Transition to sustainable tropical land management

Kees Burger

Free University, Amsterdam
And Wageningen University
kburger@feweb.vu.nl

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By
Kees Burger
Departments of Development Economics,
Free University Amsterdam & Wageningen University,
The Netherlands

Abstract

Following the example of Tiffen *et al.* on Machakos, Kenya, new macro-based evidence was collected in Machakos, the neighbouring Kitui district and in Benin, Cameroon and the Philippines, to assess the factors à la Boserup, inducing transitions towards sustainable land management, such as terracing, stone bands etc. We find that relative scarcity of land can be seen to induce technical changes, in the sense of Hayami & Ruttan, that correspond to the new relative scarcity, making higher man-land ratios the optimal choice.

Key words: soil and water conservation; sustainable agriculture; induced innovation; Boserup; Malthus

JEL: Q12, Q21, Q28

1. Introduction

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, where most soil degradation has been brought to a halt and even reverted: hills that once were desolate, barren slopes now show 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, formed the point of departure for the NWO sponsored research programme[1]. The programme asks two questions: *what were the causes for these and other successful transitions*, and *can the same be effected elsewhere*. Machakos is not the only example, there are many regions where from a seemingly hopeless situation a healthy agriculture was established.

The importance of such type of research is evident. For one, the population in these areas is hurt by the perennial pressure on their physical environment, rendering agriculture and cattle farming less productive. Governments too are concerned. Their policies include efforts towards seeing 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*. The research should provide insights into the factors that can be influenced so as to contain 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% of GDP is mentioned for the aid flow towards environmental issues, including water provision and sanitation. Her white paper on Africa gives due emphasis to soil degradation and the extent to which this 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).

[1] The research programme was 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 DPhil students), The Leiden University (Wouter de Groot and Adri Zuiderwijk, with Marino Romero from the Philippines as PhD student) and Free University Amsterdam (Jan Willem Gunning, Kees Burger and Remco Oostendorp and Esaïe Gandonou as PhD student from Benin).

2. Approaches

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

The literature shows 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 an equilibrium level for the population density 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 realisation of innovations. A more economic approach of the same transition is given by Hayami and Ruttan's (1981) *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 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 the approach is that they 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 individual profitability of adoption central stage.

The fourth and final approach builds upon Von Thünen who wrote in 1826 how the use of land is related to the distance to the market: more intensive near the market and more extensive farther away. Population growth in a region can lead to the formation of markets causing 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 it were mostly Boserupian elements that played a role, while Nairobi's growing vicinity admittedly was an important factor as well, thus bringing in Von Thünen. They point at the growth of the population and increasing interaction among this population, an effect of more schooling and greater women involvement, to substantiate the Boserupian claim. The contribution by the nearer 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.

The group of Tiffen and Mortimore has continued its 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. They see provincial capitals as important engines of agricultural growth and the ensuing incentives towards sustainable management of the land. This regards land that can be reached from the centres. Improvements in infrastructure brings the centres closer to the surrounding land and area that was in the outer circles of Von Thünen is brought within inner circles. The land correspondingly is now more suited for intensification, higher land prices result and profitable conservation can be undertaken.

3. Micro level approach

Our own research programme 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 distinguished themselves in distance and population density. Finally, four villages in the Philippines were selected to check 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 interviewed these. 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. Local Ph.D. students with guidance from local staff and Dutch researchers performed the major part of the data collection. The data formed the basis for their thesis work and the analyses by post-doc research staff.

The analysis focussed on establishing econometrically 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.

4. Evidence from Kenya and Benin

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* book. Kitui was chosen so as to measure the changes in a district that is less well endowed, because somewhat poorer and dryer, than Machakos but otherwise in a similar economic setting. The three authors of the book participated in the starting workshop that we staged in Machakos. In total, around 200 households were interviewed, most them both in 1999 and in 2001. The households were randomly selected in four villages that were chosen so as to represent cases close to and far away from Nairobi and in relatively low and high population density conditions.

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

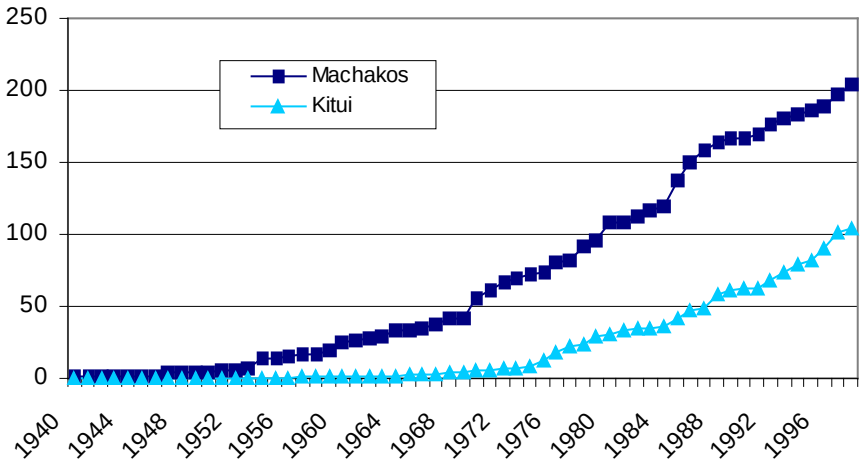


Figure 1 Number of terraced plots in the sample in Machakos and Kitui, Kenya, by year of first terracing

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 plays an important role indeed, and villages differ along the lines predicted by their population density and distance. 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 indicated that revenues from coffee have been used to establish new terraces. One important policy implication of this finding is that a policy of not transmitting the high coffee prices to farmers, such as in Tanzania at that time, missed the opportunities of contribution to soil and water conservation.

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

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 investments into soil and water conservation. Detailed analysis of the farm data should show if the higher production on terraced plots justifies the costs that farmers make to construct these. And indeed they do. The returns to 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% higher. The costs of terracing, on the other hand, are not so high in Kenya. Their order of size (approximately 12 man-days per ha) is around 10-20% of the annual labour requirements of crop production. By it self 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 the investment is labour force and this is often sufficiently available in poor farm households. Why then, do we observe that such investments into terracing are not more widespread? Why only with good access to markets (or, in the other extreme, in case of isolation)? 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% of the initial construction costs. Because of this, terracing is more a choice for a different technology than a choice for a particular capital good. Secondly, the technology requires good access to the market in order to purchase fertiliser and other inputs

and sell the products. If the market is not nearby, 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 network, bring the region closer to markets. This enhances the profitability of agriculture, notably the cultivation of crops for the market. This makes the region a better place to stay and more people may want to settle there or fewer people leave the region. This pressure combined with the profitability of farming, increases land prices. Where land is not traded, it becomes scarce nevertheless, as – in this case – can be observed from farms becoming smaller. 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 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 to the factor land, and a lower share to the factor labour.

The new technologies on the terraced plots give an important role to production factors land and fertilizer, and a lesser role to labour, both compared with the technology for non-terraced plots. Some estimation results are in Table 1 below, taken from Burger and Oostendorp (2002). The dependent variable is the production value per plot and in addition to the factors mentioned the estimation accounted for type of soil, slope and household characteristics. Estimation was done at the plot level with village fixed effects to account for specific (partly unobserved) characteristics common to the plots of a village. Mean farm size is 3.3 ha (with 5.2 plots) in Benin and 1.9 ha (with 2.5 plots) in Kenya. Household size in both countries is just over 6 persons. In Kenya just over half of the household income is derived from crop production, against over 70% in Benin. Labour input per ha in Kenya is around 140 man-days per ha, and in Benin around 60.

Table 1. Partial effects of production factors in Benin and Kenya

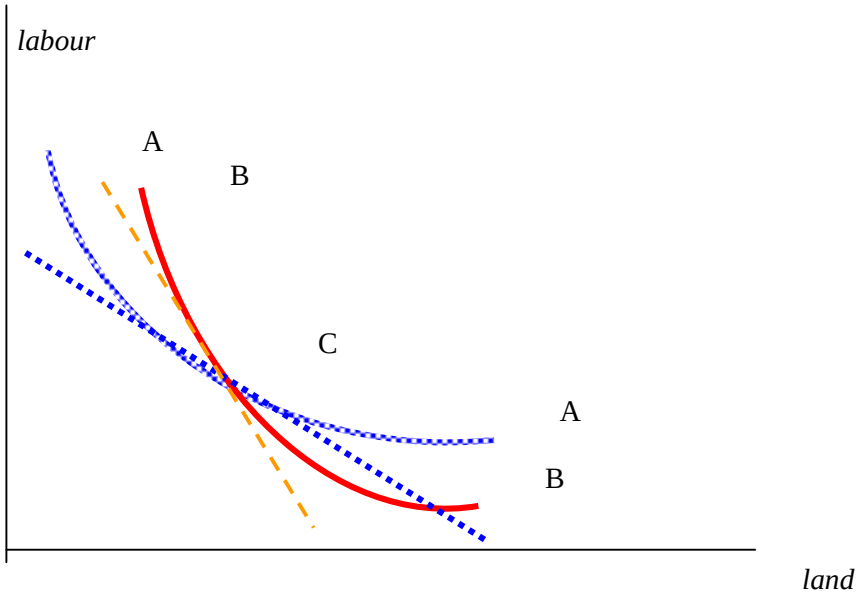
Variables	Without Investment		B: with tie ridging1 K: with terrace	
	Coef	t	Coef	t
	Benin			
Log labour	0.625	4.4	0.241	1.4
Log size plot	0.318	2.4	0.384	2.6
Fertilizer (kg)	0.005	2.2	0.006	1.8
	Kenya			
Log labour	0.387	2.6	0.178	1.7
Log plot size	-0.274	-1.1	0.471	4.3
Fertilizer (kg)	0.001	0.2	0.009	3.0

The econometric estimations consistently show higher production-elasticities for land and fertilizer, and lower elasticities for labour. Application of the new technology requires therefore access to those now more important production factors: usage rights of land, also in the future, and cash to purchase the new means of production. Where access to both is limited, the investment may be cheap, but still not attractive, as the benefits of the terraced plots cannot be reaped. The greater importance of the factor land vis-à-vis labour confirms what followed from Barbier's (1998) simulations for villages in West-Africa: the more limiting soil fertility is, the higher are the prices of land and fertilizer and manure relative to labour. Murton (1999), who also analyzed the case of Machakos distinguished the investment into SWC as such and the economic attractiveness of its subsequent use. Poor groups, in particular, could afford the former, as their labour is not scarce, but lack the incentive as they still would not have access to

credit to purchase the fertilizer, planting material etc. and might lack the knowledge to valorize the investment.

The technological change is shown in Figure 2 by the change from curve A-A to curve B-B. At the vertical axis we have labour, at the horizontal axis, we have land, either non-terraced (for curve A-A) or terraced or otherwise upgraded (for curve B-B). Looking at the effects of such changes in central point C, we see that such a point, optimal under the old technology A-A, would only remain optimal under the new technology B-B if the price ratio labour to land would change. The straight lines in the figure show the ratio: the dotted (blue) line that is tangent to curve A-A shows the price ratio with which little labour could buy lots of land: labour is relatively expensive. The price ratio, shown by the striped (orange) line is the new price ratio with land being relative expensive.

Figure 2. Two technologies at one point

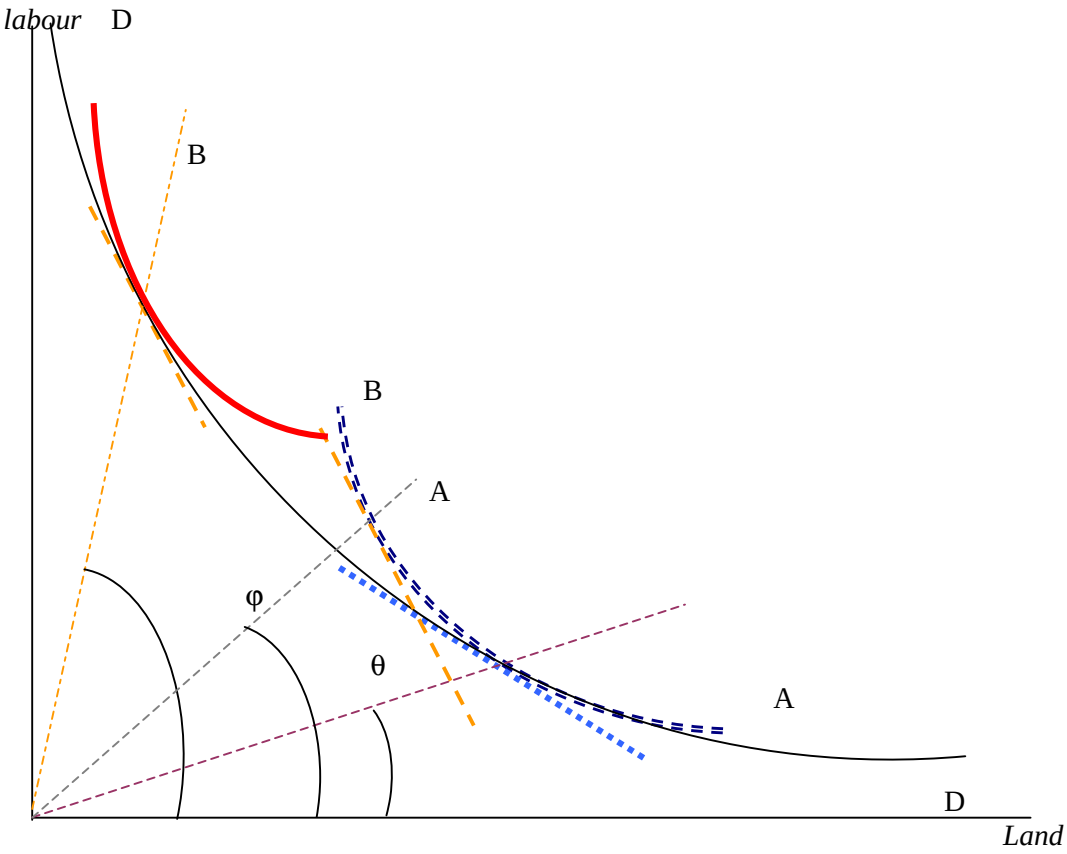


Positioning the two curves A-A and B-B in a wider space where labour and land form the two dimensions yields Figure 3. Curve A-A typically applies to a situation of abundance of land and should be more in the South West of the quadrant, while curve B-B should rather be in the North East, where there is little land relative to labour. Both curves are valid for their sections in the quadrant: they show the immediately available technologies. When price ratios change drastically, gradually a new technology can be adopted, that is better adapted to the new price ratio. De hull of the local curve, here indicated by D-D contains the technical combinations of labour and land to produce one unit of output. The transition from one technology to the other, and the investments in other forms of land is in this way, a clear example of *induced innovation* as described by Hayami and Ruttan (1985).

If, in a situation with abundant land, land becomes somewhat more scarce, and therefore relatively more expensive, at first some adjustment might occur along the topical technology frontier, line A-A toward the North-West. At the same time pressure would be mounting to seek technologies that enable higher yields of the land so that less of this is needed to achieve the same unit output: a shift toward line B-B. It seems quite probable that the introduction of technology B-B requires more than just a modified factor land, such as terraced land, but also other resources including fertilizer. Where access to such inputs is restricted, the transition will not easily occur. Hence, market access plays a catalytic role. In a study of the relationship between poverty and soil degradation in various countries in Latin America Swinton, Escubar en Reardon (2003) reach the conclusion that the poor not just lack the means to invest in

sustainable agriculture, but also the incentive. They continue working with the same technology and do not adjust the ratio of labour to land sufficiently.

Figure 3. Two technologies resulting from *induced innovation*



An implication, and way to test the relevance, would be to assess that this co-incidence of technologies, poverty and land-labour ratios does occur is to check the following two implications:

1. Terraced plots have much higher man-land ratios (φ compared with ξ), and smaller labour-production elasticities relative to land production-elasticities
2. Those without access to the market. But faced with similar relative scarcity, show only slightly higher man-land ratios than those without such scarcity (a bit more to the NW along the line A-A (θ compared with ξ). The same might apply to the isolated along the B-B line.

As to point 1, the production elasticities are confirmed by the estimation results in the table. The man-land ratios on the plots are derived from the means of the two factors in the two regressions. For non-terraced plots, the ratio is

For Benin, the raw data show that on plots with tie-ridging-1, the man land ratio (man days/area) is higher, especially on plots with light slope. On such plots the man land ratio is higher by a factor of 1.5 (48 vs. 32 man days per ha), while on very steep slopes, the difference is negligible (both 26 man days/ha). Kenyan data (Burger and Ge, 2003, table 3) show that

labour inputs per ha on terraced plots are 50% higher than on non-terraced plots, similar to the difference in Benin.

Finally, is there evidence, that not just the elasticities and the labour intensities differ in the way described, but also the price ratios? Data on the value of land are too scarce to be useful (hardly any land is traded), while not much labour is hired. Farmer perceptions, however, are that the value of land goes up because of terracing (80% think the value is "much higher", 17% "higher"), while the use of labour is less affected (more for harvesting, less for ploughing, planting and weeding).

In more isolated areas, such as the long time inhabited mountainous area in northern Cameroon and the Atacora in Benin, the shift toward terracing once took place without outside market access. Here, however, there was enormous pressure on land by a growing population who was confined to the small region for security reasons, making land very expensive compared to labour.

The empirical research done in Kenya confirms the effect of 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 to the factor land, and a lower share to the factor labour.

Land implies location

Land is not just more valuable because of its price or its rental value in the market. It is also more valuable because other inputs such as fertiliser can be used. Those who have land are in a position to benefit from the closer distance to 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 that are constrained in 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 that 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 land and land is only cared for, if they 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 (cf. Otsuka, 2004). It is the ethnic group, tribe or village that determines how durable access to land is, and membership of 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 high land values compared to the price of labour, we still need to ascertain what caused land – on this 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. In a relatively short period of time, large parts of Machakos became more densely populated, mostly through immigration into the area. The area with more than 50 persons per km^2, more than tripled between 1962 and 1979. And in the latter half of this period terracing really took off, as Figure 1 showed. Towards the end of the period, several reasons for terracing coincided. Coffee prices had surged to incredibly high levels, land had become relatively scarce, and the technology to establish terraces had become widely known. Coffee planting and terrace construction also helped the new settlers feeling more secure about their entitlements to the land.

The Kenyan case, therefore, 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 investments in its sustainability.

Benin

The Atacora in the North West of Benin is a hilly region, far away from large population centres. The area is traditionally densily populated. The Boukombé district had a population density of 45 persons per km^2 in 1979 and 56 in 1992. Within the district large differences appear. 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 published showing the dramatic predicament of the population and the high demand on the land. Our survey recalled this experience from the farmers themselves: not until recently, when other regions in Benin became accessible for 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 cultivated. To cultivate the hills, stones must be moved. These stones can be used for erosion control.

The econometric estimates of Adegbidi, Gandonou and Oostendorp (2004) show that the use of erosion control measures enhances yields by some 25%. Unlike the Kenyan case, however, labour requirements, especially for the annual reconstructions 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 become less isolated, the response is that more people migrate from the region. Improved infrastructure in the more remote areas lowers the scarcity of land, contrary to the Machakos case, and also contrary to one of the villages in Atacora: the village with good access to roads and markets.

5. Other research sites.

Cameroon

The research area in Cameroon was the remote Koza plain, bordering the Mandara Mountains. Over the last 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 past, the Mafa culture is rich in experience with erosion control and integrated sustainable farming on the slopes. Yet, hardly any soil and water conservation was used in the new flatter land that was taken into cultivation since the 1960s and 70s. There was no strong incentive to do so, as this land was not scarce and its ownership also not very secure. Cotton, with subsidized fertilizer, provided reasonable income opportunities, and some farmers, using tractors, benefited form economies of scale. To this end, many trees were uprooted. When fertilizer prices went up, it became clear that the region had become lacking in organic material, making a return to sustainable farming difficult and slow. As result, the region, though more open and secure now than some decades ago, is impoverishing both in economic returns to the original farmers, and in terms of natural capital. Though land near to the villages has become scarce, a Machakos-like transition did not take place. The reason appears to be the lack of organic material that puts a ceiling to 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 and near to and far from major markets. In addition, the Philippine case

differs as to the involvement of the government and NGOs that 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 Manilla shows even more than Machakos, what value the land can get. On terraced plots, up to ten vegetable crops per year can be obtained. Here too, the highest costs of terracing are the yearly returning costs of the upkeep, rather than the original establishing costs. An interesting finding of the work by Marino Romero was the ethnic influence in terracing: the Ifugao migrants knew how to construct these, and even without the incentive of the nearby city, their preference for rice would have led them towards terracing.

6. Policy implications

What is the development policy relevance of these findings? On the one hand this can be found 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 refer to the interaction between environment, land scarcity and poverty. In land abundant regions, the rural poor are typically found in households who 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, accessible) land become more and more scarce, local institutions tend to deal rather well with this situation, and if this is not sufficient, migration may offer a way out. Investments into land, such as terracing and stone lines require yearly input of labour. This is only remunerative, if there is reasonable security of ownership, and if land is valuable enough. Without infrastructure, land can be very valuable in extreme isolation, but otherwise, it becomes valuable mostly by its location near roads and markets, permitting the use of fertilizer and the sale of crops. The cheaper is fertilizer or the better the price of the crops, the more it pays to invest in 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 on the social structure of the local society the farmers find themselves.

Apart form such fundamental issues that can help in evaluating on-going 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 to Manilla 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 good physical and social infrastructure; security by stable social policy. In the Philippines, the government stepped in where the market failed to protect the natural resource from degrading, and in doing so created both scarcity and security of land. The vicinity of a market makes land valuable and therefore scarce. In the Cameroon case, land became less scarce and sustainability 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 to 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 about sustainable practices.

Finally, security of 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, and 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 for broad groups in the society.

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