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The transition to sustainable tropical land use

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Summary

East of Nairobi in Kenya lies the district of Machakos. In 1937, the district was described as:

> *'an appalling example of a large area of land which has been subjected to uncoordinated and practically uncontrolled development by natives whose multiplication and the increase of whose stock has been permitted (...) under benevolent British rule'*
> (Maher, quoted by Tiffen et al., 1994, p. 3).

In their book *More People, Less Erosion* (1994), Tiffen, Mortimore and Gichuki studied the causes of the change from the situation thus described to the present, where more and richer people now live in the same area and where most soil degradation has been brought to a halt and even reverted: hills that once were desolate, barren slopes now have coffee plantations on terraced plots.

Examples such as this, where large-scale improvements have been brought about and now provide a sound basis for agricultural development, are the point of departure for this article.[8] The article addresses two questions: (1) *what were the causes for these and other successful transitions*, and (2) *can the same be effected elsewhere*. Machakos is not the only example; there are many other regions where from a seemingly hopeless situation a healthy agriculture was established.

Environmental degradation and poverty

The importance of research on environment-poverty linkages is evident. For one, the perennial pressure on their physical environment hurts the population in these areas, rendering agriculture and cattle farming less productive. Governments, too, are concerned. Their policies include efforts towards seeing

[8] The article is the result of the NWO-sponsored research programme carried out by a multidisciplinary team of the University of Amsterdam (Ton Dietz, Fred Zaal), their affiliate, the School of Environmental Studies of the Moi University in Eldoret, Kenia (with Samuel Mwakubo and Michael Bowen as D.Phil. students), Leiden University (Wouter de Groot and Adri Zuiderwijk, with Marino Romero from the Philippines as Ph.D. student) and Free University, Amsterdam (Jan Willem Gunning, Kees Burger and Remco Oostendorp, and Esaïe Gandonou as Ph.D. student from Benin).

certain regions evolve into sustainable agricultural areas, whereas other regions should preferably be kept intact as forestry or nature reserves, or simply because the slopes are too fragile to be exposed to cultivation. In the international context, one of the Millennium Development Goals of the United Nations, MDG-7, calls to *ensure environmental sustainability* and more specifically to *reverse loss of environmental resources*. Research should provide insights into the factors that can be influenced so as to prevent further loss of resources *and* – in doing so – serve the first of the Millennium Goals: reduce poverty and hunger.

Official reports of the Netherlands' Ministry of Foreign Affairs pay considerable attention to the issue of soil degradation. In the white paper 'Aan elkaar verplicht', in which Minister Van Ardenne sets out her policy, a target of 0.1 per cent of the GDP is set for the aid flow on environmental issues, including water provision and sanitation. Her paper on Africa gives due emphasis to soil degradation and the extent to which this problem threatens the livelihood security of the population. The paper proposes to collaborate intensively with UNEP to enhance 'ecological governance' and points out the role that land ownership can play. Environmental degradation, it is claimed, disproportionally affects the poor. Neither of the reports, however, elaborates in any great detail on the many positive developments in this field such as 'Machakos' and the many local initiatives in Burkina Faso (Reij and Steeds, 2003).

Different approaches

Soil degradation is linked to land use. At low levels of population density, people can feed themselves by using the land extensively: after some years of use, other land can be taken into cultivation and the original area can have time to restore itself naturally. This type of land use is still widespread in Africa. The mobility of the agricultural population itself is considerable and in many places land is abundant. Where labour is less mobile and the population is growing, the demands on the land increase. The question then is what road will be followed.

The literature mentions four approaches to this problem. The oldest one is from Thomas Malthus, who wrote in 1798 that food production would not be able to follow the growth of population, so that eventually population growth would be stopped by the availability of food. He, therefore, foresaw that the population density would reach equilibrium at a low level of welfare, just enough to survive.

The second approach is from Esther Boserup, who argued in her 1965 book *The Conditions of Agricultural Growth* that in times of increasing population density (and land scarcity) people shifted towards using technologies, often involving cattle, that made sustainable land use possible at higher levels of productivity. This made it possible to maintain the food production per capita. She describes this transition mostly as a social process in which the interaction between people is crucial for the realization of innovations. A more economic approach

to the same transition is Hayami and Ruttan's (1985) *induced innovation*, in which the change in technology depends on prevailing price ratios.

The third approach is the neo-classical version of this process. The emphasis is on individual households for whom the adoption of the new technology should be remunerative. Investments in terracing, for example, can become attractive when product prices increase faster than construction costs. Many recent studies try to show this by comparing benefits and costs. The importance of this approach is that it can show that many profitable investments are not made, simply because the money is lacking due to imperfections in the credit markets. The difference with the Hayami-Ruttam approach is the latter's emphasis on the price ratio of production factors and the innovation process, whereas the former gives centre stage to the individual profitability of adoption.

The fourth and final approach builds upon Von Thünen, who wrote in 1826 that the use of land is related to distance to the market: more intensive is near the market and more extensive is farther away. Population growth in a region can lead to the formation of markets, creating new outlets for agricultural products that may induce the use of other technologies and increase the value of the land.

In their analysis of the changes in Machakos, Tiffen et al. indicate that Boserupian elements played the leading role, while also admitting that Nairobi's growing vicinity was an important factor, thus bringing in Von Thünen. They point to the growth of the population and increasing interaction within this population, an effect of more schooling and greater women's involvement, to substantiate the Boserupian claim. The contribution made by a closer market was to facilitate migration and the transfer of remittances, but more importantly to provide outlets for new and profitable products. In addition, the new crop, coffee in this case, provided a strong stimulus to create terraces on which trees could be planted.

Tiffen and Mortimore have continued their research along these lines. In a recent publication (Tiffen, 2003) on research in West Africa, more weight is given to the role of commercial opportunities than in the case of Machakos. The group see provincial capitals as important engines of agricultural growth and of the ensuing incentives to stimulate sustainable management of the land. This concerns land that can be reached from the centres, however. Improvements in infrastructure bring the centres closer to the surrounding land, and the area that was in Von Thünen's outer circles is brought within inner circles. The land is now more suited to intensification, higher land prices result and profitable conservation can be undertaken.

Rationality of soil and water conservation

Our own research was aimed at measuring the individual rationality of soil and water conservation, as well as the importance of population density and distance to markets. To this end, four regions in Africa were selected, two in Kenya, viz. Machakos and the neighbouring (and poorer) district of Kitui; the

Atacora region in Benin; and the Koza plains in Northern Cameroon. In each region, four villages were selected that differed in distance to markets and population density. Finally, four villages in the Philippines were selected to see if the relationships found for the semi-arid or sub-humid regions equally apply to humid tropical regions. In each village, we randomly selected 25 households and conducted interviews there. In total more than 500 households were interviewed. The survey focussed on costs and benefits of conservation activities such as terracing, grass strips, stone bunds, tree plantings, etc. In addition, we collected data on the cropping pattern of the households, the input of labour and other factors, crop production and sales and other sources of income.[9]

The analysis focussed on econometrically establishing the weight of the various factors that might explain investments in soil and water conservation. This can be studied at village level (transport facilities, banks, social cohesion, knowledge) or at the level of a household (size, education, wealth, etc.) or the level of a plot of land (slope, fertility, conservation measures, etc.). The initial idea was to use these estimates to construct a 'transition indicator model' that should indicate the probability of a successful transition to sustainable agriculture and the way in which this could be influenced by policy intervention.

Kenya

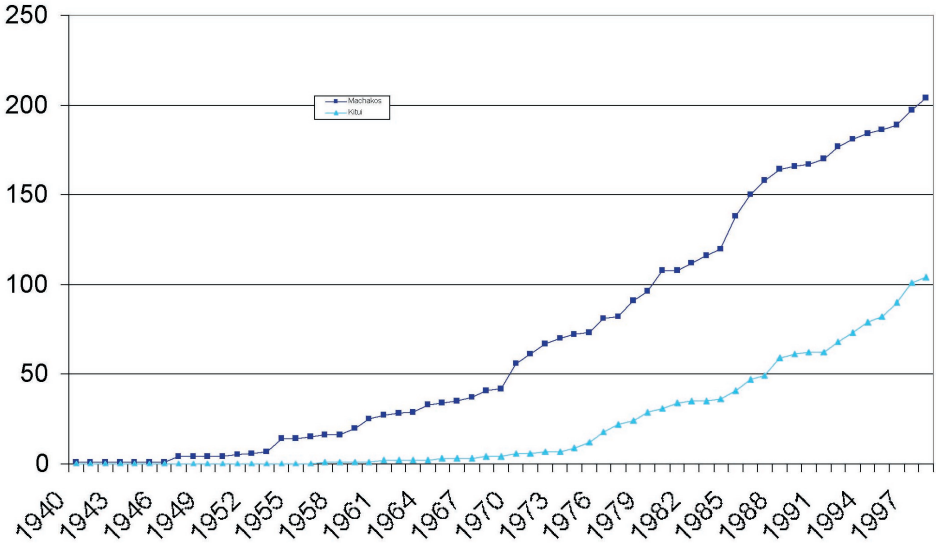
The choice for Machakos was dictated by the objective to check the Tiffen et al. findings at the level of the household, as this was not done to any great extent in the famous *More People, Less Erosion*. Kitui was chosen so as to measure the changes in a district that is less well endowed than Machakos because it is somewhat poorer and dryer, but otherwise in a similar economic setting. The three authors of the book participated in the starting workshop that we held in Machakos. In total, around 200 households were interviewed, most them both in 1999 and 2001. The households were randomly selected from four villages that were chosen so as to represent cases close to and far away from Nairobi and cases with relatively low and high population density conditions.

Generally speaking, the research provided a confirmation of the positive trend towards conservation. This is clear from Figure 1, derived from Zaal and Oostendorp (2002).

Zaal and Oostendorp focussed in particular on the factors that can be held responsible for the individual decisions of the farmers (both male and female) to establish terracing. Their analysis, which was done at village level and at plot level, showed that distance to the market does indeed play an important role, and villages differ along the lines predicted by their population densities and

[9] Local Ph.D. students, with guidance from local staff and Dutch researchers, performed most of the data collection. The data formed the basis for their thesis work and the analyses were made by post-doc research staff.

Figure 1 **Number of terraced plots in the sample in Machakos and Kitui, Kenya (by year of first terracing)**



distance to markets. In addition, the high coffee prices of the late seventies proved to have been an important incentive, more so than the occurrences of drought. The survey shows that revenues from coffee have been used to establish new terraces. One important policy implication of this finding is that not passing on to farmers the yields from high coffee prices, as in Tanzania at that time, missed an opportunity to contribute to soil and water conservation.

Access to markets, both for cash crops and for other marketable crops, is clearly important. The thesis work by Samuel Mwakubo, written on the basis of these data, confirms this role of distance to markets, and indicates that when distance is a negative factor it is not only apparent in the marketing of products but also in the use of fertilizer.

We now look somewhat deeper into this finding. The statistical evidence is obvious, but how would this factor work out at the farm level? Lower transaction costs increase the prices for the products sold and lower those of the goods bought. This enhances the profitability of production for the market. If this were to have an effect on soil and water conservation, this notion of profitability should induce investment in soil and water conservation. Detailed analysis of the farm data should indicate whether the higher production on terraced plots justifies the costs that farmers make to construct them. And indeed it does. The returns on terracing are substantial (Burger and Oostendorp, 2002). On plots with such investments in place, cereal yields, adjusted for other factors (fertilizer, labour, etc.) are about 25 per cent higher. The costs of terracing, on the other hand, are not particularly high in Kenya. Their order of size is around 10-20 per cent of the annual labour requirements

of crop production. By itself this should imply that terracing is highly profitable. It should also imply that the investment is attractive not just for rich farmers but also for poor farmers.

The major instrument for investment is the workforce, which is often sufficiently available in poor farm households. Why, then, do we observe that such investments in terracing are not more widespread? Why do we only see them in connection with access to markets (or, in the other extreme case, isolation from markets)? Why would the high coffee prices have contributed so significantly? There are two major reasons. Firstly, the maintenance costs of terraces are high. The annual labour requirements to maintain them amount to about 50 per cent of the initial construction costs. Because of this, terracing is a more technological choice than a choice for a particular capital investment. Secondly, the technology requires good access to the market in order to purchase fertilizer and other inputs and to sell the products. If the market is not accessible, simply because of distance or indirectly because of language, knowledge or the need for credit, the profitability of the investment is much lower and the investment of time is not made.

The sequence of events leading to investments in soil and water conservation in areas that are not isolated is likely to be as follows. Population growth and general economic development, resulting in better road and communication networks, bring the region closer to markets. This enhances the profitability of agriculture, notably the cultivation of crops for the market. This in turn makes the region a better place to stay; more people may want to settle there or fewer people may want to leave the region. This pressure, combined with the profitability of farming, increases land prices. Where land is not being traded it becomes scarce nevertheless, which can be observed from farms becoming smaller, as in this case. The scarcity of land, relative to labour, induces farmers to opt for a technology that uses land more intensively.

The empirical research done in Kenya confirms the effect of the relative scarcity of land. We find that the characteristics of the technology on terraced plots are consistent with land being more valuable relative to labour. A higher share of the revenues goes into the land factor and a lower share to the labour factor.

Land implies location

Land is not just more valuable because of its price or its rental value on the market. It is also more valuable because other inputs such as fertilizer can be used on it. Those who have land are in a position to benefit from the closer proximity of the markets. The position of landowners changes therefore. They become more important. Access to land becomes crucial. Whereas in land-abundant regions, the poor are to be found among the groups with less access to labour, in the land-scarce regions it is access to land that makes the difference.

Land can be scarce in a particular location for other reasons, too. Land situated at a strategic crossing of roads, which implies perfect access to inputs and selling opportunities, will be in high demand. The same goes for land situated in areas where people find it attractive to dwell. Good amenities in terms of schooling, health care and social capital pushes up the 'price' of land and hence the attractiveness of technologies that sustain the use of land. Security of tenure is an element in this domain: land can only become scarce if many people want to be entitled to the use of any piece of it, and land is only cared for if people feel secure about being able to reap the fruits of any investment in the land. This feeling of security is often ascribed to formal land titles. In an African context, however, security is more often derived from the social environment to which one belongs. It is the ethnic group, tribe or village that determines how durable access to land is, and membership in such groups provides security. A sustainable community is a prerequisite for sustainable agriculture.

While the empirical findings corroborate that the sustainable technology of terracing is consistent with land values that are high in comparison with the price of labour, we still need to ascertain what caused land at this particular location to become so valuable. There are technical reasons (high inherent soil fertility), economic reasons (high prices for the products) and demographic reasons (high population growth). Population growth is the more structural reason. As long as abundant land is available, a growing population may find ample new land to farm. In many African regions, people are mobile enough. Within a relatively short period of time, large parts of Machakos became more densely populated, mostly due to immigration into the area. Areas with more than 50 persons per km2 more than tripled between 1962 and 1979. And in the latter half of this period terracing really took off, as Figure 1 shows. Towards the end of the period, several of the factors that support terracing occurred at the same time. Coffee prices surged to incredibly high levels, land became relatively scarce, and the technology to establish terraces became widely known. Coffee planting and terrace construction also helped the new settlers feeling more secure about their entitlements to the land.

The Kenyan case provided a good example of how population increases, combined with improved economic conditions – including better access to the town – made land much more valuable. The high value warranted investment in its sustainability.

Benin

The Atacora in the northwest of Benin is a hilly region, far from large population centres. The area is traditionally densely populated. The Boukombé district had a population density of 45 persons per km2 in 1979 and 56 in 1992. There are large differences within the district. Of the four researched villages in the area, only one – close to the main road – recorded an increase in population over this period. As long ago as 1929 reports were being published that showed the dramatic predicament of the population and the high demand on the land. In our survey this experience is recalled by the farmers

themselves: not until recently, when other regions in Benin had become accessible to the migrants from Atacora, did the pressure on the land subside. The use of the land nowadays indicates that in remote mountainous villages, where land is scarce, hills are being cultivated. To cultivate the hills, stones must be moved. These stones can then be used for erosion control.

Our econometric estimates (Adegbidi, Gandonou and Oostendorp, 2002) show that the use of erosion control enhances yields by some 25 per cent. Unlike the Kenyan case, however, labour requirements, especially for the annual reconstruction of the devices, rise by the same amount! The returns per person, therefore, do not improve. The investments in 'sustainable' farming in the area are borne by the need to survive and do not improve the predicament of the population.

When other regions provide access to land, and the region itself becomes less isolated, more people migrate from the region as a result. Improvements in the infrastructure in the more remote areas reduces the scarcity of land, which is contrary to the Machakos case and also contrary to one of the villages in Atacora: the village with good access to roads and markets.

Cameroon

The research area in Cameroon was the remote Koza plain, bordering on the Mandara Mountains. Over the last few decades, farmers who traditionally lived in the hills have started to cultivate the plains. In earlier days this was not possibly due to hostilities with other tribes. In view of this history, the Mafa culture is rich in experience with erosion control and integrated sustainable farming on the slopes. Yet hardly any soil and water conservation has been used in the new flatter land that has been put under cultivation since the 1960s and 70s. There was no strong incentive to do so, as this land was not scarce and its ownership was not very secure. Cotton, with subsidized fertilizer, provided reasonable income opportunities, and some farmers, using tractors, benefited from economies of scale. To this end, many trees were uprooted. When fertilizer prices went up, it became clear that the region had become deficient in organic material, making a return to sustainable farming difficult and slow. As result, although the region is more open and secure now than it was some decades ago, it is impoverished both in economic returns to the original farmers and in terms of natural capital.

Though land near the villages has become scarce, a Machakos-like transition did not take place. The reason appears to be the lack of organic material, which puts a ceiling on the value of the land. This case shows us, therefore, that the Machakos success story owes some its glamour to the presence of sufficient organic matter in that region.

The Philippines

The three research areas in Africa provided cases for possible transition to sustainable agriculture in semi-arid or sub-humid zones. We tested the findings in a humid climate, for which four villages were selected in the Philippines, again located in densely and less densely populated regions, near to and far from major markets. The Philippine case also differs in that the involvement of the government and NGOs is more pronounced here. In particular, the government runs a settlement scheme whereby farmers can acquire rights to former forestland on the condition that they cultivate the land in a sustainable manner.

The village that is close to the city of Manila surpasses even Machakos in demonstrating the value that can be obtained from the land. Terraced plots can produce up to ten vegetable crops per year. Here too, the highest costs of terracing are the recurrent yearly maintenance costs rather than the original one-time cost of establishing the plots. An interesting finding in the work by Marino Romero was the ethnic influence in terracing: the Ifugao migrants who inhabited the area knew how to construct the plots already, and even without the incentive of the nearby city their preference for rice would have led them to terracing.

Policy implications

How are these findings relevant to development policy? On the one hand the answer lies in the insights that the study offers; on the other hand it begs the question as to the type of development assistance that is required, if any. The insights the study offers have to do with the interaction between environment, land scarcity and poverty. In land-abundant regions, the rural poor are typically households that lack access to labour. In land-scarce regions, they are among those who lack access to land. Where land is abundant (and cheap), incentives to invest in soil and water conservation are very weak. Where good and accessible land becomes more and more scarce, local institutions tend to deal rather well with this situation, and if that is not sufficient, migration may offer a way out. Investments in land, such as terracing and stone lines, require a yearly input of labour. This is only remunerative if there is reasonable security of ownership and if the land is valuable enough. Without infrastructure, land can be very valuable in extreme isolation; otherwise, it becomes valuable mostly by being located near roads and markets, permitting the use of fertilizer and the sale of crops. The cheaper the fertilizer or the better the price of the crops, the more it pays to invest in the quality and sustainability of the land. Inherent soil fertility or the presence of sufficient organic matter appears to be required, however. In addition, investments only pay off – and are therefore made – if the investor is secure about his future. This depends on legal arrangements but probably even more so on the social structure of the local society in which the farmers find themselves.

Apart from such fundamental issues that can help in evaluating ongoing policies, what does the study have to offer in terms of actual guidelines? Obviously there is a case for policy intervention only if the forces of the market and societal institutions are not able to generate an efficient outcome. The village in the Philippines near Manila and the example of Machakos show that good and sustainable solutions can be found. Next to technology, *scarcity* and *security* of land appear to be the two key issues that should assure sustainable land use. Both are required, and both are central to government policy. Scarcity of land, i.e. the sort of scarcity that makes land *valuable* in a region, is enhanced by a good physical and social infrastructure; security is enhanced by a stable social policy. In the Philippines, the government stepped in when the market failed to protect the natural resources from degrading, and in doing so created both scarcity and security of land. Being in the vicinity of a market makes land valuable and therefore scarce. In the Cameroon case, land became less scarce and sustainability was therefore less needed. Access to markets should have enhanced its value, but relative abundance and lack of inherent fertility, and – increasingly – lack of organic matter, prevented this from occurring. Here government intervention should have helped safeguard the natural availability of organic matter. Market prices change over time and government intervention is justified when short-term market influences would jeopardize the realization of longer-term benefits.

The study areas also show how the knowledge of appropriate technologies helps people making a transition towards sustainable technology. As the market does not normally accomplish this, government action and support is called for to disseminate knowledge of sustainable practices.

Finally, the security that comes from usage rights (not necessarily ownership) can be fostered by government action. It should be acknowledged, however, that security requires not just action at the macro level but also at the local level. The frequently observed mobility of groups in Africa, the concomitant disputes about traditional ownership of land, and the insecurity often faced by migrants threaten sustainable use of the land. The promotion of social capital formation between the various stakeholders in local land use is perhaps the more challenging of the tasks faced by local and national governments. It would have a high pay-off in terms of sustainable land use and access to this land for broad segments of the society.

References

Adegbidi, A., E. Gandonou and R. Oostendorp (2004) 'Measuring the Productivity from Indigenous Soil and Water Conservation Technologies with Household Fixed Effects: A Case Study of Hilly-Mountainous Areas of Bénin'. *Economic Development and Cultural Change*, 52(2), 313-46.

Barbier, B. (1998) 'Induced Innovation and Land Degradation: Results from a Bioeconomic Model of a Village in West Africa'. *Agricultural Economics*, 19: 15-25.

Burger, K. and R. Oostendorp (2002) *Investments and Uncertainty in Soil and Water Conservation in Africa*. Working paper ESI, July 2002.
Murton J. (1999) 'Population Growth and Poverty in Machakos District, Kenya'. *Geographical Journal*, 165:1, 37-46.
Hayami Y. and V. Ruttan (1985) *Agricultural Development: An International Perspective*. Baltimore: Johns Hopkins University Press.
Reij C. and D. Steeds (2003) *Success Stories in Africa's Drylands: Supporting Advocates and Answering Sceptics*. A paper commissioned by the Global Mechanism of the Convention to Combat Desertification.
Swinton S.M., G. Escubar and T. Reardon (2002) 'Poverty and Environment in Latin America: Concepts, Evidence and Policy Implications'. *World Development* 31:11, 1865-1872.
Tiffen, M. (2003) 'Transition in Sub-Saharan Africa: Agriculture, Urbanization and Income Growth'. *World Development* 31:8, 1343-1366.
Tiffen, M., M. Mortimore and F. Gichuki (1994) *More People, Less Erosion: Environmental Recovery in Kenya*. Chichester, UK: John Wiley & Sons.
Zaal, F. and R. Oostendorp (2002) 'Explaining a Miracle: Intensification and the Transition Towards Sustainable Small-Scale Agriculture in Dryland Machakos and Kitui Districts, Kenya'. *World Development* 30:7, 1271-1287.