples using animal power live in the flat plains and practice paddy farming. While it is known that livestock raising and farming generally do not coexist in Sub-Saharan Africa, the "agrosilvipastoral" system by the Chagga stands out as a highly sophisticated, unique, and efficient system.

## III. The Agrosilvipastoral Complex in a Modernizing Society

There are other aspects of agrosilvipastoral complex to be considered.

The first is with regard to the commodity economy or cash economy. The cash economy has infiltrated subsistence societies through tax obligations, education costs, and desire for commodities such as radios, bicycles and so on. Coffee plays an important role in this problem. Recently, the international price of coffee has declined due to competition among coffee producing countries. Also, coffee diseases, such as coffee berry disease have spread in this region, such that the total yield of

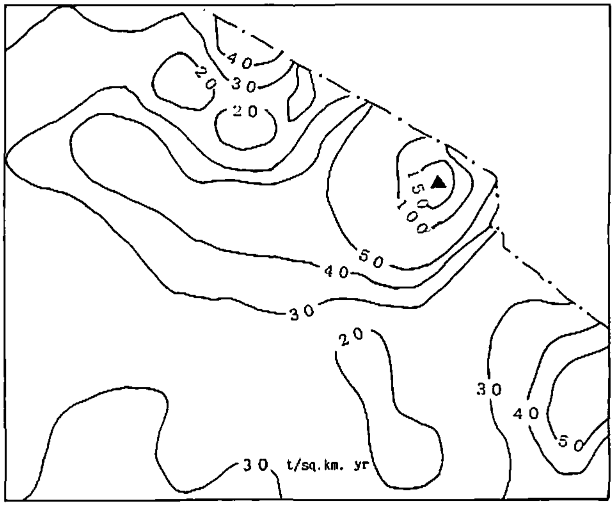


Fig. 4. Erosivity of the northern part of Tanzania.
Source: Fournier, 1974.

coffee has gradually decreased. In spite of this situation, the importance of coffee has not necessarily declined for the farmers in the Kilimanjaro zone. They earn a considerable part of cash income from coffee sold to the Tanzania Coffee Marketing Board through the Kilimanjaro Native Co-operative Union. On the other hand, the Chagga would not specialize in coffee monoculture. They balance adaptation to a cash economy and maintenance of a subsistence economy with the very sophisticated agrosilvipastoral complex. They can gain both a reasonable amount of money and necessary materials for daily life.

Secondly, it is very significant that the Chagga agrosilvipastoral complex includes beans and oil plants, in the context of nutrition, as sources of protein. The Chagga are able to guarantee a reasonable nourishment by the production of various subsistence crops.

Thirdly, there is the relationship between the agrosilvipastoral complex and the environment. Farming on the mountain slopes has negative consequences for the environment. Erosion is a severe problem, as measured by Fournier (1974), whose estimate of erosivity around Mt. Kilimanjaro reached more than 50 tons of soil per sq.km. a year, as much as more than 100 tons near the top (Fig. 4).

The agrosilvipastoral complex shows that the indigenous farming systems sometime incorporate anti-erosion measures. Multi-cropping and covering of the surface with mulch and manure are methods of erosion control. Moreover, guatemala grass planted intensively along the boundaries of the steep bluff plays an important role in soil conservation. *Gramineae*, including guatemala grass, with deep and thick root systems are efficiently preventing fertile soils from being eroded. Thus, guatemala grass can be regarded as an important device for soil conservation as well as a source of fodder for livestock. However, as guatemala grass originates from Latin America and still lacks a local name, it must have been intro-

duced recently.

Another component of the farming system in this area is the traditional furrow system. This acts as an important anti-erosion measure. Heavy rainfall in two rainy seasons could easily wash away topsoil down the steep slopes. However, the furrows are built as horizontally as possible along the contours, so that they prevent top soil from being carried away.

However, there are also some problems in the agrosilvipastoral complex. Highly intensive land use in the "kihamba" has already reached, so to speak, the equilibrium point. This equilibrium point is threatened by both external and internal factors. The external factors are the further penetration of a commodity economy and the depression of coffee prices caused by international trade. The internal factors are the high population growth, division of the "kihamba" into smaller plots by the customary system of inheritance, and the lack of new arable land.

## PRESENT PERFORMANCE OF PADDY FARMING IN THE LOWER MOSHI AREA

### I. Introduction

In the Kilimanjaro Region, it is estimated that about 28 percent of arable land, 45,100 ha, has been traditionally irrigated while the whole country's proportion of irrigated land is no more than 4 percent (JICA, 1987). This excludes irrigated paddy farming under Japanese assisatance. The high proportion of irrigation in the Kilimanjaro Region owes greatly to the traditional small irrigation system. However, in the Kilimanjaro Regional Development Plan, much larger-scale projects are anticipated, and the Lower Moshi Project (LMP), with 2,300 ha, and Ndungu Project in Mkomazi Valley, with 680 ha, are expected to play the role of pilot projects.

In the following sections I describe the characteristics, the present performance and the problems of the LMP, based on the field survey at Chekereni and Mabogini villages. Research consisted of interviews with farmers (25 at Chekereni and 15 at Mabogini, using a questionnaire) and the local staff and the Japanese experts of KADC and KADP. Villagers of Chekereni often had very low yield of maize some years before LMP. Mabogini farmers practiced intensive permanent farming, such as irrigated horticulture.

### II. A Short History of the LMP

In 1969, the Government of Tanzania started the Second Five-year Plan for the period 1969–74, which sought national development through the responsibility of each region based on decentralization coordinated by the Central Government. In 1970, the Government of Tanzania requested the Government of Japan to assist with the establishment of an integrated development plan for the Kilimanjaro Region. In response to this request, the Japan International Cooperation Agency (JICA) made a preliminary research from 1974, and submitted the Report on the

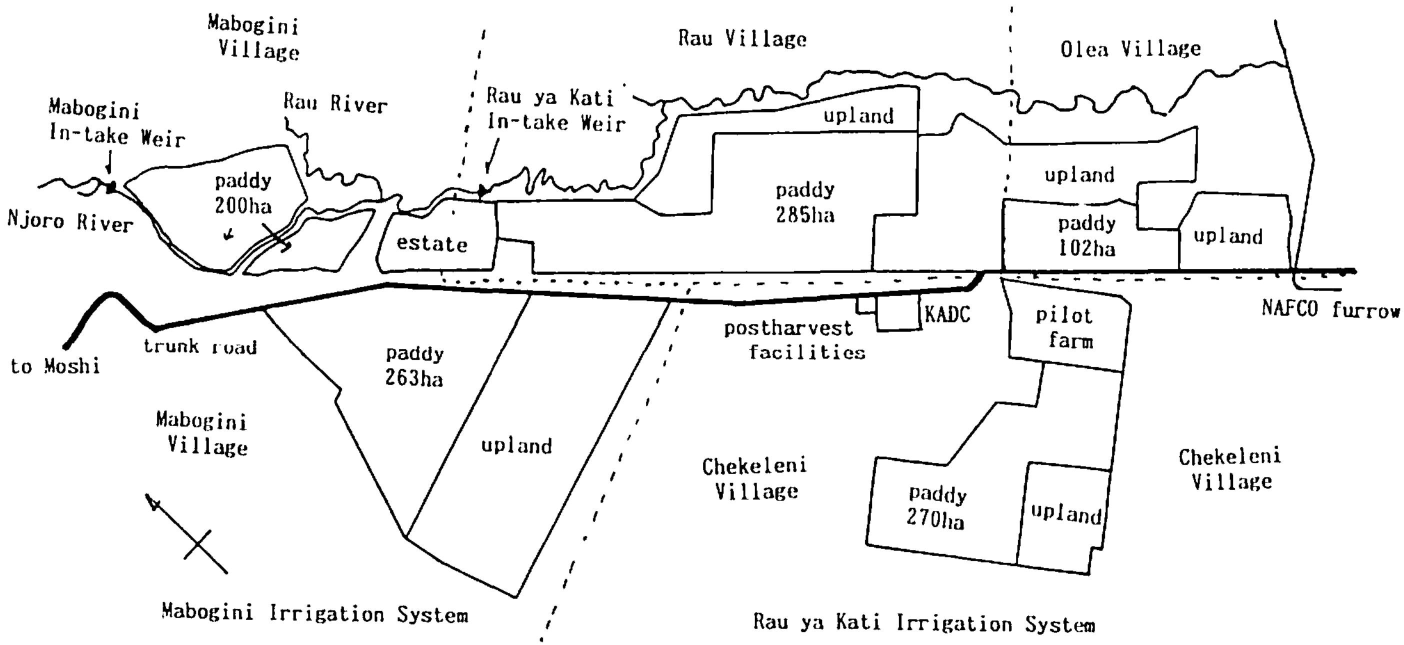


Fig. 5. Map of the Lower Moshi Project area.

Kilimanjaro Integrated Development Plan in 1977, which indicated a variety of possible projects with regard to agriculture, small-scale industry, water resources, and education.

In 1978, feasibility studies were carried out, and 38 projects were proposed. Both Governments agree on 6 high priority projects: (1) Lower Moshi Agricultural Development Project, (2) Mkomazi Valley Area Irrigation Project, (3) Development and Extension of Agricultural Technology, (4) Promotion of Agricultural Mechanization, (5) Establishment of Kilimanjaro Industrial Development Center (KIDC) and (6) Kilimanjaro Transmission and Distribution Network Project. In this year, both Governments signed the Records of Discussion (R/D), and construction of buildings, headworks, and canals started.

Kilimanjaro Agricultural Development Center (KADC) and KIDC were completed in 1981, under the Japanese Grant in Aid Program. KADC executes carries out technical training in agriculture for mostly extension workers. The following year, the R/D was extended to 1986 to preparate fields suited for paddy cultivation and to conduct agronomic studies at trial farms and pilot farms with guidance based on established technology. This period completed in 1986 was called the first phase.

The second phase started in 1986, when water began to be partially distributed, and lasted in 1991. Technical aid on paddy cultivation, mechanization and water management were promoted. The preparation of paddy fields and the farm infrastructure for irrigation and drainage networks were completed by 1987. At present, the main aim of Japan's assistance is to provide technical training of the local staff, and supervise machinery operation and maintenance.

## III. The Objectives and Features of the LMP

The LMP aims to stabilize food supply and to improve agricultural productivity through the diffusion of irrigated cultivation into the tropical semi-arid areas. Though irrigation for maize and beans was also intended at the beginning, this is not being carried out at present due to a water shortage.

The total area of the LMP is 2,300 ha, mainly divided into the paddy fields, (1,100 ha), and upland fields (1,050 ha) and the rest is a pilot farm and sugarcane estate (Fig. 5). Paddy fields basically consist of farms about 0.3 ha (30 m by 100 m), including irrigation and drainage canals. An OECF Loan from Japan was used for on-farm development and the construction of irrigation and drainage facilities. Technical guidance by Japanese experts, and promotion of mechanization with tractors and spare parts became possible with the Japanese Grant in Aid. The total amount of loan was 3,300 million yen with 1.5% interest. Grants for the establishment of KADC and KIDC reached 2,000 million yen. In addition, postharvest facilities and equipment including the most advanced rice milling machine were provided at the cost of 600 million yen in 1989. They are operated by only the local staff of the KNCU.

Paddy farming here has been operated, in a sense, in Japanese style, characterized by straight line transplanting, tractor cultivation, chemical fertilizer and pesticide application.

Agricultural chemicals are distributed through KNCU and primary co-operatives or branches of Tanzania Farmers Association. The supply is often not consistent due to late delivery. Furthermore, the price is too high for small farmers. Main chemical fertilizers are UREA and TSP, priced about TShs 1,000 and TShs 650 per bag respectively. Diazinon costs about TShs 700 per litre (1991). So small farmers cannot afford chemical fertilizers and pesticides in sufficient amounts as recommended. Tractorization has become possible with grants from various countries including Japan. As the soil is generally hard in the LMP area, the edges of rotary plough blades tend to wear out easily, and replacement is necessary. This make the problem of maintenance more severe.

Paddy farming in the LMP is characterized by "chemicalization" and "mechanization." These peculiar features of agricultural modernization improve productivity, especially labor productivity, and ameliorates food shortage. However, there is a wide gap between small farmers and such levels of modernization. In particular, it is difficult for them to match their traditional technology with modern ones because of a shortage of capital. This fact increases instability in food production.

Hybrid varieties are generally weak against pests or diseases, and so require a great deal of fertilizers and agricultural chemicals as well as the stable supply of enough water. Agricultural modernization is recommended for the hybrid rice varieties of IR54, IR20, IR36 and IR56 (Among the four varieties, IR54 is the most favored by small farmers because the rice in the husk falls off more easily com-

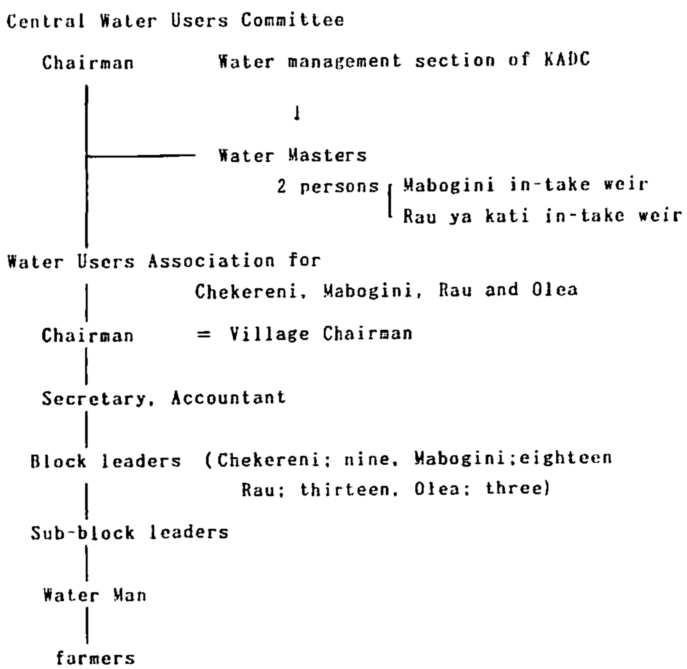


Fig. 6. Organization for water management.
Note: Based on interviews with KADC's staff.

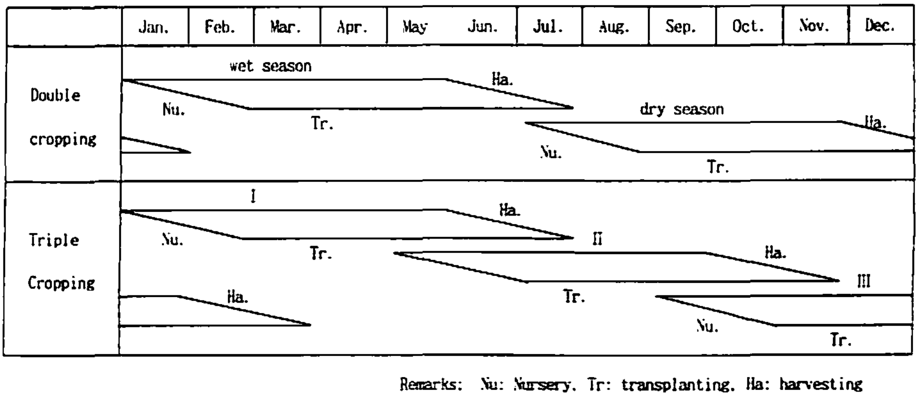


Fig. 7. Cropping pattern of paddy.
Source: Compiled from KADC.

pared to the other three varieties).

The Rau and Njoro Rivers serve as water sources for this area. Water is drawn in at two in-takes, Mabogini In-take and Rau-ya-kati In-take. It is noteworthy that the area does not depend on large-scale dams although the project area is very large. The management of water facilities and the water distribution are done by the Water Users Association (WUA), supported by KADC (Fig. 6). Block leaders collect water charges, and monitor the water distribution by waterman. As water tends to run short, the role of block leaders is very important.

Water shortage is becoming a severe problem. In the official explanation the water shortage is caused by the larger water requirement in depth than expectation. But there are more fundamental reasons. One reason is that the water balance was estimated on the basis of the water condition data not of the Kilimanjaro Region but of South East Asia. Another reason is that the irrigation and the drainage channels are separate systems. Drained water is not recycled despite the small rainfall. Furthermore, the expansion of paddy farming to the areas outside of the LMP causes competition for water.

Owing to water shortage, KADP changed the double cropping system to triple cropping in 1988, shown in Figure 7. With this, the total area of the fields cultivated for paddy reached as much as 1,500 ha. Each field is rotated, in other words, left dry for at least five months (Table 2). Drying up the paddy fields can suppress schistosomiasis. Even if one field is allocated to plant rice twice in a year, one cropping season ends in the following year.

## IV. The Economic Performance of the LMP

This is based on the yield estimation by quadrat sampling used by KADC in each harvesting season because farmers are likely to underestimate their yield.(3) Also income from paddy farming is used as one of the criteria to evaluate the performance for individual farmer, based on the interviews. Thus, Economic performance can be judged from the semi-micro and the micro levels. Average yield per paddy can

Table 2. Cultivated paddy field by Plots.

| block name | area (ha) | No. of plots | 1985 | 1986 | | 1987 | | 1988 | | | 1989 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | dry | wet | dry | wet | dry | I | II | III | I | II | III |
| · Mabogini Irrigation System | | | | | | | | | | | | | |
| MS 1-1 | 21.24 | 73 | ★ | | ★ | ★ | | | ★ | | | ★ | |
| MS 1-2 | 20.21 | 69 | | | ★ | ★ | | ★ | | | ★ | | ★ |
| MS 1-3 | 21.52 | 74 | | | ★ | ★ | | ★ | ★ | ★ | | ★ | |
| MS 2-1 | 20.80 | 72 | ★ | | ★ | ★ | | | ★ | | | ★ | |
| MS 2-2 | 27.31 | 92 | ★ | | ★ | ★ | | | | | | ★ | |
| MS 2-3 | 24.17 | 87 | ★ | | ★ | | ★ | | | ★ | | ★ | |
| MS 3-1 | 17.64 | 67 | | | ★ | ★ | | ★ | | | ★ | | ★ |
| MS 3-2 | 26.55 | 91 | | | ★ | | ★ | | ★ | ★ | | ★ | |
| MS 4-1 | 20.85 | 76 | | | ★ | ★ | | | ★ | | ★ | | ★ |
| MS 4-2 | 31.82 | 113 | | | ★ | | ★ | | | | | ★ | |
| MS 5-1 | 39.67 | 140 | | ★ | ★ | | ★ | | | ★ | | | ★ |
| MS 5-2 | 27.59 | 95 | | | ★ | ★ | | ★ | | | ★ | | ★ |
| MS 5-3 | 28.89 | 97 | | | ★ | ★ | | ★ | | | ★ | | |
| MS 6-1 | 32.07 | 119 | | | ★ | ★ | | ★ | | | ★ | | |
| MS 6-2 | 21.29 | 76 | | | ★ | ★ | | ★ | ★ | ★ | | ★ | |
| MS 6-3 | 11.80 | 44 | | | ★ | ★ | | | | | ★ | | ★ |
| MS 7-1 | 39.63 | 140 | | ★ | ★ | | | ★ | | | ★ | | ★ |
| MS 7-2 | 39.82 | 138 | | ★ | ★ | | | ★ | | ★ | | ★ | |
| sub-T. | 472.97 | 1663 | 93.52 | 119.12 | 472.97 | 271.21 | 122.31 | 248.66 | 133.82 | 173.12 | 198.68 | 234.62 | 177.39 |

**Table 2.** cont.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| · Rau-ya-kati Irrigation System | | | | | | | | | | | | | |
| RS 1-1 | 15.18 | 50 | | | | ★ | | ★ | | | ★ | | ★ |
| RS 1-2 | 28.82 | 98 | | | | ★ | | ★ | | ★ | | | ★ |
| RS 1-3 | 28.45 | 98 | | | | ★ | | | ★ | | | ★ | |
| RS 1-4 | 25.56 | 90 | | | | ★ | | | ★ | | ★ | | |
| RS 1-5 | 22.35 | 82 | | | | ★ | | | ★ | | ★ | | ★ |
| RS 1-6 | 22.43 | 80 | | | | ★ | | | ★ | | ★ | | |
| RS 1-7 | 22.55 | 83 | | | | | ★ | | | | ★ | ★ | ★ |
| RS 1-8 | 11.52 | 40 | | | | | ★ | | ★ | | | ★ | |
| RS 1-9 | 10.95 | 39 | | | | | ★ | | ★ | | | | ★ |
| RS 3-1 | 20.28 | 70 | | | | | | ★ | | ★ | | ★ | |
| RS 3-2 | 23.81 | 81 | | | | | | ★ | | ★ | | ★ | ★ |
| RS 3-3 | 28.93 | 98 | | | | | | ★ | | ★ | | | |
| RS 3-4 | 26.31 | 91 | | | | | | ★ | | | ★ | | ★ |
| RS 4-1 | 34.78 | 125 | | | | | ★ | | ★ | | ★ | | |
| RS 4-2 | 13.54 | 45 | | | | | ★ | | ★ | | ★ | | |
| RS 4-3 | 41.11 | 137 | | | | | ★ | | ★ | | ★ | ★ | ★ |
| RS 4-4 | 29.80 | 109 | | | | | ★ | | ★ | | | ★ | |
| RS 4-5 | 22.27 | 84 | | | | | ★ | | | ★ | | | ★ |
| RS 4-6 | 18.80 | 70 | | | | | ★ | | ★ | | ★ | | |
| RS 4-7 | 22.06 | 84 | | | | | | ★ | | | ★ | ★ | |
| RS 4-8 | 18.75 | 70 | | | | | | ★ | | ★ | | ★ | |
| RS 4-9 | 42.34 | 140 | | | | | ★ | | | ★ | | | |
| RS 8-2 | 37.25 | 126 | | | | | ★ | | ★ | | ★ | ★ | |
| RS 8-3 | 33.41 | 117 | | | | | ★ | | | ★ | | ★ | |
| RS 8-4 | 32.66 | 116 | | | | | ★ | | ★ | | | | |
| sub-T. | 633.91 | 2223 | | | | 142.79 | 350.98 | 184.14 | 329.20 | 218.61 | 301.92 | 282.89 | 235.91 |
| Total | 1106.88 | 3886 | 93.52 | 119.12 | 472.97 | 414.00 | 473.29 | 432.80 | 463.02 | 391.73 | 500.60 | 517.51 | 413.30 |

Source: Comiled from KADC.
Note: Marks of ★ show real cultivation in the applicable years.

Table 3. Change of paddy yield (tons, t/ha).

| | total yields | yearly average |
|---|---|---|
| 1985 (dry) | 655 | 7.0 |
| Total & yearly Ave. | 655 | 7.0 |
| 1986 (wet) | 834 | 7.0 |
| 1986 (dry) | 3,074 | 6.5 |
| Total & yearly Ave. | 3,908 | 6.6 |
| 1987 (wet) | 2,691 | 6.4 |
| 1987 (dry) | 3,076 | 6.5 |
| Total & yearly Ave. | 5,767 | 6.5 |
| 1988 (I) | 3,030 | 7.0 |
| 1988 (II) | 3,010 | 6.5 |
| 1988 (III) | 2,542 | 6.5 |
| Total & yearly Ave. | 8,582 | 6.3 |
| 1989 (I) | 3,224 | 6.5 |
| 1989 (II) | 3,105 | 6.0 |
| Total & yearly Ave. | 6,329 | 6.2 |

Source: Complied from KADC (Collected by Sakamoto, K.).

be used as a method to measure the performance of the LMP.

1. Average Yield of Paddy in the LMP area

The LMP has been praised highly, as "a healthy start to a constant and stable supply of major foodstuffs in the area" (The Daily News, May 21, 1987; Katsuki, 1989; and Yoshida, 1989).

One reason for this positive evaluation lies in the high paddy yield. Table 3 shows the change in average yield per ha of unhulled rice since the beginning of paddy farming. The planned target was only 2.5 tons, almost equal to the national average yield of 2.4 tons. However, even the lowest yield during the 5 year period was 6 tons. Production levels in the LMP area were much higher compared to the national average.

This high productivity is mainly due to the adoption of hybrid IR varieties and the effect of first cultivation on virgin land with enough nutrients. But the average yield level has been declining slowly. Whereas average yield reached 7 tons at the start of LMP, while it has been stagnant at 6 tons since the dry season of 1986. Why does yield level decline? The major reason may be the unsuitability of the modern technology to the socio-economic conditions in rural societies. In particular, problems regarding the adoption of hybrid IR varieties in the LMP area illustrate this most clearly.

Previous evidence and experiences from the third world countries have shown that hybrid IR varieties, the basis of the green revolution, do not always conform to the traditional farming.

First, the seeds of hybrid IR varieties are expensive. Small farmers in the LMP area prefer home seed-raising to buying from agencies. Home seed-raising results in low productivity due to the crossing of some undesirable varieties and the loss of

hybrid characteristics.

Second, hybrid IR varieties can perform well only with enough chemical fertilizers, much chemicals and good water management. In other words, hybrid IR varieties need a great deal of external inputs. As mentioned already, such inputs are likely to run short owing to their high cost, compared with farmer cash income, and the poor distribution system.

Thirdly, soil fertility is on the way to exhaustion. If efforts to maintain soil fertility are not taken seriously, paddy farming will be supported only by nutrients contained in water. In this case, the average yield may drop near to the national average. Therefore, it is strongly suggested to develop and encourage the use of organic fertilizers as in the agrosilvipastoral complex farming system.

## 2. Farm Income from Paddy Farming

Table 4 shows the average income from paddy farming per household by 5 categories of farming households in the LMP area. The 5 categories are the three landholder households of (1) a land-owner, (2) a farmer with employed agricultural laborers and (3) a family farm, and two tenant households of (4) a farmer with employed agricultural laborers and (5) one with no employee. The standard rent paid by tenant farmers was only Tshs 3,000 per plot (0.3 ha) at the beginning of the LMP, then it rose to between Tshs 20,000 and Tshs 25,000 in 1989.

Farm income from paddy farming differs very much according to sales to the official bodies or the open markets. Clearly, income from the open markets is larger than from the official bodies. Even the tenant farmer who depends on agricultural laborers made up to more than Tshs 30,000 from sales to the open markets.

**Table 4.** Farm income from paddy per plot by types farming (Tsh).

| types of farming | gross income | primary cost | surplus |
|---|---|---|---|
| land holders | | | |
| I pure land owner | 20,000 | — | 20,000 |
| II employed laborers | | | |
| case A | 75,000 | 24,195 | 50,805 |
| case B | 36,750 | 24,195 | 12,555 |
| III family farming | | | |
| case A | 75,000 | 7,045 | 67,955 |
| case B | 36,750 | 7,045 | 29,705 |
| tenant system | | | |
| IV employed laborers | | | |
| case A | 75,000 | 44,195 | 30,805 |
| case B | 36,750 | 44,195 | ▲7,445 |
| V family farming | | | |
| case A | 75,000 | 27,045 | 47,955 |
| case B | 36,750 | 27,045 | 9,705 |

Source: Based on interviews with farmers.
Note: Case A indicates sale to the open markets, where the price just after harvesting is Tshs 3,000, and case B indicates sale to the official bodies, the price of which is Tshs 1,470. Gross income is calculated on the assumption that yield of yearly average is 25 bags.

Although the family farm is the most profitable, the other farm types also have fairly high economic performance. The good performance is mainly sustained by four factors: (1) the fairly high yields of paddy, (2) the low tractor fee and the water charge below the depreciation cost, (3) the high price of paddy in the open market, and (4) the previous experience of traditional paddy farming.

How do farmers evaluate paddy farming? The villagers of Chekereni came to like the security of stable food production and the increased cash income by sale of surplus paddy, because their living standard rose very much. On the other hand, the villagers of Mabogini showed both affirmative and negative attitudes. The reasons for the former was the same in Chekereni. The negative opinions were due to the changes in dietary habits, especially the inconvenience of cooking rice, the fixed agricultural schedule, and the labor intensity in paddy farming.

These negative evaluations will influence the establishment of modern paddy farming, but will change through the solution of some of the problems. In fact, 91% of interviewed farmers recognized the advantages of paddy farming, whether their evaluations were affirmative or negative. This is because paddy farming is more profitable and stable than rainfed agriculture.

## CONCLUSION

This paper examined the significances and the problems of the agrosilvipastoral complex and the modern paddy farming. Factors such as natural conditions, historical background as well as some common socio-economic conditions, the penetration of the commodity economy, population pressure, need for food security and farming system sustenance seem to influence the present and future outcomes.

The agrosilvipastoral complex is characterized by diversity and sustainability, which originate from: (1) the organic combination of farming, forestry and livestock, (2) multi-storied plot system (3) maintenance of soil fertility by the use of manure and domestic composts, and (4) adoption of a variety of anti-erosion method.

However, the Chagga agrosilvipastoral complex seems to have reached an equilibrium point in resource distribution, owing to several internal and external factors. In particular, a severe land shortage was caused by population increase, resulting from the high population carrying capacity of the agrosilvipastoral complex itself. Hence, the Chagga migrated to the lowland, where the production level was very low and unstable.

Therefore, the modern paddy farming is expected to improve the living conditions of farmers, if irrigation is possible. Up to now, the LMP has achieved high economic performance and even provided the small farmers within and outside of the LMP area with labor opportunities as agricultural laborers. Owing to this fact, the LMP is accepted by most farmers, though some voice negative opinions. However, it is possible to foresee problems in sustaining high performance for the LMP.

Although rice has the dual advantage of being a commodity and food for home-consumption, the modern paddy farming is a monoculture and lacks the mechanism for maintaining soil fertility. Thus, it requires large amounts of chemical fertilizers, which are too expensive for many farmers who end up not using them as de-

sired. As many farmers have only 1–3 plots and they hope to leave their children equal areas of fields, it is necessary to improve land productivity. Therefore, the traditional fertilizing methods, especially through manure as have been practiced in the agrosilvipastoral complex, becomes very important.

Second, it is necessary to introduce the Chagga way of housing cattle in the hut, so as to combine paddy farming with stock raising. In this case, it is indispensable to strengthen the basis of livestock feed. Particularly, fodder tends to run short in the dry season. At present, in the LMP straws and husks from paddy are burnt in the field or thrown away. They can be used as feed after simple proceeding. In addition, the storehouse of fodder should be built in the future.

Thirdly, the LMP area has faced water shortage, owing to several reasons. It is accelerated by the expansion of the modern paddy farming outside the project area. Therefore, it is more important to adjust water distribution and maintenance of water facilities, and its success depends on the ability of the WUA. But the WUA is not established on a communal basis, especially where there are absentee landlords. For this reason, the WUA cannot oversee all the maintenance works by farmers. Thus, the WUA must be vested with the compulsory power not to supply water to farmers who do not participate in maintenance work, as was the case in the traditional furrow system in the agrosilvipastoral complex. Water rights must go hand in hand with water use and obligation. There is another reason for the weakness of the WUA, financial weakness, because the collected water charge goes to the National Treasury. It may be useful to adopt a system of a revolving fund, proposed by KADP, which would make it possible for farmers to use their own water charge for themselves.

Lastly, there are two kinds of "hidden costs" within the LMP. One is the depreciation of tractors. The other is the low interest rate of the OECF Loan. These unrealized costs were justified by the low income of farmers, while they sustained good economic performance. Currently, there seem to be a few farmers who can endure higher charges than at present. Therefore, it is worth considering the introduction of a progressive charge system.

## NOTES

(1) This field research was supported by the Grant in Aid for Scientific Research of the Japanese Ministry of Education, Science and Culture, No. 01041046.
(2) With regard to this point, I referred to Schlippe (1956), Ruthenberg (1980) and Norman (1979).
(3) According to the interviews with farmers, the average yield of paddy per plot was 25 bags (each bag was 70–75 kg).

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