



FIGURE 1.2. Kalama Hills from Kivandini, June—July (?) 1937. Map Sheet 162/2, GR 3104E, 98302N Brg. 145°. (Photo: KNA: R. O. Barnes, 1937, photo 1. Reproduced by permission of Kenya National Archives.)



FIGURE 1.3. Kalama Hills from Kivandini, September 1991. Map Sheet 162/2, GR 3104E, 98302 145°. (Photo: M. Mortimore)

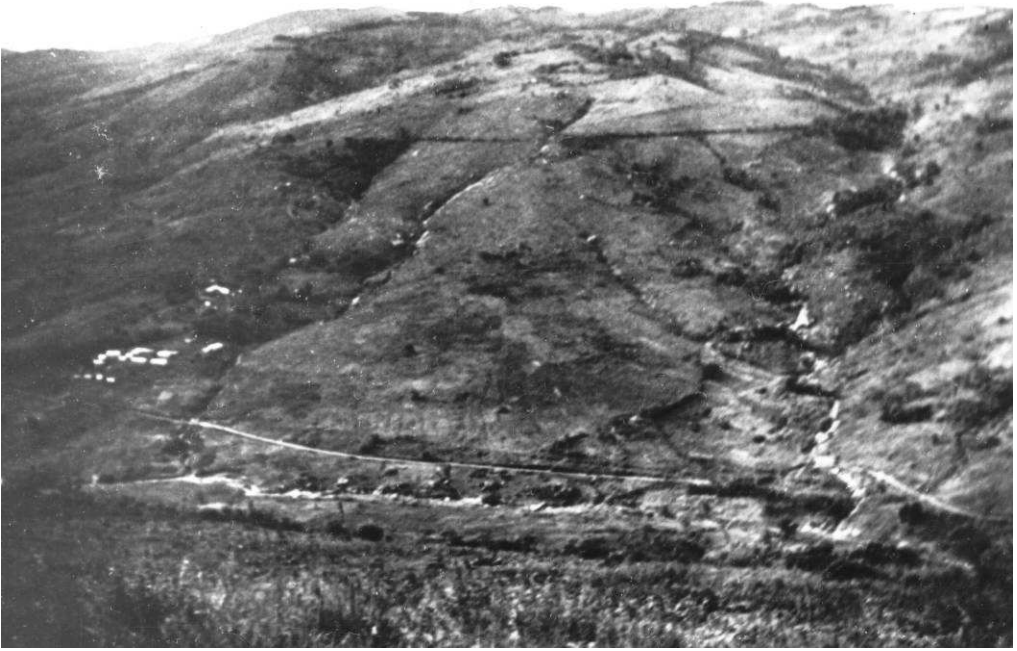


Figure 1.4. Southern slopes, Iveti Hills, June-July (?) 1937. Map Sheet 162/2. GR 3083E, 98300N; Brg 25°. (Photo: KNA: R. O. Barnes, 1937, photo 17. (Reproduced by permission of Kenya National Archives.)

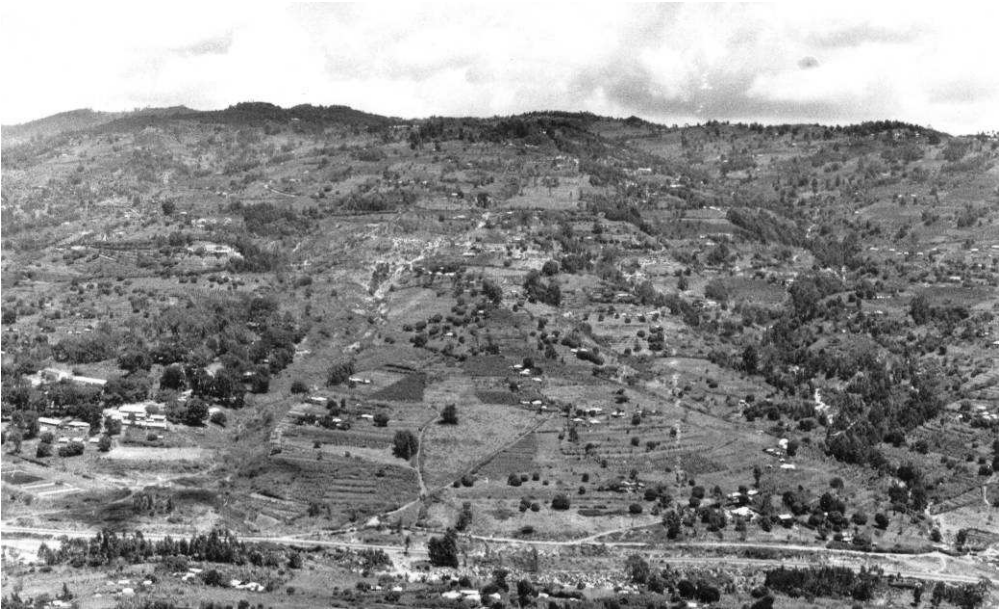


Figure 1.5. Southern slopes, Iveti Hills, June-July (?) 1937. Map Sheet 162/2. GR 3083E. 98300N; Brg 25°. (Photo: M. Mortimore)



FIGURE 1.6 Kyamunyu, from Mumandu (Mbevo S.) hill, June—July (?) 1937. Map Sheet 162/2, GR 3096E, 98175N; Brg. 90°. Photo: KNA: R. O. Barnes, 1937, photo 7. Reproduced by permission of Kenya National Archives.)



FIGURE 1.7 Kyamunyu, from Mumandu (Mbevo S.) hill, January 1991. Map Sheet 162/2, GR 3096E, 48175N; Brg. 90°. (Photo: M. Mortimore)



FIGURE 1.8. Plains of Iuni, from Mumandu (Mbevo S.) hill, June—July(?) 1937. Map Sheet 16/2, GR 3096E, 98175N; Brg. 140°. (Photo: KNA: R.O. Barnes, 1937, photo 22. Reproduced by permission of Kenya National Archives.)



FIGURE 1.9. Plains of Iuni, from Mumandu (Mbevo S.) hill, January 1991. Map Sheet 16/2, GR 3096E, 98175N; Brg. 140°. (Photo: M. Mortimore)



FIGURE 1.10. Kūima Kimwe Hill (NE slope), June—July(?) 1937. Map Sheet 162/2, GR 3085E, 98296N; Brg. 110°. (Photo: KNA: R. O. Barnes, 1937, photo 18. Reproduced by permission of Kenya National Archives.)



FIGURE 1.11. Kūima Kimwe Hill (NE slope), January 1991. Map Sheet 162/2, GR 3085E, 98296N; Brg. 110°. (Photo: M. Mortimore)



FIGURE 4.1. 'Looking north from below Muisuni trig point to Tula and the Matungulu slopes, possibly the finest stretch of agricultural land in Kenya, producing with Kangundo 5/6 of the maize and beans exported from the Ukamba reserve.' (KNA: R. O. Barnes, 1937, photo 21. Reproduced by permission of Kenya National Archives.)



FIGURE 4.1., Cultivation of coffee and other crops on the terraced slopes of Muisuni in 1990, near the site of Barnes' photo 21 (his exact standpoint could not be identified). (Photo: M. Mortimore)



FIGURE 4.5. This new settler's home in Kikumbulyu in the 1960s illustrates both the hardships of new settlement and the methods of clearance and farming that were alarming conservationists at the time. (Photo: F. N. Owako, 1969. Reproduced with permission.)



FIGURE 1.6 Many such sites are now examples of excellent cultivation and cropping systems to maximise rainfall infiltration, with useful trees conserved as farm boundaries. This farm is near Kambu, Ngwata Location, 1990. (Photo: D.B. Thomas. Reproduced with permission)

with sloping land that lacks effective conservation measures and with terraces that are incorrectly laid out, poorly constructed or not stabilised with grass.

After virgin land is cleared for cultivation, the organic matter levels can be expected to decline and if farmers fail to install effective conservation measures, the risk of erosion is high, especially on sloping land. Erosion might not become apparent till rills have appeared and damage has already been done. Once rills have developed, it is more difficult to make effective conservation structures owing to the concentration of run-off.

Erosion of grazing land in Machakos District has been noted since the early years of the century and has been one of the hardest problems to deal with (Pole-Evans, 1939; Pereira and Beckley, 1952; Peberdy, 1958). Early incidences of erosion were attributed to increased livestock numbers as a result of improved veterinary services, protection from theft, and reduced grazing area. The natural vegetation of the District is characterised by tufted and patchy perennial grasses which, when grazed down, expose the intermittent bare soil to erosion and compaction by rain drops. Such bare patches can be seen clearly in Figure 1.2. Erosion removes the humus in the topsoil, and compaction impedes the infiltration of rainwater and the germination or growth of grasses and herbs (KNA: Cowley, 1947/18). Intensified grazing of the better pastures during periods of drought would have worsened the problem, and at such times, the activities of termites became more noticeable than usual. Pole-Evans (1939) noted that 'they were attacking living thorn trees in the absence of any other material'. Areas of bare or nearly bare ground expanded and coalesced in the manner of a skin disease. These bare lands with capped soils became known as *mangalata*, or 'bad lands', as shown in Figure 7.1



FIGURE 7.1. 'Typical eroded bare ground covering hundreds of square miles.' (KNA: R. O. Barnes, 1937: photo 14). Barnes notes that the area had been closed to grazing 'a short time' and moisture-holding silt was collecting against the grass at the edge, where seed could take hold. To hasten this process, he advocated artificial barriers to hold silt (Reproduced by permission of Kenya National Archives)

7.2 and 7.5(a)),

...which must have been one of the finest stretches of agricultural land in Kenya ... local natives say the land was not worked extensively until the War of 1914-1918. Prior to the War the slopes were covered with thick Bush Type Forest and had very fertile soil. One native told me that when he left to go to the War as a porter there was only isolated cultivation . . . [Now] In some parts cultivation is continuous for almost a square mile *in a block*, and there are only odd trees left all over the area.

Now the whole area is suffering from erosion, natives will show you gulleys up to 30 feet deep with vertical sides that used to be paths through the bush. They say that many of these gulleys have increased from small watercourses to their present depth of over 20 feet in 10 or 20 years and two up to 18 feet deep in the last three years [shown in Figure 7.2). The largest of these gulleys are about a mile long. There is sheet erosion over the area and it is very severe to the north of Matungulu Government school.

The reason they give for these gulleys is that the cover is now off the hills above but they do not realise that the enormously increased run-off is also due to the drop in humus content of these huge expanses of cultivation. They do attribute small washouts and gulleys to their own practice of marking out their plots with drains, which catch and concentrate the water (shown in Figure 7.2).

All natives agree that greatly increased areas are responsible for accelerated erosion on cultivated land. They rightly blame the use of ploughs without sufficient care and knowledge, many used to plough up and down hill. They also blame the use of cultivators with oxen. (KNA: Barnes, 1937: 4. Reproduced by permission of Kenya National Archives.)

The Agricultural Officer Hobbs' estimates of the proportion of uncultivated land subject to erosion (quoted in RH: Maher, 1937) range from 13% to '76% in different locations, and were generally lower for the hilly than for the lower locations. (These estimates are reproduced in Thomas, 1991, Table B.1; they were approximate and subjective.)



FIGURE 7.2. 'Showing erosion in the rich Matungulu area, starting from paths and boundary trenches' (KNA: R. O. Barnes, 1937: photo 25). This illustrates why observers were worried by cultivation on the hills. See also Figure 1.4, where Barnes notes numerous small gulleys starting out of 'abandoned or closed native shambas' above the road (Reproduced by permission of Kenya National Archives)

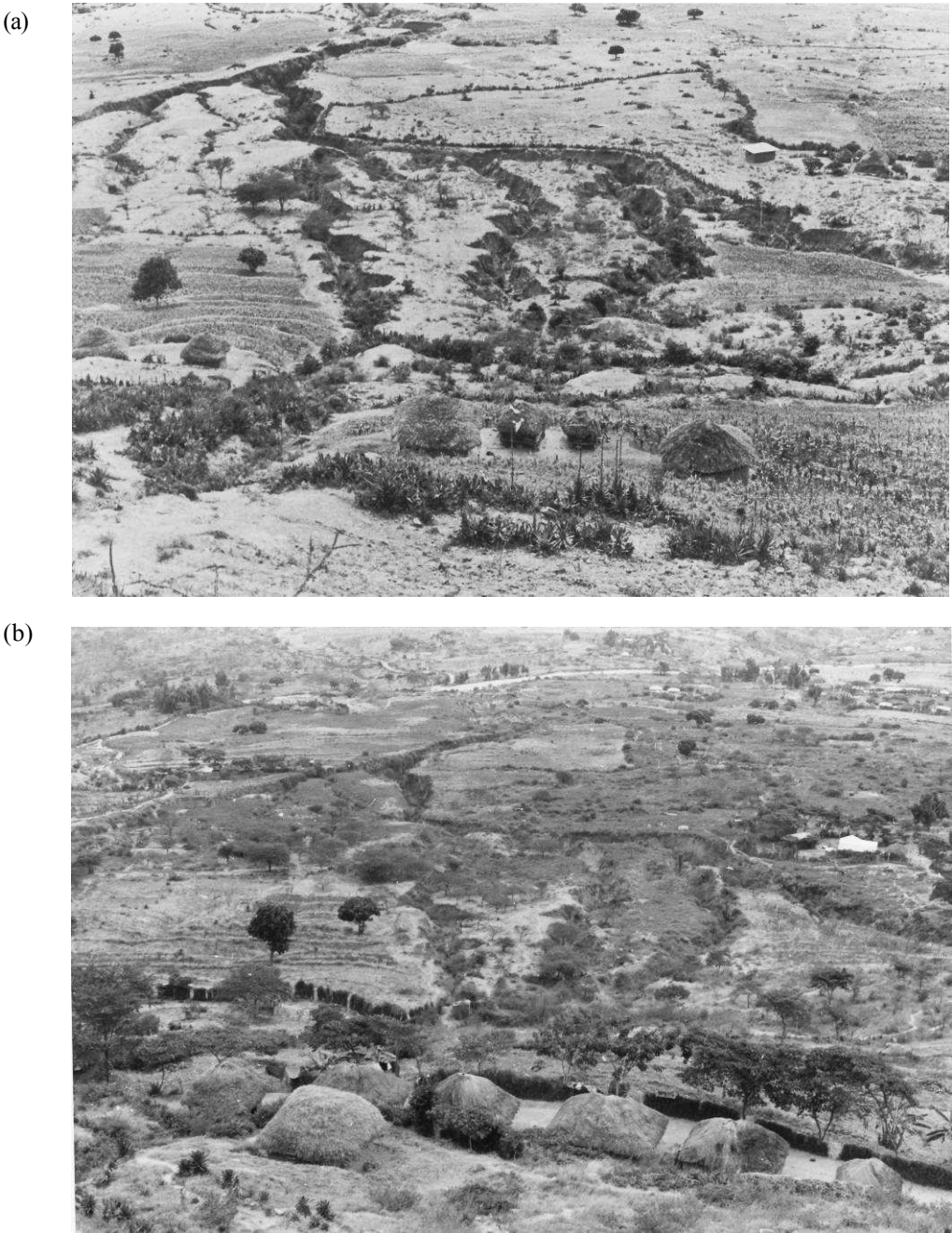


FIGURE 7.3. Gullies in Kalama photographed in (a) 1974 (Thomas, 1974) and (b) 1990. The centre gully, which started forming circa 1950, is about 12 m deep. In 1974 it was still widening. In 1990 it was relatively stable. Note the increase in trees. A woman farmer interviewed had planted trees near the gully edge to try to prevent it expanding. (Photos: D. B. Thomas. Reproduced with permission

(a)



FIGURE 7.4. (a) Bottom of the central gully in Figure 7.3, in 1972, when major slumping was still occurring (Thomas, 1974). (b) In [990, vegetation was taking hold at the same spot. (Photos: D. B. Thomas. Reproduced with permission.)

(b)



(a)



FIGURE 7.5. (a) Gully in Matungulu in 1937, said to have expanded from a small water course that could be stepped over 1.0 years previously, due to run-off from the cultivated fields above (KNA: Barnes, 1937, photo 29. Reproduced by permission of Kenya National Archives)

(b)



FIGURE 7.5 (cont.) (b) The same gully in 1990, wider, but largely revegetated. (Photo: D. B. Thomas.) The site is near the spot photographed by Barnes, but the exact location of this cannot be identified. Note terracing and additional tree cover on the hill above (Reproduced with permission)

TABLE 7.2. Land-use change in two catchments, 1948-1978

	Study catchment					
	K			Makulani (166 ha)		
	alusi (238 ha)			1948	1967	1978
	(%)	(%) change	(%) change	(%)	(%) change	(%) change
1 Arable areas with soil conservation	9	44	46	1	12	31
2 Arable areas without soil conservation	22	15	3	16	13	7
3 Bush and grazing land, good cover (>50%)	14	5	6	8	9	3
4 Bush and grazing land, poor cover (<50%)	53	33	45	75	66	60
5 Woodland and forest	1	2	1	0	0	0
6 Others	1	1	0	0	0	0
7 Soil conserving land use (1 + 3 + 5)	25	51	52	9	21	33

Note: Column totals may not add up to 100 owing to rounding
Source: Zöbisch (1986: 102) (Reproduced by permission of M. Zöbisch)



FIGURE 7.8. Denuded grazing land in 1990 near Mavindini, Makueni Location, in the left foreground, separated from excellent cover in the right background which is protected by a hedge of thorn branches, demonstrating the effects of different individual management. (Photo: D. B. Thomas. Reproduced with permission.)

of ground where the soil surface was sealed and bare, adjacent to quartz-covered land which was well vegetated. It is possible therefore that the rate of erosion on grazing land has decreased not only because of better management, but also because of the removal of the most easily eroded material.

Although the problem of grazing land management appeared for a long time to be almost insoluble, it is clear that changes have been taking place and the situation is now much more hopeful than in the past. One major reason for this is that most land has been demarcated and registered. Boundaries are now generally recognised and respected and it is not uncommon to find one farm with well managed grazing land separated only by a sisal hedge from another with poor cover, as in Figure 7.8. Improvements in grazing management have been associated with changes in the functions of livestock and in the methods of feeding them (see Chapter 10). The trend towards fodder growing and stall feeding, on certain farms and especially in AEZs 2, 3 and 4, has to some extent reduced the pressure on natural pasture and *the* hazard of erosion.

An improvement in the general condition of grazing land up to 1991 is also attributable to better rainfall, and there will no doubt be deterioration in cover when the next sequence of dry years occurs. There are certain areas near water supplies where livestock are concentrated that continue to degrade, due to the combined effects of grazing pressure and livestock tracking and trampling (Muya, 1990).



FIGURE 9.1. A young woman takes a moment off to attend to her children while she works with her husband at planting onions. This was just before nightfall: it typifies the longer inputs of labour that intensive farming requires. (Photo: M. Mortimore)

different forms. In the older-settled areas the inheritance of smaller farms, and the lack of new land to settle, means that brothers sometimes farm the land they inherit jointly. In more newly settled zones, where land was available to those who could cultivate it till the 1970s, polygyny remained common, for additional wives gave control over additional farm land. Village leaders said that most men in Ngwata were polygynous in 1990 — and this was confirmed by a survey in the Kibwezi area (CARE, 1991).

A positive aspect of the change to nuclear families is that men no longer confine themselves to clearing land for new farms and caring for livestock, but, if their main role is farming, like the women they may contribute to all stages of crop production (see Figure 9.1). One woman leader in Mbooni told us that men have now become more helpful. The farm labour force has become more flexible. It is, however, reduced in size, on average older, and predominantly female, since more men than women have off-farm jobs. The expanding local off-farm sector has provided men with new local roles in trade, transport, building, etc. (see Chapter 10). (Women predominate in retail markets and basket making (both are combined with farming) and are important in the professions, particularly in education, health, community development, and agricultural extension.) With young people going to school or working off-farm, parents or hired labour have taken over most of the activities traditionally performed by children. If the father is away or in a local non-farm occupation, these additional tasks add to the daily load on women. However, many of the off-farm workers, male and female, swell the work force at peak periods.

Feelings of obligation towards the head of the family remain strong and family resource pooling is still important, not only in labour but also through remittances and gifts. Although land



FIGURE 9.3. The Iiani women's group of the Catholic diocese run a tree nursery as their main activity but also do gully protection (on which their male members were engaged the day we visited). (Photo: M. Mortimore)

Diocese, with 973 development staff for 80 projects (this seems to have included teachers for church-supported schools and adult education classes; Mutiso Consultants, 1986; Kaluli, 1992).

John Mbiti credits the churches with effecting a major change in philosophical attitude (Mbiti, 1971). They taught a society which had been oriented towards the immediate past, and in which grandfathers set the rules, to govern its actions by contemplation of the future and the Second Coming. It is quite possible that the new orientations of Christianity undermined traditional constraints, and made the acceptance of change and of planning for the future socially easier.

EDUCATION

The development of the education system in Machakos is the result of the concerted efforts of the Government, the local Council, the churches and parents. It is notable for its emphasis on primary and technical education; secondary education has been a comparative laggard. The LNC did not wish to rely on the missions for education and by 1930 had established a school teaching literacy in most of the Locations. Initially, people had to be encouraged to attend by gifts of clothing, sugar and salt. However, there were already those who saw technical education as a means of transforming their own economy and society. A government technical school had been established in Machakos Town in 1914. The colonial authorities were frequently disappointed that graduates dispersed to the villages and set up their own businesses rather than joining government services, but in so doing they provided vital repair and support services for the



FIGURE 9.4. Women weave baskets, some of which will be exported, while waiting for local customers for their cabbages in Masii market place (on a non-market day). (Photo: Mary Tiffen)

1924, the AIM missionaries had constructed a road system connecting Kangundo, Machakos Town, Mbooni and Mukaa (Aaron Kasyoki, pers. comm., 1990). This helped to make Kangundo the leader in agricultural development (as Barnes observed in 1937; see quotation in Chapter 7). By 1932 there were more than 200 Indian trading *families* in the District (KNA: MKS AR 1932).

During the 1930s, despite hampering restrictions, new shops and transport businesses were established throughout the District, usually by returning migrants. Newman quotes a former worker turned entrepreneur who by 1938 reported, 'I had many helpers: some to push carts, others to assist in the shops, and when I bought a vehicle I hired a driver and with him a turnboy

. I had a large farm and two ploughs and harrows' (Newman, 1974: 13). The DC recorded in 1946 'an avalanche of applications for trade plots and lorries' to be funded from soldiers' savings and gratuities (KNA: DC/MKS Annual Report 1946).

The increase in number shown in Table 9.3 indicates the increase in commercialisation. Village leaders in Kangundo credited Indians with the increased production of grams, coriander and Indian vegetables in the 1940s. The long-standing connections continue today, particularly through the export of what are known as 'Asian vegetables' to the Indian communities now living in the United Kingdom (see Chapter 14). Indian traders aroused jealousy and after Independence they were banned from rural areas. However, by then the development of African trade meant that there was generally a competitive situation. A survey in 1957 recorded an average of 75 shops per Location (Peberdy, 1958); most were described as 'general goods' (which would still be true today), but butcheries, hotels and hide dealers formed other large categories.

(a)



(b)



FIGURE 10.1. (a) A tethered cow in a recently settled area, Kambu, Ngwata Location, showing grazing management. (b) Livestock feeding on pigeon pea residues, in the same Location. (Photos: D. B. Thomas. Reproduced with permission.)

were reduced by nearly half in the 1983-1984 droughts, when a survey in neighbouring areas of southern Machakos found the average post-drought holding was 18 cattle, 25 goats and 7 sheep. Losses in the drought were lower and recuperation rates after the drought were higher than on immediately adjacent Maasai ranches, showing the value of the mixed farming system that had been evolved (Mukhebi et al, 1985).

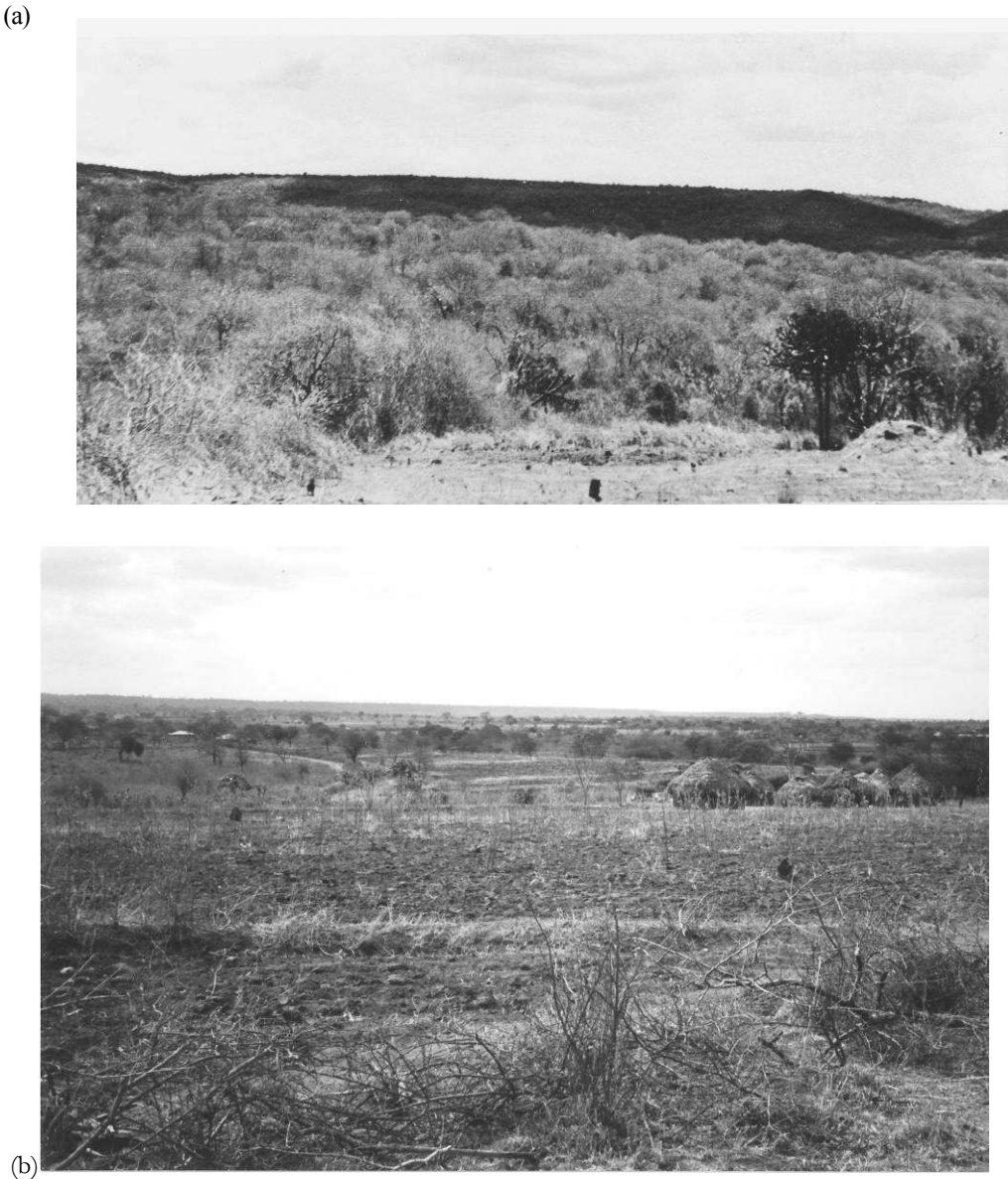


FIGURE 10.2. (a) *Acacia tortilis* in the unsettled Yatta Plateau, circa 1969. (Photo: F. N. Owako, 1969). Reproduced with permission. (b) Farmland in the Yana Plateau, 1990. (Photo: Mary Tiffen)



FIGURE 10.3. A co-operative carving workshop, Wamunyu, 1990. The building received finding from MIDP, but the activity goes back to 1917. (Photo: Mary Tiffen)

In the 1960s working capital requirements were very small, and not much of a problem except after famine, when purchases of seed was necessary (Heyer, 1967: 56). She subdivided fixed capital into items that could be acquired through labour and free local materials, such as stores, fencing and soil conservation works, and items requiring cash outlays, such as oxen, ploughs, sprayers, etc. By the 1990s this distinction was no longer valid; Chapter 11 shows that many farmers used hired labour to construct or rehabilitate terraces. She found that capital for equipment could be a problem because of the risks involved; people preferred non-farm investments.

By the Late 1970s capital was much more important in farming than in 1960. However, the surveys carried out then ignored fixed capital such as terraces, dams, trees, etc, and only one analysis included farm buildings. An economic analysis showing high returns to terracing for maize and beans is quoted in Chapter 11. In AEZs 2 and 3, farmers, through their co-operative societies, have invested in coffee-bean processing plants. Initial capital is also required for a switch to grade cattle, not only for the beast, but also for housing and watering, etc. Many farmers have invested in brick houses, tin roofs, guttering and roof-water catchment tanks, which save labour (see Chapter 12). Orange and other fruit-tree cultivation on a commercial scale requires cash investment for the initial planting material, and, very probably purchases of manure and hired labour to prepare the planting site. The value which farmers put on trees can be seen in the prices they are prepared to pay; in 1990, land in Kangundo with coffee trees cost Ksh 200 000 per ha, compared with Ksh 100 000 without. In Ngwata, untterraced grazing land cost Ksh 5000 per ha, compared with Ksh 12 500 for arable with terraces.

In the AEZs 2 and 3 areas, working capital for fertiliser, hired labour and other inputs is



(b)



FIGURE 11.1. Matungulu conservation area, (a) 1952 and (b) 1990. The original 'contour ditches' which 'spill into grassed run-offs' have been converted to benches (Photos: Kenya, ALUS, 1953, Crown Copyright, Reproduced with permission of the Central Office of Information, and D. B. Thomas)



FIGURE 11.2, One of the original waterways in Matungulu, as seen in 1990. (Photo; D. B. Thomas. Reproduced with permission)

temporary relief grazing on the Yatta Plateau was very much a second best, necessitating the transport of food from the home. The desirable areas for settlement and grazing were the lands disputed with the Europeans in the north, or the Yattas, and resentment at land lost was particularly strong in the north (KNA: Lambert, 1945). In 1938 the DC told a meeting in a northern location that they were putting too many cattle on too small a land (comparing this to a bag). One of those attending reported: But I said we had a bigger bag on Yana and Mua Hills where we could take our cattle but the Europeans had made the bag too small . . . the people . . . all raised their hands [in agreement]' (Newman, 1974: 14).

They thought the proposed settlement area at Makueni very unhealthy (KNA: Lambert, 1945). (This was not unreasonable; on lowland irrigation schemes in Kenya there has been considerable mortality from malaria amongst the families of new settlers coming from highland areas.) The majority did indeed see new settlements as the answer, but under their own control and in areas of their own choice.

LARGE-SCALE INVESTMENT WITH LITTLE LOCAL CONSULTATION: 1945-1962

During the period 1945-1962 government policy and people's reactions to the various aspects of a considerable investment programme are examined together. Machakos benefitted from

for paying labour. This made the programmes more effective. Respondents told us that people used to fight to get the tools. However, touring notes show a mixed response, with work going on in some areas on building long terraces which crossed both cultivated land and *mangalata*, while in other areas terracing was neglected except when the administrative officer got the chief to prosecute those who did not turn up.

Unfortunately, there seems to have been no scientific assessment of the impact of the compulsory terracing, closure and grass-planting programmes on the *mangalata*. However, by 1954, the Annual Report, Southern Province reported considerable improvement:

Four years ago standing on any hill top in Machakos provided a terrible spectacle of bare red land by the thousands of acres. The 'badlands' ... amounted to two thirds of the total, were a desolation ... Today a trip through the area presents a remarkable difference. Masii and Kiteta Locations, which were then amongst the worst, are now appreciably grass covered and the old '*Mangalata*' is hardly to be seen. Indeed, the pasture is still not capable of carrying much stock, but it is ground cover again ... On all sides today bush clearing and paddocking can be seen and river valleys are being stabilised with napier grass. (Kenya, Agricultural Dept, Southern Province, 1954.)

In the period following the Swynnerton Plan, 1954-1962, there were far more agricultural officers and even stricter enforcement of closed grazing areas with cattle confined to roofed sheds. Today these lands have become private farms, part grazed, part cultivated and terraced (see Figure 11.3 and interviews later in this chapter). A 1981 survey in AEZ 4 found that 30%



FIGURE 11.3. Pastor Mutua and his farm, 1990, on land reclaimed from *mangalata* in the 1950s. (Photo: D. B. Thomas. Reproduced with permission)

(a)



(b)



FIGURE 11.4. Banana trenches, (a) 1952 and (b) 1990. The 1952 caption notes how the trench prevents wash from the road and hill-side destroying the terraced arable. Pastor Mutua's banana trench in 1990 is also trapping water from a small road near the farm; water infiltrating out of it will feed his recently planted coffee, which he is experimenting with although this is AEZ 4. (Photos: Kenya, ALUS, 1953, Crown Copyright, reproduced with permission of the Central Office of Information and D. B. Thomas)

to Independence, achieved in 1963. Officials had to reduce their pressure, and were switched into duties such as preparations for elections. They were disheartened by the slackening conservation effort as shown in Figure 11.6, and the lack of 'discipline'. As already noted in Chapter 2, a report in the mid 1960s implied that the programme had only been very partially successful (de Wilde, 1967).

SOIL CONSERVATION BY THE FARMER, 1960-1978

By 1961, the area conserved by both types of terrace had fallen to 27 000 ha, compared with a peak of 42 000 ha in 1958 (Figure 11.6). The cultivated area was about 110 000 ha. In the short rains of 1961, much damage was done by abnormally heavy rainfall. Officially, compulsion was ruled out, with what observers regarded as a devastating effect. Closed grazing areas were re-opened, and red 'sores', the forerunners of serious erosion, began to reappear in 1962-1963 (Heyer, 1966: 25). Figure 11.7 shows deteriorated terracing in Kilungu, circa 1964. (The photograph was taken by Owako to illustrate achievements in terracing under the **ALDEV** programme).

Agricultural staff were cut back (Mbogoh, 1991). They concentrated on farmer training and extension programmes; and grazing controls, soil and water conservation and controlled settlement largely ceased (Lynam, 1978: 62, writing of 1974). Officials periodically recorded large numbers of narrow-based terraces and grass strips (Gichuki, 1991: 49), but surveys carried out in the 1970s made no mention of them. Our own informants all recollected that benching began again,



FIGURE 11.7. Terracing in Kilungu, 1964. Although this was taken to illustrate 'post World War II achievements in soil conservation', it clearly shows the decay of narrow-based terraces, and other areas where *fanya juu* have been installed. (Photo: F. N. Owako, 1969. Reproduced with permission)



(b)



FIGURE 12.1. Carrying water home, near the Kambu river, AEZ 5, August 1990. (b) A hand pump supplied by the African Medical Research Foundation (AMREF) in Kibwezi Division, typical of NCO programmes. (Photos: D. B. Thomas, reproduced with permission)

(a)



(b)

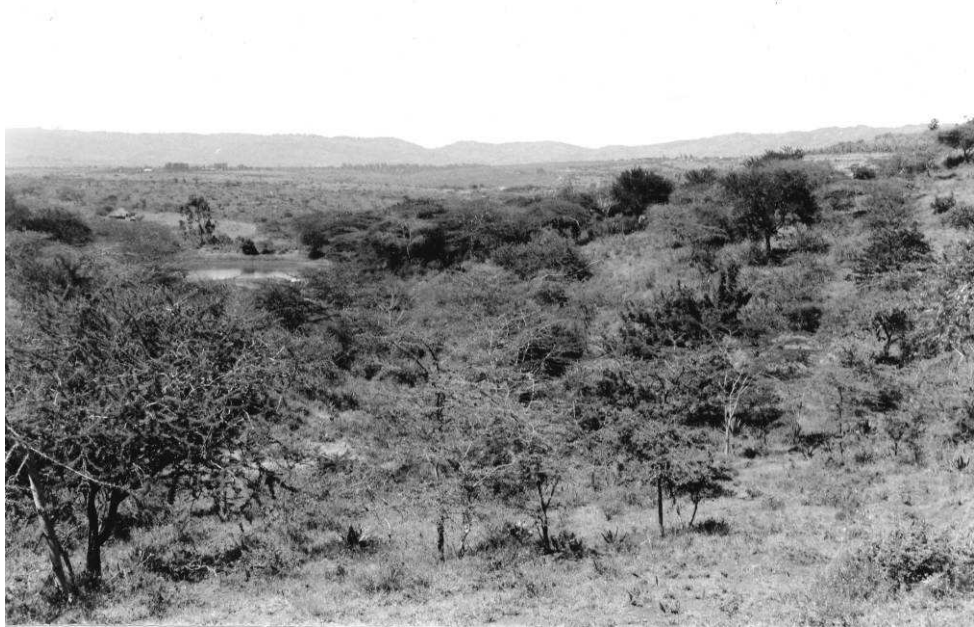


FIGURE 12.2. (a) A dam built by the mechanical unit of ALDEV, photographed in 1952. It also showed 'the extent to which the terraced badlands have recovered'. (Photo: Kenya, ALUS, 1953. Crown Copyright. Reproduced with permission of the Central Office of Information). (b) In 1990 this land was still used for grazing, with increased tree cover, and the dam was still in use. (Photo: M. Mortimore.)

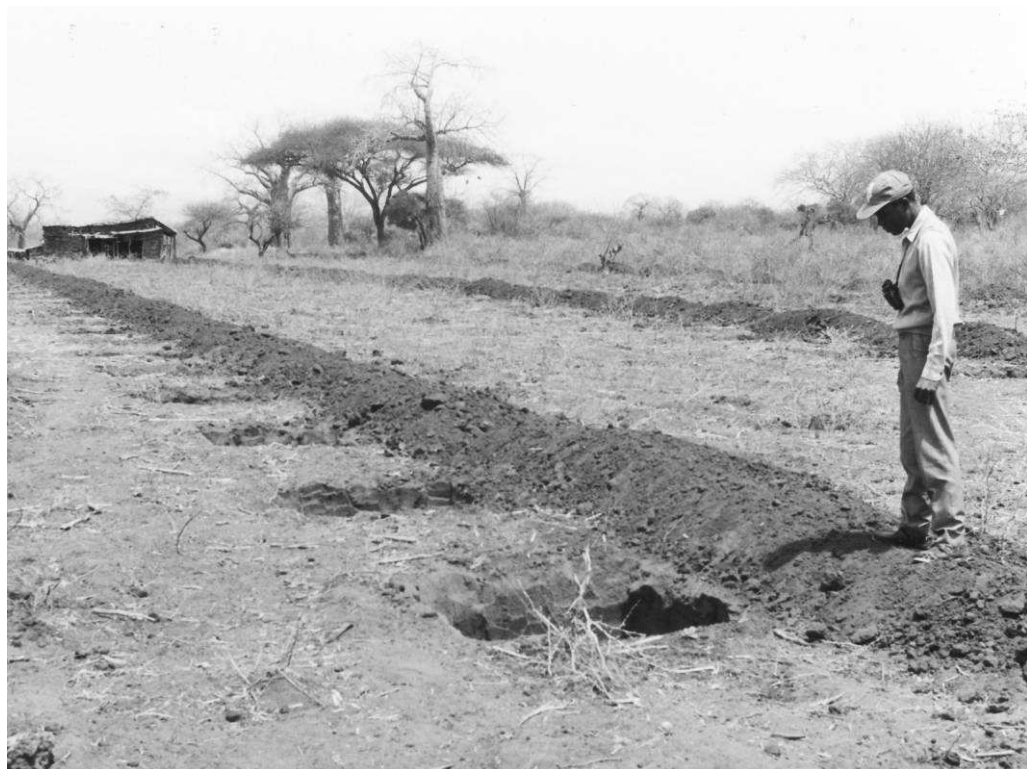


FIGURE 14.1. Hole digging for citrus in AEZ 5, Kamu, Ngwata Location, 1990. The soil is being used to form terraces to trap run-off. The holes look similar in size to those insisted on for coffee in AEZs 2 and 3 in the 1950s and demonstrate the way technologies travel and are adapted. (Photo: D. B. Thomas reproduced with permission)

where water is within the reach of roots (see Figure 11.4). In 1981 (Ecosystems, 1982, Vol.1: 78) the average density of bananas in the District was $12/\text{km}^2$; the highest density was in Northern Division ($40/\text{km}^2$), but even in Makuani Division a density of $8/\text{km}^2$ was recorded.

Irrigation now permits some vegetable crops (and fruit) to be marketed in the dry seasons when there is no glut. (Horticultural production, though not originally for the external market, may have been the driving force behind several intricate, hand-constructed spring-diversion systems in the hills, a technology that is said to go back 200 years, and which may still be observed.) The Yatta Furrow was originally constructed to support grazing in an area where permanent settlement was forbidden. In 1967 a 50-ha smallholder irrigation scheme was constructed at Matuu (Bottrall, 1969). Local settlers applied for land, and were organised into intake groups sharing the water for a block. Pump-driven sprinklers proved uneconomic, but gravity fed irrigation, first under close DoA supervision, but recently largely self-regulated, continues to support a prosperous enclave of market gardening. Fruit (mango, pawpaw and banana), vegetables (tomatoes, onions, karella) and field crops (maize and cotton) are grown mixed, or in rotations, at the discretion of individual producers. Notwithstanding a favourable assessment in 1968 (KNA: DoA CROP/2/11/235), there have been no major irrigated developments since.



FIGURE 14.2. Alice Mulandi and her plough. She is a member of one of the composting groups in Makeveti. Her grain store illustrates one of the reasons why building timber is in demand. (Photo: M. Mortimore)

negligible. Several hundred units were left unsold, and most users preferred their old ploughs, finding the MIDP equipment too heavy for their draft oxen and much more expensive (ODI, 1982). There is no record of farmer participation in research and development. An evaluation report concluded that the problems of the mouldboard plough had been overestimated. The mouldboard plough, slightly modified and available in different sizes, is the one principally used in Machakos today.

Associated practices

Dry planting

Animal power had a considerable impact on cultivation practices. From the 1960s, extension workers advocated dry ploughing and planting (particularly for the Katumani maize varieties). Ox-ploughs enabled farmers to take this up. However, early planting means that stronger oxen are needed for breaking hard ground, when fodder is scarce; two cultivations of the seedbed are necessary; there is a higher risk of seed loss; and weed growth is more dense. Thus by the mid-1970s, acceptance of dry planting was mixed. Its rates of adoption by farmers in Makaveti (AEZ 4) and Makueni (AEZ 4/5) were 78% and 6.1% respectively, but in Kalawa (AEZ 5), it was less than 25% (Lynam, 1978). Dry planting is now fairly widespread, according to our interviews, but depends on the rainfall pattern and the conditions of animals in a given year. To spread risks and save time, many farmers plant both before and after the rains.

areas (for example, Yana: Neunhauser et al, 1983); they were spreading manure over whole fields, in lines or in selected patches. (Placement, to save manure, was taught in the 1950s; J. R. Peberdy, pers. comm., 1992.) In Mwala, about 66% of farmers were using it; in Nzau, about 50% used it on maize, 33% on beans and fewer on cotton (Rukandema et al, 1981). The ADEC sample survey (ADEC, 1986: 6.34) reported that 87% of farmers in the District used boma manure on crops, and 3% were selling it. Only 10% did not collect it. These figures imply that, in terms of the percentage of users, the adoption curve is almost complete. By contrast, inorganic fertiliser use is minimal, the bulk of it on coffee (ADEC, 1986: 7.6).

The percentage of adopters, of course, tells us nothing of the rates of application, which are known to be highly variable in space (from field to field and within fields) and time (from season to season).

Factors influencing use

The use of boma manure is influenced by (i) yield expectations, (ii) rainfall risk, (iii) supply and (iv) labour and transportation. With regard to expectations, most reports suggest that the best returns from the use of boma manure (especially if it is purchased) can be obtained from coffee, cotton, and improved maize. However, little information has been found on farmers' choices. The residual effects are also recognised.

With regard to risk, the probability of losing a crop through drought deters farmers from using manure (and perhaps other) inputs. Also, it is known that manure may 'burn' the crop,



FIGURE 14.3. Boys transporting waste from Kangundo town to use as manure on the farm. (Photo: D. B. Thomas. Reproduced with permission)