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Population Growth and Environmental Recovery: Policy Lessons From Kenya

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POPULATION GROWTH AND ENVIRONMENTAL RECOVERY: POLICY LESSONS FROM KENYA

Mary Tiffen, Michael Mortimore and Francis Gichuki

Conflicting Views on Population Growth

Almost the only agreed view on population growth is that in many countries it is inevitable, given the present age structure of the population, even if more families adopt family limitation. There is strong disagreement on whether population growth can be compatible with income growth per head, and with the conservation of natural resources. The pessimists take their views from Thomas Malthus, whose first essay was published in 1798. They see natural resources as finite, and believe, therefore, that more people have to make do with smaller shares. This applies also to government services, such as education. Simon (1986) calls this the capital dilution effect. A second strand in the Malthusian view is diminishing returns to the same input, if technology is held constant. Malthus viewed new technology inventions as accidents, which could not be counted on.

An alternative view, expressed by Boserup (1965) in respect of agriculture, and by Simon (1987) in relation to industrial societies, is that more people contribute to the generation of new technologies. Boserup (1965) saw new technologies as being impelled by the need to replace long fallows as population increased; she also saw population growth as ultimately leading to cheaper transport, easier marketing, and more specialisation. This led to the growth of local towns, and more profitable agriculture, provided there were no cheap imports. Simon (1987) saw more people interacting with the existing large stock of ideas and technologies to spark off new technologies and improvements, so that resources can be improved, or substituted, or economised.

Although both Boserup and Simon, in different ways, emphasise the pressure of necessity in stimulating new technologies, the importance of incentives is also implicit in their thinking. People take up a new technology, which has perhaps been invented by someone else, because they think it will be profitable, and enable them to improve their standard of living. Farmers are partly motivated to change by the need to feed their families more securely, but also by a desire to buy better clothing, schooling, housing, etc. And although some new technologies will come from their own experimentations, a far larger number will come from other people – via their observations of what other farmers are doing, via traders who suggest a profitable new crop, via research and extension services, or through the introductions of churches and other non-governmental organisations. Hence, the more open an economy is, in the sense of freedom to trade and to reach and discuss many sources of information, the more innovative it is likely to be. A society without trade is much more

limited, in the incentives which people have to make improvements, in their means to make the necessary savings to implement change, and in the information base.

As population density increases, the cost per user of infrastructure and services decreases. This is most evident in the case of roads, but it applies also to institutions that spread information, whether these be schools, extension services, or missionaries promoting a 'green' message. It also applies to traders' overheads, enabling them to offer higher farm gate prices.

The beneficial interactions between population growth, growth in output per head, and improvements in environmental status, have recently been studied for the period 1930-1990 in Machakos District, Kenya, through research by the Overseas Development Institute, London, and the University of Nairobi. The outcome of the study not only shows improvement of the environment, but also conflicts with other common beliefs, for instance, that there has been little increase in agricultural productivity in Africa, that increased commercial production harms food supplies, that investment in semi-arid areas does not pay as well as investment in more humid areas, that out migration is all negative, and that development depends overwhelmingly on government initiative and aid support. It finds considerable progress, much of it generated by local effort, in the relatively supportive policy environment provided by Kenya. This paper summarises the results, and then discusses how far the experience of the District could be replicated elsewhere.

More people, more output and less erosion, 1930-1990

The District

Machakos District is inhabited by the Akamba people. Its northern edge lies some 60km from the Kenyan capital, Nairobi. From thence it stretched, in 1990¹, some 300km south east, with its southern border about 260km from the chief port, Mombasa. The greater part of the District, as defined by its 1990 borders, is semi-arid, with only about 8% lying on somewhat better watered hills. The climate is characterised by great annual variability. There are two rainfall seasons, but only a 60% chance in either of getting the minimum rainfall, 250 mm, for a decent crop of the preferred foodstuff, maize, given good distribution. Making the most of erratic and limited rainfall is essential for reasonable yields.

In 1930 there were estimated to be 240,000 people in the 'Reserve' area to which the Akamba were confined in the colonial period, before independence in 1963. Of this about 4,600km² was inhabited in 1930. In addition, the Akamba were permitted, on payment of licence fees, to graze Crown Land in the Yatta Plateau. In calculating the output per km² shown in Table 1 we divided district output by the area they had settled, or were allowed to graze. This was 7,000km² by 1961, less in 1930. After independence, the Akamba recovered lands to which they had always felt entitled, to the north and south of the Reserve.

1. The southern part was made into the separate Makueni District in 1991.

The former European ranch land in the northwest of the District also became partially open to settlement. Thus, total land available expanded to 13,600km². However, while most of the Reserve area was either relatively high potential land (AEZ 2&3, the marginal coffee land), or medium-potential land (AEZ 4), much of the additional land was AEZ 5 & 6 (officially deemed most suited to livestock and millet)². Therefore, the average quality of land available for farming fell after 1960. By 1990 the whole of the District was settled, and almost all was under private ownership whether used for grazing or for arable.

The increase in output and income

Table 1 shows that by 1989 the population had grown to 1.4 million and had spread into the more arid areas. Despite the addition of AEZ 5 & 6 land, Figure 1 shows that over time output per head has risen more than three fold, and per km² about eleven fold, when agricultural output is converted to maize at the exchange value between maize and other products at constant 1957 prices. This gives a measure of changes in the volume of output. One source of output data was the District Department of Agriculture's Annual Reports, which were compiled using the same methodology from about 1974. We selected two years with average weather (i.e. one good and one bad season), 1977 and 1987. For earlier data we were dependent on a rough estimate made in connection with the 1930 world agricultural census, a more detailed estimate made by the Agricultural Officer in 1957, a very good year climatically, and a sample survey by transect in 1960-61, unfortunately a very bad year climatically. Average production at this time was probably between these two points. The results are shown in Figure 1. While the data is rough, the orders of magnitude of the increase in productivity are probably approximately correct. This is confirmed by the two pairs of photographs shown in Plates 1 and 2. These were taken in 1937 and 1990 respectively, and confirm that it is highly likely that the value of output per hectare had risen eleven times in the interval³.

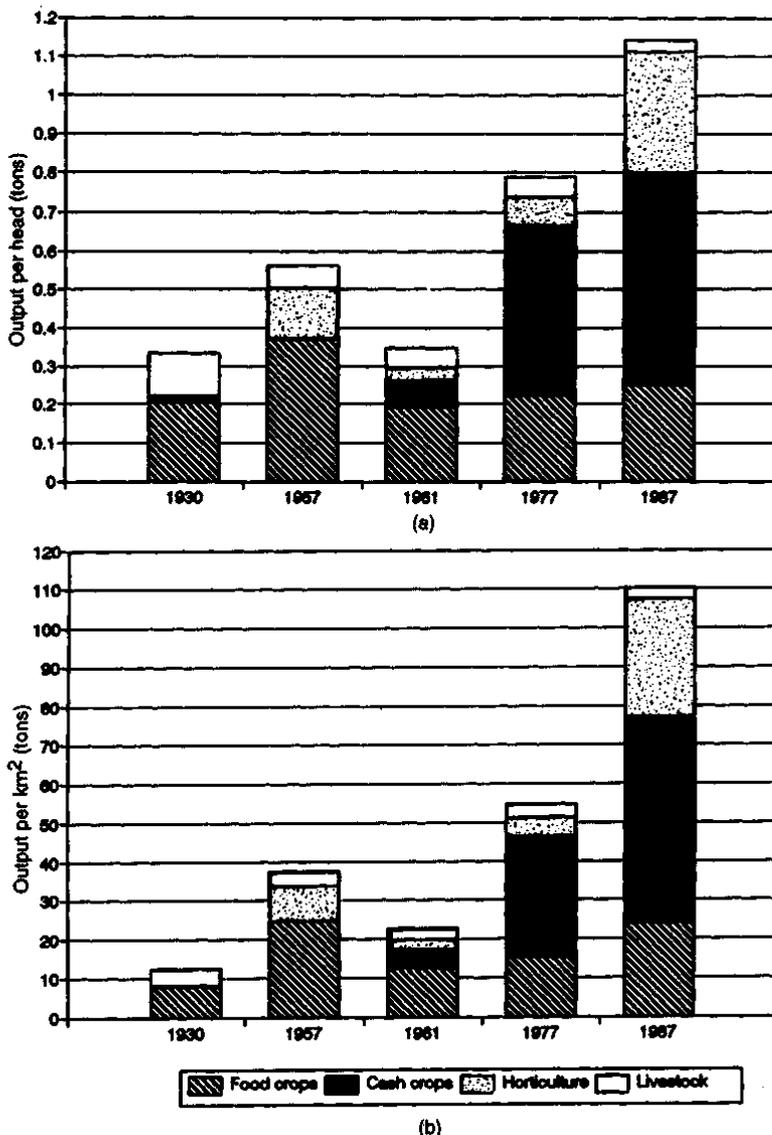
Year	Total Population	Percentage of population in AEZ 2&3	Percentage of population in AEZ 4	Percentage of population in AEZ 5&6
1930	240,000	36	55	9
1990	1,400,000	22	35	36

2. Jaetzold and Schmidt, 1983, elaborated a large number of Agro-Ecological Zones (AEZ) in Kenya, based on rainfall, temperature and evaporation, and soil properties. We amalgamated these into three groups for the purposes of our study.

3. The direction of change shown by the official data was also in conformity, in orders of magnitude, with information taken from five different groups of community leaders, and with farm studies carried out at different times. We had the impression official data often lagged behind reality, particularly in recording production in areas of new and unofficial settlement.

Figure 1 understates output, since fuel and timber are not included. (Fruit is included with vegetables in the horticultural output). A cursory inspection of Plates 1 and 2 shows that trees have been planted for many purposes, including environmental protection, fruit production, fuel wood, timber sales, as shelter, and to define boundaries. Some, on the hill tops, are the result of Forestry Department activities; other moist hill tops have private

Figure 1. Output per head and per km² in constant 1957 maize values:
(a) Output per head; (b) Output per km²



wattle plantations. Most trees are on private land. Our investigations did not reveal any evidence that fuel wood availability was more or less in 1990 than earlier. (Mortimore, 1992).

Figure 1 illustrates that output per head of food has remained pretty constant, although subject to the vagaries of the weather. Machakos still imports some food from other districts in bad years, and needs food aid after successive severe droughts, as in 1984-5. However, our best calculation is that maize imports and aid per capita declined from an average of circa 17kg per head annually in 1942-62 to about 7kg per head for a larger population in 1974-1985. Machakos has no natural advantage for maize production, but farmers know prices will rise steeply in bad years and many of them aim to produce enough for family needs, although not always achieving this. However, more achieve it now that food sales have become profitable, due to the growth of a non-farm population, and the fact that some farmers deliberately put a high proportion of land to a crop such as coffee, and rely partly on purchases. Coffee is only feasible in AEZ 2 and 3; these farmers form a market for nearby farmers in AEZ 4 and 5. In the early 1960s AEZ 4 farmers were reported to put little effort into a second crop after an exceptionally good harvest, since sales were not profitable, and storage of more than a year or so might be problematic. This left them short of cash to finance purchases if a third poor season followed.

The value of output is affected by changes in relative prices. A kilogram of coffee purchased a large amount of maize in 1957, when coffee production was in its infancy and prices high, and in 1977, one of the coffee boom years. It purchased much less maize in 1987, when the coffee price, relative to maize, had fallen. Consequently, many farmers increased production of fruit and vegetables, which by the 1980s found expanding markets locally, in Kenyan towns, and internationally. However, the recorded increase in horticultural output did not quite compensate for the fall in the coffee price, and if we use current prices for 1977 and 1987, rather than constant 1957 prices, it appears that value of farm output may not quite have kept up with the 3% per annum increase in population in this period (although value of output per hectare continued rising).

The advantage of production for the market is that it generates a multitude of non-farm jobs. Market production has to be processed, packed, transported, and retailed. It puts money into the pockets of farmers, who create a local demand for better housing (see Plates 1 and 2), furnishing, clothing, educational, and health services, etc. This creates local jobs. In 1929 there were only 85 Akamba-owned shops in the Reserve. In 1987 the local authorities received licence fees from 8,000 shops and kiosks. Further, some farmers require additional labour to improve their farms, or to help at peak labour times. In consequence, by 1981-2, only 50% of rural income in Machakos was from farming (Table 2). More of the non-farm income was local than in the 1950s, when most men who needed work had to go outside the district, remitting part of their earnings home. A study in 1962-3 (Heyer 1966) showed that this was then a much more profitable use of their time than producing unsaleable food crops.

The means for change

A study of the transformation shown in Plates 1 and 2 indicates the requirements for change were firstly, the means and the incentive to invest money and work in farm improvement, and secondly, knowledge of new and appropriate technologies.

Investments for improved farming

The Akamba follow a normal investment strategy of investing first in the things that they perceive to give the highest reward, and later in those things that give a smaller reward. They saw that investment in education gave a high return, enabling young men (and subsequently, also young women) to get good jobs. The young were expected to use part of their earnings to help their parents, and to make investments in family enterprises. The second investment was often in a non-farm enterprise, such as a shop or a transport vehicle. This gave a higher return than farming land such as that shown in the 1937 photographs. In the area shown in Plate 1, a few kilometres outside Machakos town, surplus grains and livestock could be marketed. People had begun investing in ox ploughs and teams, to extend their cultivation⁴ and to hedge some grazing areas. The third investment, therefore, has generally been in the improvement of arable land and the enclosure of grazing. The fourth, to which farmers have only begun moving more recently, is other measures to improve grazing land, which yields less per hectare than arable land. As population increased more grazing land has been converted to bush, and more intensive methods of feeding livestock, using crop residues and fodder-crops have been undertaken.

Table 2: Farm and non-farm income estimates (percentages)

	Farm income	Non-farm business	Wages	Remittances
1960 ¹	80	2 ²	6 ³	11 ³
1981-2 ⁴	51	17	245	9 ⁵

Notes and Sources

1. Peberdy (1961, Table VI Calculation of Total District Income plus subsistence production). 1960 was a bad year, so farm income may have been higher in an average year.
2. Refers to carvings only. There were some other non-farm businesses, so this is understated.
3. Wages: earned in District. Remittances: 20% of wages earned outside District.
4. Kenya. CBS. Economic Survey, 1988, Table 3.12. Machakos District. Total household income: Ksh 10,368. 1981 had a severe drought in the short rains, affecting the early 1982 harvest, but good long rains.
5. Wages - no information on whether internal or external. No 'Remittance' heading. It is assumed this was included under remaining heading, 'Other sources'.
- 6.

4. This initially led to the increased erosion visible on the land in the centre foreground above the lower road in Plate 1a.

Plate 1a and 1b. The Iveti Hills, near Machakos town

Plate 1a was taken in 1937, when the area already had a population density of 100/km². Barnes, the Soil Conservation Engineer who took the photo, said it showed continuous native cultivation to the left of the white buildings, (a school), showing dark. In the centre between the two gullied water courses above the road and right up to the line of trees on a higher road he noted an eroded area. Just above the lower road numerous small gullies can be seen starting out of abandoned or closed agricultural plots. (Photo: courtesy of Kenya National Archives). Plate 1b shows the cultivated area extended, terraced and productive. The hedges and woodlots started in 1937 are still there, but trees and houses are more numerous. The gullies are largely revegetated, although there is still one patch of eroded grazing land. Population density in 1989 was 654/km². (Photo: M. Mortimore).



Plates 2a and 2b. Kiima Kimwe hill

Plate 2a Kiima Kimwe hill in 1937. Barnes notes that oilfields are showing signs of soil slip and erosion, often the top of a field hardly having a crop while the bottom was yielding better. He called hillside cultivation, often on slopes steeper than this, the biggest problem in the Reserve and asked whether the 'natives' would ever put the same energy into protecting their hillsides as they put into dances that lasted most of the day and night. (Photo: courtesy of Kenya National Archives). The answer appears in Plate 2b. Woodlots and boundaries carry quick-growing exotic trees, and on the terraces appear bananas and other fruits. Embankments are maintained with care, and planted with fodder grasses. Prosperous looking homesteads give a hint of the rise in productivity. (Photo: M. Mortimore).



The slow pace of improvement was such that the Government considered it necessary to embark on a compulsory programme of communal work, digging contour trenches (also called narrow-based terraces) and planting grass on the many bare eroded hill-sides, 1940-1960. Soil from the trench was thrown downhill, and officials perceived this as the most appropriate technology given the shortage of labour. The intention was to prevent soil erosion by leading excess water off into a safe drain way, while at the same time conserving some of the water in the ditch. However, people found these structures needed a lot of maintenance. They were apt to overtop and collapse in heavy rainstorms, damaging the terraces below. The ditches needed cleaning out each season. The conserved water percolated to the bank, which in dry seasons grew the best crops, but cultivating crops on the bank weakened it.

The Akamba adopted an alternative, more labour-intensive, technology, the *fanya juu* terrace. In this, the soil is thrown uphill, as the first stage of forming a forward-sloping or level bench terrace. The ditch is then at the back of the terrace, and the water in it percolates through to the crops on the terrace. This type of terrace was demonstrated by a Soil Conservation Engineer near a school in 1938, but was then officially abandoned in favour of the narrow-based terrace. It is next mentioned in a 1948 report as being used for onion growing by an Akamba soldier who had seen it in India; in the early 1950s it was noted as popular for tomato growing. By the middle 1950s most of the terracing was being done by work groups with their own elected leaders, who chose this technology, whereas previously, supervised communal labour used the technology directed by officials.

At the same time, communal work was being voluntarily invested in feeder roads. The towns of Machakos and Nairobi were expanding, and there was a profitable demand for vegetables to satisfy. Bench terraces were then officially promoted for coffee-growing, when this crop was permitted to selected, supervised African farmers in the mid-1950s. Farmers adopted benches also for the main food crops, maize and pulses, since yields were self-evidently better on terraced ground.

Terraces have been built by three main methods:

- compulsory communal work (most of these were narrow-based terraces later replaced by a voluntary investment in *fanya juu*);
- voluntary work groups, where members rotated round each others farms till each had terraces (this was common in the late 1950s but has also been used since by poorer farmers); and,
- hired labour, financed by livestock sales, off-farm work, or farm profits.

Hired labour is preferred by those who can afford it, since the terraces are built at the time of choice, and the family labour is reserved for more directly profitable activities. There has been, therefore, both capital formation by direct labour investment and monetary investment. The greater part of the cost, which is the labour involved, has been borne by the farmers themselves. Most of the existing terraces, as shown by air photograph evidence, were built between 1961 and 1978 when there was no special aid programme. However,

during the period 1946-1962 and 1978-86 there were official programmes which supplied some of the necessary capital, in the form of free tools distributed to the work groups, and technical advice and training. Perhaps half the new terraces built from 1980-85 got some such assistance.

Tree planting in this semi-arid area similarly often requires substantial investment to dig large planting pits, and to acquire manure and planting stock. Cut off drains have been built to carry water to the head of terrace systems. Small dams have been made to water patches of vegetables. Other investments have been in the improved housing, seen in Plates 1 and 2, whose roofs catch water for human and livestock use, and in solidly constructed granaries, which store grain from one season to the next.

Sources of knowledge

Some of the required new technologies and knowledge of new markets have come through official research and extension, particularly a drought-escaping maize variety (which farmers now use, often in combination with other varieties which they have selected and bred themselves), methods of combating coffee-berry disease, coffee cooperatives and marketing structures, livestock health measures and some of the trees and fodder grasses introduced into the district at various times. Others have come through farmers' own experimentations and observations they have made during their travels. Service abroad during the 1939-45 war seems to have been a particularly fruitful source of new ideas, but others have come from travel within Kenya in pursuit of work or trade. Others have been introduced by traders, particularly from two canning factories, and traders who are supplying the growing export markets for vegetables. Indian traders initially sought supplies of preferred foods for their own communities in Nairobi, and later exported them also to communities of Indian origin in Britain and elsewhere. Others come from educated relatives. Still others come from NGOs, often church-connected, but others who are development or environmentally-oriented. The Akamba self-help groups have learnt how to capture aid from these bodies.

The new technologies have to be evaluated and managed, and the products have to be marketed. Literacy, numeracy, and general knowledge are increasingly useful not only to get a non-farm job, but also to make the most of a farming enterprise, and to operate the various social and commercial networks with which people are increasingly involved. Initially, secondary education was rare and expensive, having to be provided on a boarding basis to a scattered clientele. Now, day schools are commonplace, though fees and contributions are still a heavy parental burden. School teachers are amongst the educated leaders and information-bearers in every village. Schools are usually built by self-help. Table 3 gives an idea of the very substantial community investment in education between 1958 and 1987.

Table 3: School infrastructure, 1958 and 1987

		Total	Government	Church		
1958	Primary*	264	112	152		
1987	"	1,287	N/a	N/a		
1958	Intermediate	44	20	24		
1987	"	-	-	-		
				Harambee	Private	
1958	Secondary	3	N/a	N/a	N/a	
1987	"	218	40	150**	28	

* Four years in 1958; 8 years in 1987. Intermediate schools were equivalent to upper primary.

** Categorised as 96 assisted Harambee, 54 pure Harambee. These include church-linked schools.

Source: Peberdy (1958) and Kenya. Ministry of Planning, 1988.

Policies and Replicability

An important question is whether the Machakos experience is replicable, by growing populations elsewhere. It has certainly been replicated elsewhere in Kenya. A recent comparative study of Kenya and Tanzania found in both countries very rapid growth of cash crop production by smallholders from the middle of the 1950s (when colonial policies began to favour this) until the late 1960s. Thereafter, output continued to grow rapidly, well in excess of population growth, in Kenya, but stagnated in Tanzania. Both countries have had rapid population growth (though densities have always been lower in Tanzania, making transport infrastructure more expensive). They have a similar range of agro-ecological zones. Bevan et al (1993) find that the difference lies in different pricing, marketing, and educational policies. They conclude that there is a strong diffusion effect, whereby farmers copy each other and move into more profitable activities, which can be supported by educational policies. The direct price effect – that is, the proportion of the world price of a particular commodity which government allows to go to the farmer, also has a significant but smaller effect on production, and, (as they point out, but do not sufficiently stress) indirectly contributes to the disequilibrium between the profitability of different activities which leads to changes in farmer investments.

There is no evidence that specific pro-agricultural policies, either pricing or investment, have played much direct part in augmenting agricultural production. There is, however, evidence that policies can severely damage, indeed completely arrest, what could otherwise be a vigorous autonomous process of smallholder growth (p.99).

The Machakos study confirms the autonomous effects of an increased population, deriving from the availability of more mouths (more demand) more hands (more labour) and more brains (more people interacting more), accompanied by a reduction in the per capital costs of physical and social infrastructure, as shown in Figure 2. The dashed lines show where these autonomous effects can be assisted or impeded by government interventions and policies. This can, in the worst case, weaken the forces which promote investment in appropriate new technologies, fructified by improved information and increased management ability. (Unwise investments produce losses, not benefits).

Machakos has some advantages, including its relative nearness to Nairobi and Mombasa. However, these towns developed because the Kenyan economy developed, as its population expanded. Kenya as a whole has the further advantage that it has never suffered a major breakdown in law and order and the horrors of civil war, which can put development into reverse. Machakos also has some major disadvantages, including its low and variable rainfall, and low average soil fertility. Its relatively successful seizure of new opportunities therefore owe much to the relatively favourable policies of the Kenyan government, which are replicable elsewhere.

We now examine these policies⁵.

Policies to encourage investment and technology development

An inevitable consequence of population growth is a changed land: labour relationship and an increase in demand for food and other goods – (A) in Figure 2. The increasing scarcity of land leads to investments in its improvement. We emphasise the importance of the mainly unrecorded investments (M) which farmers make in response to changing circumstances, provided government policies do not shut them off from incentives, opportunities, and new sources of knowledge and capital, and provided that peace and security are maintained to facilitate trade, travel, and investment. These investments yield the highest benefit when combined with new, appropriate technologies (L), meeting the changing dynamics of the situation in which people find themselves.

Encouraging private investment through market growth

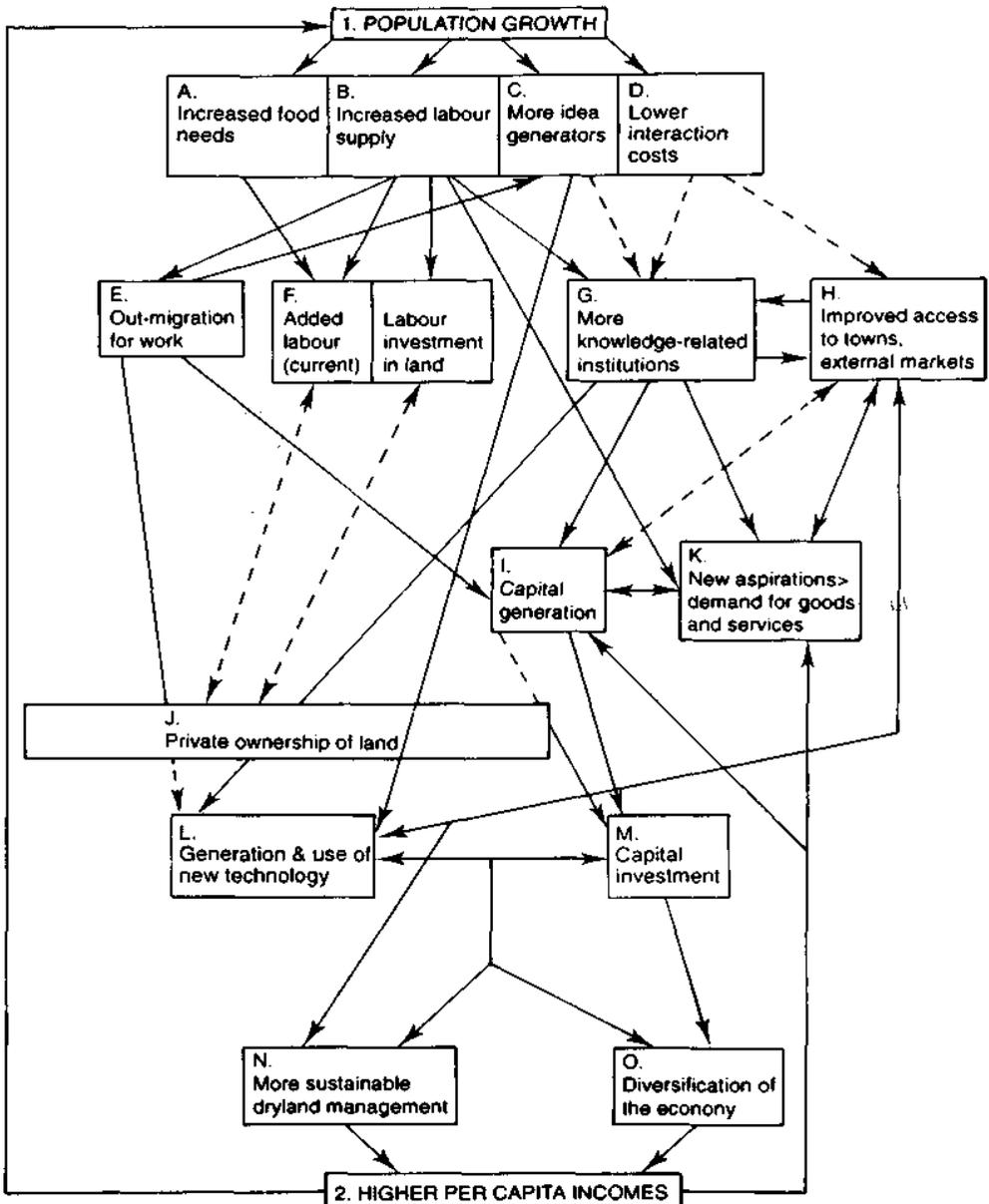
Private investment in agricultural intensification is unlikely to be sufficiently stimulated by subsistence agriculture, since people have aspirations which require cash and, in a semi-arid environment, need to make provision against risk through a diversity of income sources. If agriculture is unprofitable, they are likely to migrate out. Conservation and intensification require the incentive of profit.

Policies that raise farm-gate prices are therefore the single most important action required from governments that want to encourage good land management, since they provide the

5. The remaining section of this paper follows closely material in Chapter 17 of Tiffen, Mortimore and Gichuki, forthcoming, *More people, less erosion: Environmental recovery in Kenya*, Wiley

Figure 2 Positive effects of population growth

— — autonomous
 - - - - can be increased or impeded by government action



means and the incentives for investment. Governments need to do all they can to ensure that the forces flowing from accessible markets (H) act as strongly as possibly on (L) and (M). This means, on the one hand, taxing exports at a modest level and ensuring that the bulk of the world market price reaches the farm-gate and, on the other, ensuring that marketing costs are as low as possible, with a competitive structure having either many private buyers, or both government and private alternatives, rather than any form of monopoly. It means removing controls which increase costs to the buyer or seller, or which prevent the seller from switching into more profitable commodities when circumstances change. The Kenyan Government has followed the policy of passing on the bulk of the world coffee price to farmers, although taxation increased in the 1980s. Horticultural crops are virtually uncontrolled and have a very competitive trading structure. The grain trade has suffered over-regulation, which has added considerably to the costs of inter-district trade, and deterred farmers from specialisation. Under pressure from donors this was being liberalised in the 1990s. On the whole, Kenyan policies have been more favourable to the farmer than those of many African governments which have in effect taxed tradable products highly.

Specialisation by different districts in the products in which they have comparative advantage is likely to increase profitability, and the decision how far to aim at self-sufficiency in food at the farm level should be left to individuals' judgment of their particular circumstances. It is likely that they will usually err on the side of caution, and maintain a diversity of crops that will provide some safeguard against the vagaries of both the weather and the market.

Increasing knowledge, management capacity, and skills

The main requirements here are, firstly, increasing access to sources of knowledge and secondly, increasing capabilities in using technologies, selecting and evaluating them, judging market opportunities and managing institutions in which people combine to raise capital or to organise trade. We give many examples of the way the Akamba actively sought new technologies and new opportunities. The top-down approach of the colonial government largely ignored this, and measured success in terms of their compliance with the government's directives.

Farm managers must judge the trade-offs amongst different alternatives in obtaining risk minimisation, profit maximisation, fertility maintenance, draft energy supply, etc. The selection of appropriate technologies is, therefore, assisted when local farmers participate in the definition of problems and their research and development. This is facilitated by representative institutions and handicapped by their absence. Consultation, demonstration, modification can seem slow processes compared with a top-down approach, which at its worst involves compulsion, and at its best a single message carried by an extension worker. However, the washed-out narrow-base terraces of 1961 at the culmination of twenty years of top-down activity remind us that the expert approach can lead to the waste of time as well as resources. The adoption of a community development approach to terracing in the mid-1950s was the start of progress.

The bench-terrace story is one illustration amongst many of the wisdom of offering farmers not one 'best' technology, but several, which they can evaluate and select in accordance with their needs. (The lesson of Machakos does not imply that the bench terrace should be adopted everywhere.) The selection of a cheap and sufficiently adaptable plough came through market forces. A diversity of technologies is supported by a diversity of sources of information and the policy of openness to foreign NGOs and trading companies which Kenya has followed.

The capacity to select, evaluate, and manage can be increased by both formal and informal educational experience. On the formal side, this means support to schools, adult education classes, agricultural research and extension, and a community development service that brings knowledge and management skills to communities who want to develop amenities or non-farm businesses. On the informal side, out-migration for work or small-scale trade provides information and capital flows to the home farm. Kenya has not on the whole impeded free movement of people to jobs, and has provided, generally, conditions of peace and security. This has enabled the generation of ideas through observation, and the development of new skills through practice in new situations. The out-migrant who is well-equipped by education has the best opportunities of transmitting information and capital back home. This emphasises the importance of supporting education in disadvantaged regions with low population densities and poor market connections.

The poorer members of society are inevitably least able to afford educational costs and are, therefore, the most dependent on the informal education that comes from experience. Restrictions on the often-despised 'hawking' block an avenue whereby such people can travel, make useful observations, and from that, develop an enterprise. The Akamba are noted for their manufacture of, and trade in, wooden carvings (by men) and sisal baskets (by women). At various times Nairobi City Council has severely restricted informal pavement sales, and cross frontier travel has also become more difficult. This diminishes the beneficial interactions between (G), (H), and (K), shown in Figure 2.

Facilitating saving and formal credit

Governments often attempt to tackle the capital shortage directly by providing credit, or building up cooperatives, rather than indirectly, by facilitating savings, and providing security for investments. In a semi-arid environment, savings may be literally eaten up after crop failure. Government can minimise these losses and its own expenditures on famine relief by ensuring that marketing is efficient so that farmers can buy grain as cheaply as possible when the deficit is purely local; and by having an efficient drought warning system so that contingency plans can be activated for food imports, or food relief. Government can also provide research and advice on minimising crop loss in the field or in store, and direct research to drought resistant varieties and appropriate husbandry and other techniques for soil moisture conservation.

As farmers hold some capital in the form of livestock, good veterinary services help by preventing disease losses in both cattle and small stock. Farmers are generally willing to pay for these, and this may be important for the government's ability to maintain the

service. Disease loss is still severe in Machakos, although there have been considerable improvements in regard to rinderpest, trypanosomiasis, and East Coast Fever.

Savings also take the form of money, and can be facilitated by such institutions as Post Office Savings Banks, rural branch banks, etc.

Credit in a semi-arid, risky environment is apt to create debt rather than productive assets. Machakos farmers are nervous of taking credit on the basis of their title deeds and risking loss of their land. Credit has only been used extensively by the coffee farmers who have a tree crop and operate in areas with a slightly less risky rainfall. In the semi-arid areas, a major cotton promotion programme 1978-83 led to a waste of government resources. Farmers are better assisted to raise their own working capital by prompt payment for their output.

Land tenure policies

Secure land tenure (J, Figure 2) encourages farmers to undertake investment in permanent improvements. This can be provided either by the evolution of custom, or by a change in the legal environment. The greatest uncertainties in Machakos were on former Crown Land, typical of the conflicts which often arise between a developing customary law and a statutory law that gives ownership to government.

An economy with many small holdings rather than a few large estates is more likely to develop an active local non-farm sector. Such an economy can be encouraged, for example by laws that promote inheritance of many rather than one heir, or by taxes on undeveloped land, but these policies have to be reconciled with the need to maintain security for investment in land improvement in mind, and avoid clashes with strongly entrenched social or religious customs that will mean that the law will be evaded. Legal change should be preceded by careful consideration of the implications, at present, and for inheritance, and preferably, at rare intervals. Women should be consulted on whether they prefer secure rights as wives or as daughters before instituting change in custom.

The Machakos story has shown that small farmers from crowded 'high-potential' areas can effectively develop 'marginal' land, but it is a process which requires time and capital. The speed with which they invest in land and water conservation will depend on the ease with which they can provide for all their urgent capital needs, and their perception of the value of land. Declaring an uncultivated, unsettled area open for settlement, and encouraging a rush of settlers who can obtain rights only by cultivation, is more likely to result in small, intensively cultivated and tree-planted farms than prescribing large farms based on notions of proper land use (as the colonial government attempted in the one official settlement in Machakos). Where government action can help is in providing some of the community investments such as water supply and roads.

Community investments: self-help and cooperatives

Kenya's orientation to self-help (*harambee*) has encouraged households and communities to realise that the government cannot do everything, and that much depends on their own

efforts. Self-help can be stimulated and made more efficient by community development techniques and management training, which in Kenya are part of the equipment of the churches, the very active NGO community, and the local authority community development assistants. The efficiency of a community development service depends on good training, and it is unfortunate that the course that used to provide initial training to Council CDA staff has been closed down. *Harambee* has mobilised both community work and community finance. The latter has been assisted by the general improvement in literacy and numeracy brought about by the schools, which have themselves been a main target of local community effort.

Grants of tools and topping up grants of equipment and materials to self-help groups have helped the poorer members of society, particularly when stressed by crop failure. They have worked particularly well when they were assisting a project designed and managed by the beneficiaries who have the necessary technical and management knowledge, or who have been equipped with this. Women's groups involved in manufacturing school uniforms were on the whole more successful than groups attempting intensive management of exotic poultry, for example (ODI, 1982). The objective needs to be defined by the members, who may for instance, be most interested in exotic fruit species when an NGO wants to promote indigenous tree types. Food for work has played a part in relieving hardship, but risks inappropriate investments carried out to get relief, rather than because lasting benefits are expected.

Cooperatives can succeed only when there is a suitable environment including enough educated members to check the management, and an infrastructural situation which reduces marketing and transport costs and risks to a reasonable level in relation to the cost of the product. In this situation private traders are also likely to provide reasonable services⁶. However, a cooperative can in the right circumstances be a way of raising capital to provide processing facilities which add value to the product. They have succeeded in Machakos in relation to the densely populated coffee areas with relatively good roads; they have failed to be very effective in processing milk in areas with poor infrastructure and a more scattered population. Government and aid programmes should beware of overloading their capacity, and of giving them functions from the top-down which may be in conflict with the objectives of the members' own elected management. This seems to have happened in Machakos when a cotton programme was imposed on a Union consisting largely of coffee societies.

Small towns and income diversity

The growth of marketed production has created more non-farm jobs (O). In turn, non-farm jobs reduce the risk from a family income entirely dependent on climatic vagaries, and have generated capital. Currently, non-farm jobs are more and more required, to provide for those who are inheriting non-viable plots. This could be assisted by investment in infrastructure at the level of secondary and tertiary towns, providing water supplies, electricity, sanitation, post-offices, etc. Governments can assist the growth of small market

6. A study of Kenya cooperatives is revealing in this regard (Gyllstrom, 1991).

towns by giving them municipal status (as the Kenyan government is increasingly doing), so that they have taxing and revenue raising capacity to provide and maintain essential community amenities. Market towns with a collection of mutually stimulating services will in turn improve the reach of traders into the countryside, the spread of information, the stabilisation of prices in times of shortage, and the raising of the farm-gate prices of products in demand. However, such towns will grow only if they have good transport connections, their priority need. Here, Machakos and other Kenyan Districts have been handicapped by poor systems for road maintenance as well as lack of capital funding for new roads. One consequence is that only 8% of the district population of Machakos lived in urban centres in 1989, a far lower proportion than would be found in similarly densely populated areas of Asia.

Some services and industries will best be provided from national centres outside the District. This need not be regretted, since it will provide opportunities for migrants as well as the nationally increased urban market which stimulates agriculture. We are not advocating a return to the policy of investing in industry at the expense of agriculture, which proved a policy failure of the 1960s in many countries. Rather, we are arguing for investments in infrastructure, both social and physical, which enable agriculture to become profitable and to increase its demands for services and consumer goods.

Direct interventions in agriculture

Our policy recommendations have focused on the generation of conditions that will encourage investments in land improvement and the adoption of technologies that enhance both incomes and conservation. There is, of course, also a role for direct government promotion of improved farming and livestock methods, provided it goes hand in hand with local consultation and the encouragement of access to diverse sources of information. Government promotion of technologies will succeed best if correctly timed. At very low densities, intensive agriculture is unattractive, unsuited to the land:labour ratio. Market links are likely to be weak and expensive in terms of per capita cost and in relation to usage. In such circumstance, emigration to seek work should not be discouraged, for it may widen people's experience, and enable them to raise the capital which farming cannot initially generate. Assistance to education is one way to assist the out-migrants to get the good jobs that may enable some of them to invest in new farm technologies.

The first marketable output is likely to be livestock. People are likely to respond to innovations that increase their health, productivity, and marketability. As early as the 1920s, the Akamba welcomed, and paid for, rinderpest inoculations. As livestock numbers increase, and difficulties arise in pasture management, they are likely to devise, and to welcome help in devising, methods of increasing household control over specific areas. In some cases, in some areas, there will be traditions of group control that are still strongly active, and in this case, after consultation, the government may wish to work with such groups in devising methods of increasing the productive capacity of the range. However, the Machakos experience (not related here) shows the futility of trying to impose ideas of group or tribal control of land on people whose custom has already evolved in the direction of more individualised land rights. It is also apparent that there has to be a quite high degree

of land scarcity before planted fodder, and cut and carry methods of feeding, become more attractive than open grazing. These technologies are now being adopted in the high population density areas of Machakos, but not generally in AEZ 4, 5 & 6. Some methods of range land improvement, including hedging, fencing, bush and indigenous tree management, and scratch ploughing and reseeding or replanting become attractive at a fairly early stage, and have the additional advantage that they can be carried out mostly by direct labour, an advantage in a situation where cash is likely to be scarce.

In semi-arid areas with variable rainfall, food prices will always rocket in bad seasons, and even at low population densities, people will have an interest in reducing the risk to their food supplies. Generally, this will mean finding ways to harvest and conserve what rainfall there is. Water management is likely to have a more direct impact on output than the management of soil erosion only. Fortunately, better water management goes hand-in-hand with erosion control where water is the chief cause of soil erosion. The Machakos farmer has become an expert at the use of cut-off drains, bench terraces, etc., to conserve water for crops as well as to reduce erosion, and the need to consider both the capital and maintenance costs of different technologies. Experts have put little effort into measuring water conservation effects and the maintenance costs.

Choices between maintaining fertility by fallowing, manuring, or the use of chemical fertiliser will be dictated by population density (land scarcity), livestock density, and chemical fertiliser availability and cost at a given time (Tiffen, 1976 for a Nigerian example). Manure is the natural next stage to fallowing, when land for grazing is still relatively plentiful. It is also preferable in a semi-arid area because of its improvement to the water-retention capacity of the soil. This implies a continued role for livestock, which are all the more important because many water-harvesting techniques depend on the use of the plough (e.g. early planting, contour ridging, early weeding). On small farms, with terraces, the ox-plough is likely to remain a preferable instrument to the tractor. Hence, as farms become smaller, with a higher proportion of arable, it becomes necessary to find ways to intensify the keeping of cattle. At this stage, research directed at alternative feeds for cattle which are kept in stalls for at least part of the year, becomes appropriate. On even smaller farms, there may be only small stock and poultry; research is then needed on using their droppings, perhaps in association with composting.

The need to get high returns to water may drive some farmers out of livestock and into those tree crops which can, if well managed with appropriate water-conserving techniques, survive the inevitable drought years. They will be looking to get from their trees not merely subsistence fuel needs, but cash, amenities, and a contribution to soil fertility. Some needs will be satisfied with a few scattered trees in the arable and grazing lands, or a variety of trees near the house. Others will best be satisfied by dedicating a patch of land to a tree crop. Moving into tree crops will bring its own risks, such as disease. Farmers in Machakos are already worried, for example, at the threat from citrus diseases. Given the limited resources available for research, it will be difficult to keep ahead of farmers who have already reached this diversity of practice and utilisation of trees. This again emphasises the need for consultation with the farmer as to what are the major problems that should be given priority.

Fruit tree crops with horticulture generally represent later stages of intensification, when there is a local and/or accessible external market for these higher value food products. It requires a more sophisticated research and extension service than generally available to keep up with the multiplicity of products, which suggests that government should actively encourage commercial enterprises and NGOs to join in meeting farmers' needs and listening to both their problems and the results of their experimentations. To be successful, interventions have to be in conformity with the changing dynamics of farming systems evolving in response to population growth and increased market access.

Infrastructure

Government and community investment in physical and social infrastructure such as roads, electricity, water, schools, financial services, veterinary and extension services, research services, is vital but not enough. To be useful, these facilities have to be operated and maintained, funds must be available, not merely for staff salaries, but also for the means by which staff can operate and maintain. Given the limitations on government and community resources, this means providing

- a cost-effective service;
- a revenue base from centrally or locally raised taxes and/or user fees and contributions; and,
- a monitoring and accounting system in which those using the facilities have a role, either as voters, or as people who can choose whether or not to buy the service.

Few governments solve all these problems ideally. Kenya has a relatively satisfactory system in regard to schooling, although it could certainly be improved, and very unsatisfactory systems in regard to roads. Services are seldom cost-effective, because staff are employed who have not the means to be effective. Its agricultural research services (except for some specific export crops) are now almost totally dependent on aid programmes for operational costs, which means that research proceeds on a stop-go basis according to overseas fashions. Aid agencies have been blameworthy in encouraging policies that have led to staff expansion without considering revenue sources and limitations.

Central government, local government, participation, and accountability

The choice of policies, and the oversight of their implementation, depend on the extent to which rural people are able to influence the agenda, and the disposition of resources. Elected local authorities at the District and municipal level can provide at least some of the services that are required in a fashion dictated by the needs and wishes of their electorate. Policies that deprive such councils of funds, professional skills, and functions are therefore likely to detract from the matching of policies to local needs, and accountability.

Unfortunately Kenya has been proceeding down this path, and it shows, especially in the maintenance of rural roads.

There is an important role for central government in drawing up macroeconomic policies, in maintaining law and order and the stability of the currency, in establishing fair and equitable taxation, and in setting minimum acceptable standards in matters that will affect the community as a whole. They also have to provide the national level infrastructure with which local infrastructure links up. However, central authorities should not seek to dictate the precise technologies that individuals should use, or the precise crops that they should grow. Choice should be left to the users, remembering that what is suited to the assets and resources of one family will not necessarily be best for their neighbour.

Population policies

The Machakos experience between 1930 and 1990 lends no support to the view that rapid population growth leads inexorably to environmental degradation. It is impossible to show that a reduced rate of population growth might have had a more beneficial effect on the environment. On the contrary, it might have made less labour available for conservation technologies, resulted in less market demand and incentives for investment, and reduced the speed at which new land was demarcated and conserved after being cleared. Population growth has made land a scarce and increasingly valued asset.

Falling fertility, reflected in a lower rate of population growth, suggests a spontaneous response to changed economic conditions in the period 1979-89. An extreme shortage of land in some parts of the District, diminished opportunities for income diversification with the national economy in recession, and the high educational and other costs of raising children appear to be leading to voluntary family limitation. The provision of family planning information and the making accessible of supplies can be justified as adding to peoples' choices and the control which they have over their circumstances. To argue for population limitation on environmental grounds weakens the case for it both theoretically and practically.

Conclusion

The adaptive capability of the Akamba people has been underestimated in the past, and makes it difficult to predict their future. They are not unique, and it is likely that the capabilities of others have been similarly underestimated. Given suitable policies and attention to water conservation, semi-arid lands can support larger populations and become more productive. The direction of undue proportions of government attention and resources to high potential areas (as suggested, for example, by Lele and Stone, 1989) is, therefore, not justifiable on the grounds that the semi-arid areas cannot repay investment. Direct dictation of what farmers should do to limit their families or to develop their land is not the way to assist them to retain the necessary flexibility to face the future. Rather, government support is required in increasing access to knowledge and to markets, and in maintaining the infrastructure that is provided, in order to encourage people to make informed choices in their private investments and innovations in response to changing circumstances. The

best policies are likely to derive from institutions which permit communication on policy needs between the experts who know and live in the District (i.e. the farmers), and those who derive expertise from their professional studies and knowledge of the national and international situation. It is the latter who need to learn the virtues of humility.

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