RURAL DEVELOPMENT IN SUB-SAHARAN AFRICA

Policy perspectives for agriculture, sustainable resource management and poverty reduction

Ruerd Ruben and Bart de Steenhuijsen Piters (eds.)

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Policy perspectives for agriculture, sustainable resource management and poverty reduction

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Royal Tropical Institute (KIT)
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Preface

Agriculture and rural development are – at least partly – back on the international development agenda. Investments in agricultural and rural development are important ingredients in policies for fostering broad-based and pro-poor economic development in countries where more than half – and often close to 75 per cent – of the population still mainly depend on agriculture for their livelihoods. Rural areas harbour 75 per cent of the poor, who are desperately seeking ways to improve their living conditions and income.

This publication contains four articles that were presented at 'luncheon meeting events' at the Ministry of Foreign Affairs and Development Cooperation in The Hague, in 2004 and 2005. They document different facets of rural development, starting with an analysis by Ruerd Ruben and Arie Kuyvenhoven (WUR) of the complexity of economic development in rural areas. They argue that it is this complexity, combined with a tendency of governments and donors to opt for simplistic recipes, that has led to the neglect of investments in lagging rural regions. In fact, it may be more profitable today to invest in these rural regions rather than in the so-called high potential areas, where the private sector has already invested so much. A key element for making an impact is good analysis, so that public investment is able to address the binding constraints for economic development.

The two articles by Chris Reij (VU) and Kees Burger (VU) provide interesting evidence for this point of view. Chris Reij presents the case of the Central Plateau in Burkina Faso, showing that investments in soil conservation have led to increased productivity and sustainable development in a region generally referred to as 'marginal and over-populated'. In the Machakos district experience in Kenya described by Kees Burger, it was not so much investment (by donor agencies) in land use technology that triggered higher productivity in agriculture, but more the dynamics of a growing population and increased market opportunities through infrastructure development. Both examples show the attractiveness of public investment when it comes to fostering agricultural development aimed at both poverty reduction and sustainability of land use, which cannot be separated from each other.

The fourth article by Bart de Steenhuijsen Piters, Willem Heemskerk and Floris van der Pol (Royal Tropical Institute) highlights the history of agricultural research systems in sub-Saharan Africa and current trends towards public-private partnerships to promote rural innovation. Making research more

relevant by including farmers and other stakeholders in the innovation system is a key element to achieving sustainable agriculture and livelihood improvements benefiting the various social strata in African rural societies.

These presentations have inspired people working in different DGIS departments to look at agriculture, management of natural resources and rural development in a more integrated manner. This is highly relevant, especially for the near future, when agriculture and rural development will inevitably receive more and more attention, and agriculture and related industries will become 'big business' in which the poor must have a stake.

Jan Vlaar
Ministry of Foreign Affairs
Department DGIS/DDE

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Sustainable land use: Key to poverty reduction in Africa[1]

Ruerd Ruben and Arie Kuyvenhoven
Wageningen University, Department of Social Sciences,
Development Economics Group

Summary

Stagnating agricultural yields and decreasing commodity prices during the past two decades have led to increasing poverty in sub-Saharan Africa. A substantial portion of this poverty is concentrated in rural areas, especially in marginal regions characterized by unfavourable natural conditions and limited access to the infrastructure. The options open to rural households for investing in improved methods for sustainable land use are severely hampered.

Intensification of land use can be considered a key element in strategies focussing on sustainable poverty reduction. The structural improvement of agricultural productivity is only possible when farmers acquire access to critical resources, increasing both the efficiency of external inputs and their own labour productivity. There is a broad range of locally adapted available technologies that can contribute to sustainable soil management, but adoption depends on economic incentives and an appropriate institutional structure.

Most sub-Saharan African countries have taken macro-economic measures for reinforcing the agricultural sector. The prices of chemical fertilizers have sharply increased, however, making it more difficult to invest in improved nutrient management. Investments in the physical and social infrastructure are required if soil fertility is to be improved along with a simultaneous reduction in poverty. Such win-win scenarios are only possible if access to chemical fertilizers is reinforced, transaction costs on markets are reduced and production technologies become available that lead to more efficient uptake of water and nutrients.

This article presents a number of new insights concerning suitable instruments for the promotion of sustainable land use. The careful balancing of macro-economic policy with regional investments is absolutely necessary to provide

[1] This article is based on the results of the scientific project 'Economic Policy, Agricultural Incentives and Soil Degradation in sub-Saharan Africa' conducted by Wageningen University, Free University and the Landbouw Economisch Instituut (LEI-DLO). Financial support was provided by the NWO programme Environment and Economics (MandE). The results were presented at the lunch meeting of the General Directorate, International Cooperation (DGIS) of the Ministry of Foreign Affairs, 2 October 2003. We thank Piet Klop, Jan Bade and Jan Vlaar for their support in formulating the relevant policy questions.

incentives for land use intensification. Targeting public investments to unlock marginal areas might generate unexpectedly high returns. In addition, increasing investments in rural education is important to reinforcing the position of migrants in the labour market. Finally, the development of insurance systems and markets for environmental services may provide new possibilities for promoting investments in sustainable land use.

Introduction

Stagnating agricultural yields and continuing soil degradation are structural obstacles to poverty reduction in rural areas of sub-Saharan Africa. The reliance on extensive methods of land use leads to declining labour productivity, while existing market imperfections provide limited incentives to farmers for investing in improved and more intensive methods of agriculture and stock breeding (Sanders et al., 1996).
Economic instruments for promoting sustainable land use should contribute to the improved efficiency of agricultural systems and to an increase in farm household income. In order to achieve both objectives simultaneously, it is important that optimal use be made of critical production factors, with a rational use of scarce labour resources. Strategies for sustainable intensification search for ways to enable farmers to improve their land's yields as well as their own labour productivity.

Breaking the vicious circle of poverty, soil degradation and low productivity in sub-Saharan Africa requires a combined effort of activities (a) to improve the use of chemical fertilizer, (b) to reinforce the educational and social infrastructure, and (c) to improve access to markets and institutions. For this purpose, public as well as private efforts are required in order to generate the required complementarities between economic activities. Such a strategy has a better chance of succeeding in the marginal areas of sub-Saharan Africa, where chronic poverty is most concentrated.

In the remainder of this article, we will analyze the structural causes of stagnating agricultural development and persistent rural poverty in sub-Saharan Africa. We will outline the existing technical and economic options for specific investments in sustainable land use, which can induce a process of rural intensification. Finally we will look at the instruments for macro-economic and regional policy that are available to enhance the process of sustainable intensification of agricultural production systems.

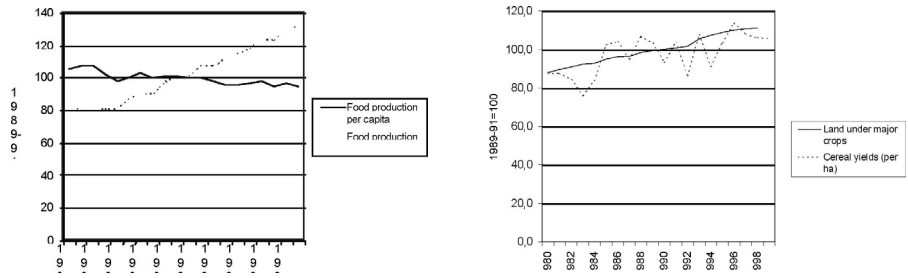
Stagnating agricultural development

Agricultural yields in sub-Saharan Africa showed only a small increase during the last two decades (see Figure 1). Most cereal yields reached hardly more than 1 ton/hectare. Although total food production has been gradually increasing, population growth rates are higher, resulting in an annual reduction in per capita food production of 0.5 per cent. The limited growth in agricultural production that has been realized is mostly owing to the expansion of cultivated

area – by 1 per cent annually – whereas development in productivity is clearly stagnating. The role of the agricultural sector as an engine for economic growth is thus subject to erosion.

One of the most important causes of the stagnation in agricultural productivity is related to the continuous decline in chemical fertilizer use. Between 1980 and 2000, the use of chemical fertilizer decreased from about 17 kg/ha to less than 14 kg/ha.[2] This is extremely low compared with most Asian and Latin American countries, where the use of chemical fertilizer exceeds 100 kg/ha. The decrease in chemical fertilizer used in sub-Saharan Africa is the result of high fertilizer prices on local markets after the abolition of fertilizer subsidies and the devaluation of the exchange rate (note that most fertilizers are imported). Therefore, the liberalization of the domestic market has not led to increased availability or lower prices for chemical fertilizers.

Figure 1 Food production and land use in sub-Saharan Africa (1980-2000)



Source: World Bank (2001) World Bank Africa Database

There are economic and technical reasons behind the limited use of chemical fertilizers in agricultural production. The structural adjustment programmes (SAP) that started in the mid-1980s mostly occasioned an accelerated increase in the prices of chemical fertilizers compared with the market prices for food crops. Consequently, the relation between output and input prices deteriorated substantially. In countries like Ghana, Mali and Burkina Faso this price relationship dropped by 25 to 50 per cent for most of the grain crops (Gerner et al., 1995). The expected positive effects resulting from the adjustment of the exchange rate and the liberalization of trade were largely nullified by scarce competition in the domestic markets (Badiane, 2000). In addition, a rise was observed in the relative chemical fertilizer price for export crops like cotton and peanuts, but in absolute terms these crops still managed to yield acceptable returns.[3]

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[2] Nigeria is a notable exception because it is still subsidizing chemical fertilizers by approximately 65 per cent.

[3] The ratio of output prices to input costs for most of the grain crops (maize, sorghum) decreased in the mid-nineties to 1.5-2.0, while for cotton and peanuts the price ratio held at around 4.0 (Heerink, 2002).

There are also a number of technical causes for the limited efficiency of chemical fertilizer applications. The low organic matter content of the soil reduces the impact of chemical fertilizers. Increasing organic matter content requires the availability of animal manure and the ploughing in of crop residues. In this respect, chemical fertilizers and organic manure are clearly complementary inputs. Farmers with their own livestock herds have more opportunities to mobilize manure and animal traction. The local exchange of nutrients is increasingly limited to farmers whose cattle are entrusted to nomads (De Beaufort, 2001). Smaller farmers, therefore, become largely dependent on physical measures for soil conservation (e.g. stone rows, earthen walls and terrace building).[4]

In order to improve agricultural input efficiency, a substantial increase in the uptake of nutrients and water is required. In the present situation no more than 30 per cent of the nitrogen and only 10-15 per cent of the rainwater is effectively used for plant growth (Breman, 1997). Combining the use of both chemical fertilizers and organic manure is generally considered an appropriate strategy for more effective uptake of nutrients and water (Scoones and Toulmin, 1999). Furthermore, the direct addition of (rock) phosphate, the use of nitrogen-fixing plants and trees, and water conservation measures are important in establishing an integrated package of soil management practices.

Measures aimed at the intensification of land use need to be accompanied by investments of time and money that guarantee pay-back within a reasonable period. A wide range of locally adapted techniques have been developed that could contribute to sustainable soil management, but their adoption puts heavy demands on the institutional setting. A structural increase in agricultural productivity – particularly in marginal areas – is only possible when farmers have critical resources at their disposal that enable them to increase efficient input use as well as labour productivity.

Structural causes of rural poverty

Poverty must be considered a structural problem in sub-Saharan Africa. About 45-50 per cent of the total population live in poverty, and most of this concerns people facing chronic poverty (World Bank, 2000).[5] Three quarter of all poverty is concentrated in rural areas (see Table 1), especially in the so-called marginal regions, which are characterized by unfavourable climatic conditions (i.e. little and irregular rain fall), unfertile soils prone to erosion, and poor infrastructure (IFPRI/WUR/IFAD, 2002). Poor communities are furthermore characterized by limited access to education and social services, vulnerability to HIV/AIDS, and an unbalanced family structure, with proportionally more women and young children.

[4] For more details see the article 'Transition to sustainable tropical land use' by Kees Burger and Ton Dietz, included in this volume.

[5] Chronic poverty means living for more than five years under the poverty line and therefore being unable to maintain reserves or stocks to compensate for income shortfalls.

Table 1 Rural poverty in sub-Saharan Africa

Land	Total poverty (% population)	Rural poverty (% poor population)
Mali	73	81
Burkina Faso	56	65
Ghana	52	52
Benin	32	35
Senegal	55	78
Mean	41	74

Source: IFAD (2001) Assessment of Rural Poverty in Africa

Rural poverty is caused by a number of structural factors. The most important factors are related to low labour productivity, a scarcity of capital and knowledge, high transaction costs and failing institutions. Because of high input costs, decreasing commodity prices and unreliable rainfall, farmers are not inclined to invest in improved land use. Therefore, labour productivity remains low and purchasing power for fertilizers and seeds is limited. Given the continuous soil degradation, the productive impact of chemical fertilizers also decreases. Consequently, a vicious circle of low investment capacity, soil degradation and stagnating labour productivity leads to the perpetuation of chronic poverty.

Important indications of continuous soil degradation in sub-Saharan Africa are the almost stagnant yield levels of most food crops and the more extensive pattern of land use. Consequently, there is less room for fallow practices and the demands for fertilization strongly increase, whereas the effective use and uptake of chemical fertilizers is under pressure. In such a situation, improvements in agriculture yields are only possible when farmers have the opportunity to develop more intensive methods of land use, increasing yields per hectare as well as labour productivity. Investments in sustainable land use can then lead to a significant decrease in rural poverty.

Investing in sustainable land use

Improving smallholder land use is a first step towards poverty reduction. A large variety of technical options are available for the intensification of agricultural systems (Hengsdijk et al., 1996). Important components rely on integrated nutrient management (INM), nitrogen-fixing plants, improved rangeland and pasture management and a series of soil and water conservation techniques.[6] Such technical options can be helpful in improving the efficient use of scarce nitrogen and reinforcing the moisture-holding capacity of the topsoil.

[6] Additional options for seed improvement, aiming at drought tolerance and disease resistance, are not being considered here but can be seen as very useful in reducing harvest losses.

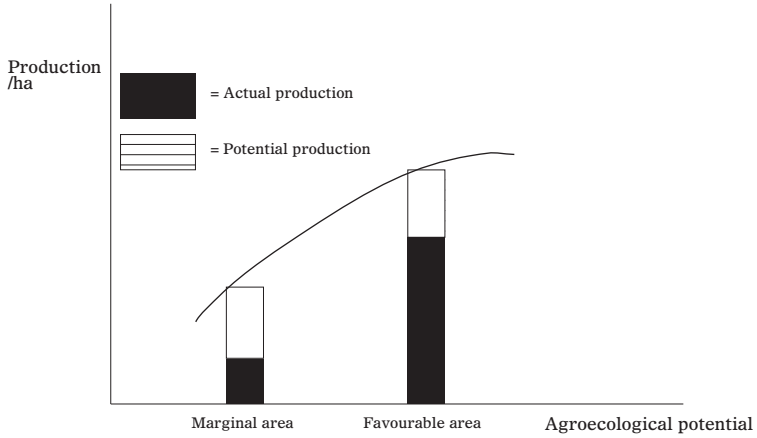
An important reason for adopting these measures is that they contribute to an increase in farm labour productivity. A number of promising technical options (e.g. agro-forestry and composting) may be less appropriate for broad applications because they require high labour input and the usual long gestation period before paying off. Intensification based on organic fertilization methods also requires a high input of family labour in many cases (Kuyvenhoven and Ruben, 2002). Better results are achieved by using combinations of organic and chemical fertilization, since this substantially improves the effective uptake of nutrients by plants.

Better integration of agriculture and livestock is a particularly effective way of sustaining intensification. Agricultural activities make use of animal traction and manure provided by the cattle, while crop residues constitute high-quality fodder for the herd. With increasing herd size, the production of special fodder crops becomes necessary. Ploughing in crop residues is important for building up organic matter in the soil. Because of the high risks in rainfed agriculture, farmers tend to keep relatively large cattle herds. The quality of the natural rangelands is under pressure due to overgrazing, especially when nomadic people adopt a more sedentary way of life.

The technical options for the sustainable intensification of land use are rather complex and require an integral assessment of decisions concerning crop choice, soil tillage, and fertilization and cropping systems. Therefore a number of organizational conditions must be met before large-scale adoption can be promoted. Measures for soil and water conservation and integrated management of catchment areas demand a proper degree of organization and collective action at the village as well as the regional level (Knox et al., 1998). On the other hand, investments in the cultivation of perennial crops and in most physical soil conservation measures require clearly established property rights. In addition, strict socio-economic differentiation within villages implies that uniform ('one size fits all') measures often do not lead to the desired results (Ruben and Pender, 2004). Community organizations and knowledge exchange between farmers are important elements in the development of locally adapted methods of land use.

In principle, intensification of land use can take place in different settings, but such investments will deliver the best results when they occur in marginal regions where the difference between actual and potential production is still relatively large (see Figure 2). Since agricultural yields in more favourable and relatively better-developed areas are already higher, additional growth will only be possible at relatively high investment costs. In marginal areas, however, there is still a large growth potential which can be realized with fairly limited investments. After an initial effort by the public sector, private investments (by individual farmers) can be expected to follow, considering the potentially high marginal returns. Once food security has been assured, investments in crop diversification and non-agricultural activities become attractive options. This enables the local population to escape from chronic poverty, which is mainly caused by the great variability in income streams and the lack of assets required for coping with risk.

Figure 2 Actual and potential production in highly and less developed regions



Source: Ruben en Pender (2004)

In addition to investments for improving land use, measures to strengthen the integration of the labour market are crucially important. Non-agricultural activities contribute to the stabilization of household incomes (Brons, 2002), while migration also decreases rural population pressure. Participation in such activities, however, is strongly dependent on the level of education and the availability of infrastructure, which implies that these alternatives are usually less accessible to the poorest people (Reardon, 1997). Moreover, decisions about migration and land use are usually closely associated. Households with a larger share of cash crops are less inclined to take part in migration (Mensah-Bonsu, 2003). On the other hand, remittances from migration could enable farmers to invest in improved land use measures.

Instruments and incentives

Different economic policy instruments can be helpful in enhancing the process towards intensification of agricultural production systems in sub-Saharan Africa. Macro-economic policies (taxes, exchange rates) influence the prices of chemical fertilizers and crops, and have a considerable impact on interregional trade and migration patterns. Regional policies can contribute to the development of specific options for improved access to technologies and supplementary sources of non-agricultural income. At the local level, most attention is focussed on institutional arrangements that influence access to chemical fertilizers and adoption of soil and water conservation measures.

Since the mid-eighties, most African countries have been taking measures to devalue their exchange rates, liberalize trade and promote institutional reforms. The traditional 'urban bias' now has largely been removed, especially in those countries where a process of political democratization was occuring at the same time (Dakurah, 2000). The rise in prices for chemical fertilizers is

greater than the rise in prices of agriculture products, however, which means that the incentives for intensifying agricultural production systems are still small. The price ratio between food and export crops has clearly improved, but this has had a negative effect on the poorest households, which are mostly net buyers of food. The results of price policy therefore leave much to be desired. Due to inadequate infrastructures and lack of competition, market liberalization and privatization of domestic trade have not yet led to better incentives for the farmers.

Supplementary measures at the regional level are therefore necessary to enable peasants to shift to more appropriate crops and suitable production techniques. Adoption will only take place when significant increases in household income can be expected. Local farmers producing for the market are more inclined to intensify their production systems when market prices increase. Smaller producers oriented towards home consumption will reap fewer profits. Improving the sustainability of land use requires the limited subsidizing of chemical fertilizers. A more substantial impact can be achieved if measures are taken to improve the infrastructure in order to lower transaction costs. The further development of financial services makes it possible for farmers to reduce the size of their herds, but this could also lead to a decrease in available organic manure. Introducing taxes on agricultural land is likely to trigger a reduction in the herd size and promote the use of crop residues as fodder, thus negatively affecting soil nutrient balances.

Integrated bio-economic simulation models can be used to assess the implications of alternative policy options (see Table 2). Whereas several technical options are available for the intensification of land use, only a limited number of instruments are suitable for stimulating farmers to adjust their production systems (Ruben et al., 2001). Improvements in infrastructure (including soil and water conservation measures) and supporting the price of chemical fertilizer are the only policy options that contribute to an increase in household income standards as well as to better nutrient balances. Both measures reinforce effective nutrient uptake. Increased access to credit shows a positive effect on household income, but the consequences for soil quality are rather ambivalent, since in some cases the farmers will prefer less efficient (but more profitable) technical options.[7]

Table 2 Instruments favouring sustainable intensification

Type of farm	Indicator	Higher output price	Lower input costs	Better infrastructure	Credit facilities	Land taxes
Large	Income	+++	+	+++	+	—
	Sustainability	+	++	++	-	-
Small	Income	+	+	++	+/-	-
	Sustainability	-	+	+	-	-

Source: based on Kruseman (2000)

[7] In addition, some instruments influence the general price level, thus reducing the effectiveness of some initial improvements (see Kruseman, 2000).

In addition to price and structure policies, institutional measures can be used to improve access to seeds and chemical fertilizers. The distribution of chemical fertilizers is first arranged by the cotton societies, with village committees playing a central role in the collection of the harvest. Chemical fertilizers are provided on credit, which is paid off through delivery of cotton. In this system, rights could be acquired to obtain cotton seed cakes (a waste product obtained after the oil pressing of the cotton seeds), an important source of energy fodder for the cattle. With the reform of the cotton societies, the domestic market for chemical fertilizers is being officially liberalized. Disconnecting chemical fertilizer purchases from credit provision has in many cases led to a steep reduction in input use, especially among farmers who do not possess guarantees. Only in villages where there is a strong community organization and more mutual trust between farmers – characterized by the application of stringent sanctions when loans are not paid back in time – does chemical fertilizer use by small peasants seem guaranteed (Spijkerman, 2001).

Particular attention has to be given to the policy incentives for livestock raising and the management of common rangelands. Because of the inherent risks of harvest loss in agriculture, farmers are inclined to keep larger herds as a precautionary measure. The role of cattle as a savings account can be partly taken over by local financial institutions. On the other hand, livestock and animal manure are of vital importance to the intensification of agriculture. It may therefore be necessary to use part of the land for cultivating high-quality fodder crops in order to reduce the pressure on the natural rangeland.

Finally, a number of new instruments have been developed that might contribute to the adaptation of agricultural systems. The introduction of insurance systems is considered an important option for stimulating investments in agriculture. Local experiments are now being carried out so that an inventory might be taken of the demand for drought insurance (Sakurai and Reardon, 1997; McCarthy, 2003). Considering the increasing risk of variability in rainfall under the influence of climate change (Dietz et al, 2003), insurances options will be of particular interest. In addition, the emerging system of national and international payments for environmental services offers some new options. Possibilities – though still limited – exist for the management of water supply areas near cities, and for CO2 and nitrate fixation in the case of rangelands. Making effective use of the GEF protocol, however, depends on the creation of well-functioning community organizations that take responsibility for the control and certification of contracts.

In summary, we may conclude that price policies are suitable instruments for promoting sustainable land use, but only to a limited extent. Investments in improving the rural infrastructure have a greater effect on poverty reduction and the development of agriculture. Educational facilities can further strengthen the position of rural migrants in the labour market, while remittances may be used to finance investments in improving land use. The influence of credit facilities on land use in marginal areas has been mixed, while the instrument of insurance has the potential of stabilizing the revenue base.

Outlook

Investments in sustainable land use represent a central element in the strategy for poverty reduction in rural areas of sub-Saharan Africa. Extensive land use and low labour productivity are major causes of persistent chronic poverty. This can only be addressed when farmers are enabled to improve the uptake efficiency of nutrients and water by means of targeted investments that increase both land and labour productivity. The perspective offered by such an approach is an increase in both family income and soil quality.

Economic policies that create the necessary conditions for sustainable land use in sub-Saharan Africa require a careful combination of measures in different areas. Macro-economic policies aiming at an improvement in market systems are important in order to strengthen the profitability of agricultural production, but they usually lack sufficient incentives to encourage the use of chemical fertilizers by farmers. Public investments aimed at improving the physical infrastructure can greatly influence the opportunities to invest in sustainable land use. Investments in rural education can contribute to the improvement of the position of migrants in the labour market. Access to credit and reinforcement of local community organization are key factors in encouraging farmers to invest in sustainable land use.

Considering the great diversity in endowments and quality of resources, and the existing heterogeneity between households and villages, a combination of different instruments should be used to promote investments in sustainable land use (Ruben and Pender, 2003). Price policies are inherently generic in nature and thus offer little room for a more differentiated approach. More important are measures for reducing transaction costs in input and output markets by improving transport facilities and providing better access to market information. At the institutional level, cooperation between farmers within villages provides possibilities for negotiating better contracts with traders, as well as for the coordination of joint investments in soil management on strategically located plots. Finally, different forms of insurance systems are important for enabling peasants to cover investment risks.

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Investing in Africa's drylands: Impacts on agriculture, environment and poverty reduction

Chris Reij
Center for International Cooperation
Vrije Universiteit, Amsterdam

Summary

It is commonly assumed that the environment in Africa's drylands is continuing to degrade. Doom and gloom stories prevail. National Action Plans to combat desertification in African countries reflect a pessimistic view about current trends. For instance, the National Action Plan for Burkina Faso mentions that the current situation on the Central Plateau is characterized by: (a) the continuing deterioration of climatic conditions: decreasing rainfall, endemic drought; and (b) the degradation of natural resources, reflected by the destruction of the vegetation cover, depletion of soil fertility and intense soil erosion.

Does this adequately reflect realities in the field? We believe it does not! Rainfall on the Central Plateau of Burkina Faso in the 1990s was higher than in the two preceding decades. Recently, rainfall has improved, but it is not back to the level of the 1960s and it has become more erratic than in the past, which creates additional problems for farmers. The destruction of the vegetation cover has continued, but there are some areas where this trend seems to have been reversed and farmers have increased their efforts to apply more and better manure to their fields.

This article presents the results of a study of long-term changes in agriculture and environment in the northern part of Burkina Faso's Central Plateau during the 1968-2002 period (Reij and Thiombiano, 2003). This is one of Africa's drylands where donor agencies have invested heavily in soil and water conservation in order to reverse the environmental crisis of the 1970s and the first half of the 1980s. After an assessment of long-term changes on the Central Plateau, we address the question of the rationality of investing in Africa's drylands and the impact of these investments on agriculture, environment and poverty reduction.

Economic and environmental crisis on the Central Plateau in around 1980

Several studies conducted in around 1980 analyzed the agricultural and environmental situation. The results showed an alarming state of affairs. A study by Marchal (1977:143) indicated that in the Yatenga region 'the last remaining forests were cut about 30 years ago and what is left is nothing more than some bushes on stony hillocks, which are used as forage by herds of goats

and sheep as well as by people for firewood purposes. Everywhere else the land is cultivated and 50 to 75 per cent of the cultivated land is prone to erosion'. Marchal (1982) characterized the agricultural situation as one of a complete upheaval of the food production system: agriculture remained extensive and agricultural production and productivity declined to very low levels. Even in years of good rainfall, sorghum and millet yields were on the order of 350-400 kg/ha on marginal land and 600-900 kg/ha on good soils. Although average population densities were high and increasing for a marginal region like the Yatenga (average 40 people/km2 in 1973, but locally up to 100/km2), this did not trigger a process of agricultural intensification. The Yatenga and other parts of the Central Plateau remained – at least until the early 1980s – an exception to the Boserup hypothesis.

The degradation of the vegetation and the declining cereal yields were also accompanied by falling groundwater levels. According to an evaluation of a wells and boreholes programme undertaken in 1981, 87 per cent of 450 modern wells dug during 1977-1980 had water during the first dry season, but this percentage then dropped rapidly to 39 per cent (Dutour, 1981).

Reactions to the crisis

One reaction to the agricultural and environmental crisis was that farm families decided to leave their villages and settle elsewhere, such as the valleys of the Volta rivers which were free of river blindness, or in the south or southwestern parts of the country that were characterized by low population densities, higher rainfall and relatively good soils. Besides this, many men left their families for Ivory Coast to work in the urban centres or in agriculture. Although many left their villages, demographic data show that the rural population remained more or less stable in absolute numbers between 1975 and 1985, but some villages experienced a reduction in population numbers of up to 25 per cent.

Another reaction was that some farmers as well as NGO staff started to experiment and innovate in order to find solutions to declining yields and land degradation. In the early 1980s this led to an improvement by farmers of the traditional planting pits or zai, which became an efficient technique for the rehabilitation of strongly degraded land. NGO staff started to experiment with contour stone bunds to rehabilitate degraded land and with level permeable rock dams to rehabilitate gullies.

The improved traditional planting pits, the contour stone bunds and the level permeable rock dams are all technical breakthroughs in soil and water conservation. They were simple, efficient and acceptable to local farmers. With support from new soil and water conservation projects these techniques started spreading rapidly in the northern part of the Central Plateau. These projects included the OXFAM-funded Agroforestry project in the Yatenga, the Dutch-funded PEDI project in the Sanmatenga region, the German-funded PATECORE project in the Bam region and the IFAD-funded soil and water conservation project in the Yatenga, Bam and Sanmatenga.

Methodology of the Central Plateau study

The investments in soil and water conservation in the northern part of the Central Plateau were substantial in the 1980s and even more so in the 1990s. It is difficult to accurately estimate total investments in this sector as the costs per hectare are different for the various techniques, they differ from project to project, and the local currency (CFA) was devalued in 1994. An amount of US$ 200 million seems a reasonable approximation, which is based on an average investment of US$ 200/ha. The Central Plateau study looked at the impact of these investments in soil and water conservation on agriculture and environment. Twelve study villages were selected, nine with project interventions in soil and water conservation and three without. A multidisciplinary team of 13 national researchers applied a wide range of research techniques, including wealth ranking, analysis of secondary data, surveys, soil samples and vegetation transects. Satellite images (CORONA 1968) were analyzed as well as aerial photos (early 1980), and in June 2002 transects surveys were flown over all 12 villages.

The nine villages with interventions in soil and water conservation include villages with a long history of investment (since the early 1980s) and large-scale treatment of cultivated land, but also villages with fairly recent and smaller scale investments. The three villages without interventions in this sector turned out to be a bit atypical because two of the three villages have access to important grazing resources nearby, which means that investments in livestock contribute to the creation of wealth.

Summary of major trends

The main trends identified by the Central Plateau study include:

- ⇢ *Millet and sorghum yields have increased by 50-60 per cent since the mid-1980s, but average yields are still low.*

This is surprising, because soil scientists have repeatedly stated that farmers do not replenish the nutrients they extract from their soils. This would imply a continuing fall in cereal yields. Yet the opposite is taking place. One probably reason is that soil fertility management by farmers has improved considerably since the early 1980s. Farmers who have invested in soil and water conservation systematically try to increase the quantity of manure they produce and to improve its quality. The presence of bunds on the fields prevents manure from being washed away by the first big rain.

Or are higher yields related to an increase in rainfall? The increase in rainfall in the 1990s has certainly influenced the evolution of cereal yields, but the investments in soil and water conservation have created favourable conditions for optimising the impact of rainfall.

➥ *In two of the three provinces studied, the cultivated area has remained stable since the mid-1980s. Expansion in the third province is mainly due to the rehabilitation of severely degraded land.*

Although the agro-pastoral statistics on which this finding is based may have their weaknesses, the trend is clear. The relative stability of the cultivated area, which varies from year to year depending on the characteristics of the rainfall, is a good indicator of agricultural intensification. The area cultivated in the Yatenga region shows an expansion, which is most likely related to the fact that in this region, more than anywhere else, a lot of barren, degraded land has been rehabilitated.

This stability of the cultivated area also takes the edge off the fear of those who think that soil and water conservation leads to an expansion of cultivated area and therefore to a reduction in grazing land available to the Fulani and their livestock. Soil and water conservation leads to a stabilization of cultivated area, and any expansion takes place on land that was entirely unproductive.

➥ *Cultivated fields treated with soil and water conservation techniques exhibit more trees than 10-15 years ago, but the vegetation on most of the non-cultivated areas continues to degrade.*

A comparison of the vegetation transects surveys flown over lands with and without soil and water conservation shows more trees and a bigger diversity of trees on land treated with soil and water conservation. A comparison of vegetation trends in the study villages in 1968, the early 1980s and in June 2002 shows a U-curve in villages with soil and water conservation. 1968 was the end of a period with higher than average rainfall. After 1968 average rainfall dropped dramatically and several periods of severe drought occurred (1970-73 and 1981-1985, for instance). This contributed to a dramatic reduction in vegetation cover in the 1970s and most of the 1980s. This is visible on the aerial photos taken in the first half of the 1980s. The photos of June 2002 show an expansion of dense cultivated parkland compared with the early 1980s and in some cases also a timid re-growth of bush. In villages without interventions in soil and water conservation, the degradation of the vegetation continued steadily.

➥ *Greater availability of forage for livestock due to local regeneration of vegetation and the production of more crop residues.*

Investments in soil and water conservation lead to increased cereal yields, but also to an increase in the production of crop residues. Most farmers note an increase in natural regeneration on their fields, which they protect for fruit and fodder. They also perceive a strong increase in the growth of perennial grasses. The Fulani of the village of Sam stated that whereas their cattle used to move southwards, they now stay in the village because of the abundance of crop residues and perennial grasses.

➙ *Increased investment in livestock by women and by men, and changes in livestock management from extensive to semi-intensive methods.*

An increase in cereal yields means improved household food security. The implication is that less cash is spent at the market to make up food deficits and more cash is available, which is now invested in livestock. This is a good example of asset building. Before investments in soil and water conservation started, Mossi farmers used to entrust their cattle to the Fulani even though they complained regularly about how the Fulani managed their cattle. After the Mossi farmers began to invest in soil and water conservation, they became more interested in soil fertility management and began taking their cattle back from the Fulani at the beginning of the dry season in order to produce more manure for their own fields. A shift is beginning from extensive to semi-intensive livestock management. This was also stimulated by the devaluation of the CFA in January 1994, which increased the possibilities for exporting livestock to Ivory Coast.

➙ *Improved soil fertility management by farmers, although more is needed to increase yields to a sustainable level.*

It is beyond doubt that farmers' soil fertility management skills have improved, but not enough to restore the nutrients they extract during a crop cycle. On average they use less than a ton of organic fertilizers/ha. Farmers with soil and water conservation use more manure than farmers without soil and water conservation. Farmers observe the performance of their crops and apply manure or mineral fertilizers where their crops need it most.

➙ *Although not a general phenomenon, most villages with soil and water conservation have seen local rises in groundwater tables (+ 5 m or more), which was not due to greater rainfall in the second half of the 1990s but to increased infiltration of rainfall and runoff.*

In around 1980 the wells in the study villages of Rissiam and Ranawa dried up at the end of the rainy season, and women had to walk long distances to find water. In Rissiam some women even abandoned their families because they could not cope with this burden. In Rissiam the water levels in wells began to rise in the early 1980s immediately after the construction of a small dam and after the completion of the first level permeable rock dams in the gullies. In Ranawa the same phenomenon occurred after soil and water conservation began in 1984. The groundwater tables began rising before the increase in rainfall in the second half of the 1990s, which means the rise is related to the increased infiltration of rainfall and runoff rather than to greater rainfall, although the latter does help. It is striking that higher water levels in wells are mainly found in wells situated in or immediately downstream of areas treated with soil and water conservation measures and not in wells situated upstream of those areas. Only in two districts have the groundwater tables not improved, which is most likely related to the geological characteristics of these regions. Higher groundwater levels have not only alleviated a major burden on women, but they have also induced men and women to start small irrigated gardens around wells.

➔ *Population growth in 12 study villages was 0 per cent between 1975 and 1985 and 21 per cent between 1985 and 1996. This indicates a strong decrease in rural to rural as well as rural to urban migration. Villages with soil and water conservation show higher growth rates than villages without.*

Whereas labour migration as well as permanent departures were normal phenomena between 1975 and 1985, the average population growth of 21 per cent in the study villages between 1985 and 1996 suggests a decrease in departures. The village of Ranawa lost 25 per cent of its population between 1975 and 1985, but its population more than doubled between 1985 and 1996. Not a single family has left the village since the start of major soil and water conservation activities leading to rehabilitation of degraded land. Some families returned from the southwest where they had settled a decade before. These families returned because of increasing ethnic tensions in that region as well as worsening production conditions, but also because of improved production conditions in Ranawa.

The recent political crisis in Ivory Coast has led to a strong return migration. Many men remain in or have returned to Ivory Coast, but they have sent back their women and children.

➔ *Increased organizational capacity of villagers (social capital).*

In the 1980s and 1990s many local organizations were created. They organized and managed a wide range of activities: soil and water conservation, tree planting, well digging, the cultivation of collective fields, sheep raising and other income-generating activities. The members of these village organizations acquired new technical and management skills, including how to use a water level to determine contour lines, how to construct stone bunds and level permeable rock dams, but also how to organize and manage groups. All this has contributed to the building of social capital.

➔ *A substantial reduction in rural poverty – up to 50 per cent – based on people's criteria, which are mainly related to the degree of household food security. An increase in rural poverty is found in villages without soil and water conservation.*

All the farm households in the 12 villages were classified according to wealth. This was done with the help of key informants and based on criteria used by villagers to determine whether a family is poor, average or rich. A key criterion used by villagers is the level of household food security. If a family is food insecure, even in years of good rainfall, then they are considered poor. In most cases the percentage of poor farm households is higher in villages without soil and water conservation (a narrow range of 55 to 57 per cent) than in villages with soil and water conservation, where the range varies widely from 27 to 69 per cent. The limited data indicate that the percentage of poor families has decreased substantially in villages with soil and water conservation and increased in villages without.

In the village of Kaartenga (Sanmatenga province), the percentage of poor households is estimated to have decreased from 72 per cent in 1980 to 30 per cent in 2001. As 1980 is a long time ago, it is unlikely that the estimates for this period are accurate, but it is likely that the trends have been assessed realistically. Harouna Ouedraogo, a farmer in Ranawa, eloquently compares the situation in 1980 and now:

'In 1980 only two families had cattle, now all families have cattle. Almost no one had a roof of corrugated iron…just look around you and you'll notice that almost every family has such roofs. All our wells fell dry and for that reason girls from neighbouring villages did not want to marry boys from our village. The land where we stand used to be barren, but now it has become productive again and all the trees that you see in these fields have grown since we started to construct bunds'.

Discussion

Are these positive trends due to soil and water conservation only?

The answer is no. Investments in soil and water conservation have triggered a range of positive trends, but these have been reinforced by such factors as the devaluation of the currency in 1994, which has made investments in livestock more attractive. The improvement of the roads to Ouahigouya and to Kaya has increased their accessibility and reduced transaction costs. Traders from coastal countries now send their lorries to the Yatenga region to procure cowpea and vegetables.

What about transfers by migrants?

Transfers by migrants in Ivory Coast were important in the 1980s but most likely decreased in the 1990s due to the prolonged economic crisis that hit that country and is now worsened by civil war. These transfers have not influenced investments by farmers in soil and water conservation. Farmers have invested their labour in soil and water conservation, and projects have provided support for the transport of stones as well as technical training.

What is the role of soil and water conservation projects?

Farmers have innovated in soil and water conservation, especially by improving traditional planting pits, which have played a key role in the rehabilitation of strongly degraded land. The usual division of tasks between farmers and soil and water conservation projects is that farmers collect stones, load these into tipper trucks and construct the stone bunds. Without the systematic support for the transport of stones provided by projects, soil and water conservation would not have been undertaken on such a large scale in the northern part of the Central Plateau.

Have women and poor farmers benefited?

The common assumption was that soil and water conservation increased the burden of women, and that they benefited little or not at all from soil and water conservation. Women interviewed during the study indicated three ways in which they have benefited: increased household food security, improved water supply and treatment of their individual plots, which increased their agricultural production.

Because projects opted for treating blocks of land (20 to 100 ha), these blocks also included fields belonging to poor farm families as well as fields cultivated by women, and in this way the poor and the women benefited.

What are the costs and benefits?

Cost-benefit calculations have not been made. The existing calculations have major weaknesses as they limit the benefits to the impact of soil and water conservation on cereal yields. This study shows that soil and water conservation has a wide range of benefits, which also include local replenishment of groundwater, natural regeneration of vegetation and even a decrease in migration, which also means less exposure to HIV. It is urgent that the important secondary benefits of soil and water conservation be quantified, such as the monetary value of a rise in local groundwater levels and the value of additional firewood.

At a macro level it is useful to point out that the total investments in soil and water conservation in the northern part of the Central Plateau in the 1980s and 1990s was on the order of US$ 200 million This has benefited tens of thousands of farm households and produced a wide range of benefits. The cost of the Ziga dam, which was built to improve the water supply of Ouagadougou, is also on the order of US$ 200 million, or an investment of US$ 200 per inhabitant of Ouagadougou. If investments in soil and water conservation lead to a reduction in rural to urban migration, then this may reduce the substantial capital investment in the urban infrastructure.

Lessons learned

Are the positive trends on the Central Plateau an exception to the prevailing doom and gloom scenarios?

The answer is no. A recent review of successful agricultural and NRM projects in Africa's drylands shows that the economic returns to investing in drylands can be high (Reij and Steeds, 2003). This review looked at a wide range of individual projects in the fields of soil and water conservation, forestry, irrigation, extension, community-based natural resource management, but also at examples of long-term area studies in East and West Africa. It shows that examples of positive local development dynamics can be found everywhere, but success stories are not always underpinned by hard data.

The potential of drylands is often underestimated. Investments in on-farm water harvesting techniques in semi-arid regions lead to immediate and perceptible yield increases and contribute to reducing rural poverty as well as to environmental improvement. A study by Irz et al. (2001) has shown that in Africa an increase in agricultural production of 10 per cent leads to a 6 per cent to 9 per cent reduction in rural poverty. Investments in water harvesting techniques such as contour stone bunds lead to yield increases on the order of 20 per cent to 80 per cent (Zougmore, 2003). The 50 per cent increase in cereal production in the northern part of the Central Plateau alone would lead to a poverty reduction on the order of 30 per cent to 45 per cent. It is therefore no surprise that villagers perceive a reduction in rural poverty.

An important lesson that can be drawn from the Central Plateau study in Burkina Faso is that **improved natural resource management is the key to increasing agricultural yields, which in turn is the key to reducing rural poverty**. It is therefore vital to mainstream agriculture and natural resource management in the national poverty reduction strategies. It is surprising that most of the funding for PRSPs (poverty reduction strategy programmes) in Africa goes to health and education, whereas agriculture is and will remain the economic engine for most African countries. Is it because agriculture and natural resource management are considered too complex and their impacts too slow in maturing and too uncertain? In the 1990s most donor agencies dramatically reduced their funding for agriculture. World Bank funding for African agriculture dropped from 30 per cent to 3 per cent of the total funding for Africa. However, agriculture is getting back on the agenda again. There are indications that World Bank funding for African agriculture is increasing again, and recently both Canada and Norway have formulated new agricultural development policies.

Current policies for agricultural modernization tend to ignore the dynamics and potential of small-scale family farming in drylands and focus too strongly on a combination of elements including irrigation, mechanization, increasing farm size, high potential areas and biotechnology. This will not lead to pro-poor growth and to poverty reduction.

The InterAcademy Council report on 'Realizing the Promise and Potential of African Agriculture' rightly urges policy to 'Recognize the potential of rainfed agriculture and to accord it priority. Because the possibilities for economically viable and environmentally benign irrigation development in Africa are limited, rainfed agriculture will remain the dominant system for decades to come. This type of farming therefore offers the best opportunities for the improved productivity that reduces poverty and food insecurity' (IAC 2004, p. xxii).

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The transition to sustainable tropical land use

Kees Burger
Vrije Universiteit, Amsterdam
Economic and Social Institute (ESI)

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

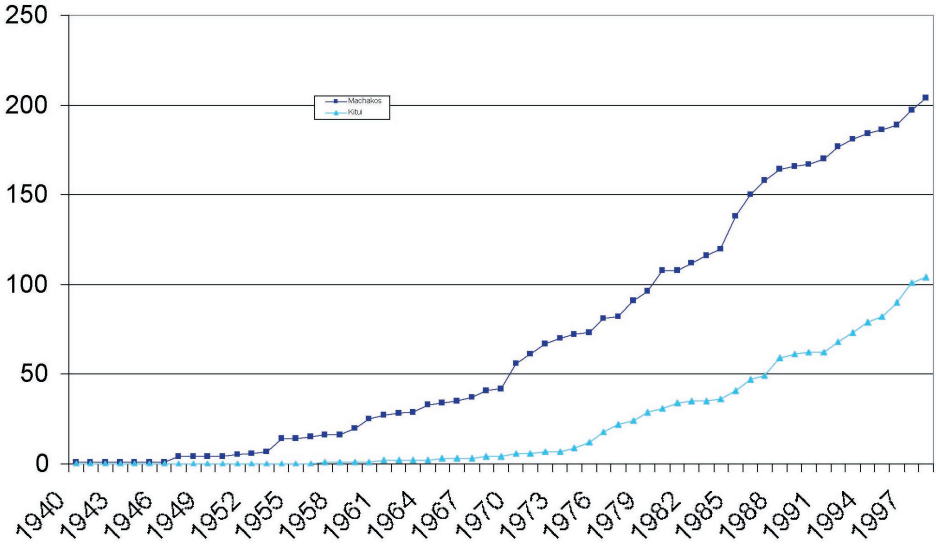
The choice for Machakos was dictated by the objective to check the Tiffen et al. findings at the level of the household, as this was not done to any great extent in the famous *More People, Less Erosion*. Kitui was chosen so as to measure the changes in a district that is less well endowed than Machakos 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.

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The public and private agricultural research discourse in sub-Saharan Africa: A case of Romeo and Juliet?[10]

Bart de Steenhuijsen Piters, Willem Heemskerk, Floris van de Pol
KIT Royal Tropical Institute, Amsterdam
Department of Development, Policy and Practice

Summary

Over the past decade agricultural service providers for internationally traded commodities have been largely privatized. This has caused a shift from a systems perspective to a more commodity-oriented approach and has resulted in the partial neglect of the concerns of rural communities and households that focus on self-sufficiency and local markets. Moreover, there has recently been substantial decentralization of decision-making related to development-oriented research. Village organizations are increasingly involved in priority setting for district development planning, including decisions on the focus of research and extension efforts. More and more of the rural development research being funded by district governments, as well as by local non-governmental organizations (NGOs), has to respect the criteria of social and gender accessibility, environmental friendliness, impact effectiveness and cost efficiency.

The trade commodity research chain is increasingly being privatized, resulting in increased centralization in apex organizations. The development research chain is decentralized, but remains public. This paradoxical trend implies a shift from a holistic systems approach to approaches based on a segmentation of interests, particularly commercial value generation versus rural development. Commercial and social sub-sectors are evolving within the agricultural sector, resulting in the emergence of parallel structures and contrasting procedures, as well as very different levels of influence for local stakeholders. This separates farming households into two groups: those considered economically viable and the non-viable.

In this article, trends in privatization and the decentralization of agricultural service delivery are illustrated with case studies from East and West Africa. The emerging inconsistencies will be highlighted with examples. Critical issues will be discussed in the light of current poverty reduction strategies and the desired promotion of autonomous development through democratic decentralization. Conclusions will be drawn regarding the impact of these different research approaches. Recommendations will be made for a more integrated approach, emphasizing the crucial importance of stakeholder

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empowerment and relating the decentralization of decision making to the privatization of service delivery.

Prologue

Two households, both alike in dignity,
In fair Verona, where we lay our scene,
From ancient grudge break to new mutiny,
Where civil blood makes civil hands unclean.
From forth the fatal loins of these two foes
A pair of star-cross'd lovers take their life;
Whose misadventur'd piteous overthrows
Doth with their death bury their parents' strife.
(Shakespeare, Romeo and Juliet, c. 1594)

Public-private partnerships are in vogue in international development cooperation. In the aftermath of the Cold War, pragmatism and neo-liberalism dominate the debate on poverty reduction in sub-Saharan Africa. Waves of privatization and decentralization are invading the continent, profoundly changing the institutional landscape. Central governments divest and transfer power to local administrative levels. State enterprises and institutions are privatized, leaving various productive and service sectors to market forces. The question arises whether these changes will provide an impetus for structural poverty alleviation in sub-Saharan Africa.

Agricultural research in sub-Saharan Africa is also involved in processes of privatization and decentralization. These trends are not new to African research systems. During the colonial era, all agricultural research was organized along public-private partnerships. Information and financial flows were managed according to commercial commodity lines, involving a select group of scientists, planters and representatives of multinationals. At the same time, food production and subsistence agriculture were not addressed, resulting in poverty and social unrest. After independence, these systems imploded and new approaches were developed to meet the new goals of enhancing peasant food production. The Farming Systems Approach to research and extension was based on paradigms that were more appropriate to agricultural systems in Africa than the colonial single commodity-based research system.

This integrated approach to agricultural research lasted only 20 years. Poor research performance and financial pressure on government budgets contributed to a change in policies. Due to the privatization of commercial commodity research and the decentralization of food production research, a dichotomous system is evolving. One may wonder whether this separation of resources and interests is the result of a master plan for agricultural research in sub-Saharan Africa or whether it is an unfortunate side-effect of international divestiture and the careless politics of *laissez-faire*.

This article is concerned with past and recent trends in agricultural research in sub-Saharan Africa. With the benefit of hindsight, it analyses these trends in the light of public-private partnerships, with particular attention paid to information and financial flows. Two cases of research systems in Mali and Tanzania will be highlighted to compare recent trends and identify common dilemmas. Finally, the article will identify some important imperfections in the current research systems and recommend interventions needed to re-establish their integrity.

The authors base their observations on their long-term professional involvement in restructuring agricultural research systems in Africa, notably Mali and Tanzania, as well as on a plenitude of reports presenting the results of consultancy and advice missions conducted for national governments and the World Bank. Taking a slightly less formal approach, this article uses the metaphor of Romeo and Juliet to argue that privatized agricultural research and public, decentralized research need to go hand in hand.

Act I Trends in public and private agricultural research in sub-Saharan Africa

Act I, Scene I The colonial research system: a perfect marriage

During the colonial era, agricultural research systems in sub-Saharan Africa, Asia and Latin America were a copy of the systems in the Western world. They were based on the same principles: technology development for controlled biophysical environments and strong linkage with mainly large-scale commercial producers. This was facilitated by collective public and private interests. Colonial governments and Western firms were interested in value addition through the production and export of commodities such as rubber, cocoa, coffee, cotton and tea. Agricultural research was financed by commodity-based public-private partnerships: the Royal Tropical Institute has its roots in this form of cooperation. Large-scale monoculture and concentrated research efforts proved to be very effective in generating new technologies. In francophone West Africa, commodity production also involved small-scale peasants through systems of taxation. Here, agricultural research also contributed to the development of cocoa and cotton sub-sectors. These successes were due to the close combination of information (especially priority setting) and financial flows. The public and private partners shared the same goals, spoke the same language, and combined their resources. As such, the research system was a perfect marriage in the true orthodox tradition. The production of raw materials for Western industries prevailed, however, over the alleviation of poverty in the colonies. With the help of agricultural research, new and alien systems were designed that profoundly changed the agrarian landscape in regions governed by the colonial powers.

Act I, Scene II The research system after Independence: living in different worlds

Soon after Independence, most African governments turned their attention to the production of food instead of commercial commodities. In contrast to the

monolithic plantation systems, peasant farming systems were characterized by diversity in biophysical and socio-economic conditions that resulted in a great divergence of agricultural practices. Instead of controlling the production environments, farmers responded with a variety of techniques and local technologies adapted to internal and external variations and fluctuations (De Steenhuijsen Piters, 1995). The research systems inherited from the colonial administrations did not immediately adapt their principles to the new situation. In Africa, these systems completely failed to contribute to enhanced food production. The disruption of the close linkage between information and financial flows can be considered the main cause of this failure. The financing of agricultural research became government and donor driven. Scientists were confronted with a multi-linguistic, often illiterate clientele that had not sufficient resources to co-fund research. Whereas during the colonial era Western scientists and planters shared a common intellectual and cultural background, the same scientists were now completely estranged from the small farmers. This resulted in centrally funded, top-down managed research systems that excelled in the generation of irrelevant technologies.[11] Instead of partners in a marriage, scientists and producers lived in different worlds (De La Rive Box, 1985).

Act I, Scene III Farming systems research: living apart

Poverty and food shortages increased in Africa while more and more technologies were shelved at the research institutes. Modern media developed and showed the world the tragedies taking place on the African countryside. During the 1970s, it dawned on the scientific community that the principles of research, so successful in the past, needed adaptation to the new conditions. It was acknowledged that science did not have adequate understanding of its new object of intervention, namely the African farming systems, and that innovations developed on research stations did not actually fit these systems. Case studies by unorthodox scientists, including Collinson, Norman, Hildebrand, Fresco and Jouve, diagnosed the different rationale for and composition of African systems and thus iterated the enormous lack of information. New concepts and approaches to agricultural research were developed under the common name of Farming Systems Research (FSR). A hundred years after the Western exploration of Africa, a wave of FSR teams re-explored the interior in an unprecedented scientific effort to lay the foundation for agricultural development. In merely two decades, FSR teams diagnosed the entire African continent. Through the medium of participatory rapid rural appraisals, FSR scientists informed themselves of the components of local farming systems and their internal relationships, including the priorities set by local peasants. Donors and national governments invested massively in FSR. The principles of systems research and holism were gradually adopted among agricultural scientists, although it proved difficult to completely integrate FSR

[11] In 1978 D.W. Norman published his well-known results on farming systems research in Nigeria (see Kowal and Kassam, 1978). Profits for farmers of a number of innovative technologies proved to be negative, especially in terms of remuneration of labour.

with more conventional research. Under financial pressure from donors and national governments, integrated research systems were created. However, with a few exceptions, these systems did not live up to expectations. In retrospect, one can conclude that the main cause of the disappointing impact of research on agricultural productivity in Africa was the disrupted linkage between information and research funding. FSR and commodity research were living apart rather than in a newly established marriage.

FSR continued to develop and became an umbrella approach for a wide variety of participatory, diagnostic methods. The Farming Systems Approach (FSA) to research and extension laid the foundation for potential success but remained rather paternalistic and was a top-down approach in disguise. Peasants were consulted in the process of diagnosis and research priority setting, but their role was limited to the provision of information needed by the scientists. As Mike Collinson (2000) put it himself, FSR is defined as a diagnostic process: a basket of methods f*or researchers* [italics by authors] to elicit a better understanding of farm households, family decisions and decision-making processes.

Act I, Scene IV Participatory research as a reaction

FSR was based on the assumption that better knowledge of farming systems would lead researchers to develop innovations that would be more acceptable to farmers. This assumption proved to be questionable for a number of reasons. Firstly, it proved difficult to fully understand the often complex African farming systems.[12] Secondly, the current process of innovation development was not able to sufficiently exploit the indigenous knowledge of small peasants. Available information was filed but hardly used in the creation of innovations. Thirdly, researchers got trapped in the process of generating more and more detailed information, leaving the innovation development to others.[13]

As a reaction to this, new approaches that emerged in the mid-1980s argued that farming systems were already understood by the farmers themselves and, as a consequence, researchers would not need all the knowledge generated and should concentrate more on confronting their technical innovations with farmers' local knowledge in a participatory research process (Chambers, 1983; Richards, 1985; ILEIA, 1990). This idea found support at the international research institutes, which already had a number of innovations that only needed minor adaptations by local farmers. The approach led to many surprising

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12 Van Nugteren (pers com.) reports that farmers in the northern Sahel zones of Mali use over 80 varieties of millet to cope with variable soil conditions and rainfall. N. Jika (2001) collected over 130 millet varieties in farmer fields. Research covers only a fraction of these varieties.

13 Some researchers from an FSR programme in Western Africa complained that they were no longer welcome in the village where they had studied farming systems for more than three years (Van der Pol, pers. com. 2001).

successes,[14] but also easily deteriorated into a process best characterized as 'pottering' with farmers. Although Participatory Technology Development (PTD) and Farmer Field Schools are currently accepted approaches for information exchange between farmers and researchers, the outcome in terms of innovation development remains of mixed quality.

While a certain evolution did take place in the organization of information flows between stakeholders (farmers) and researchers, financial flows tended to remain unchanged. The new research systems remained or became even more donor-driven, thus responding to decision makers residing far from the daily realities of African peasants. Priorities by local peasants had to fit the donor agenda, and when contrasted with these agendas the peasants' priorities were disdainfully referred to as 'shopping lists'. Although information was obtained from below, financing continued to flow from above. FSR and PTD had two great merits: providing the basic information about farming systems and enhancing the creation of integrated research systems. However, the research systems needed to take one more step to be successful: critical participation by the African peasant in the financial flows and decision making on research. Donor domination of research funding obstructed this step and disappointment in FSR overshadowed the initial enthusiasm.

Act I, Scene V Private commodity research and public food research: a premature divorce

By the mid-1990s, donor fatigue related to agricultural research reached a maximum and budgets were cut more and more. Regional research centres were subjected to rigid evaluation missions looking for impact and adoption that were hard to find. National governments reduced their spending on agricultural research. Commercial commodity-based research and extension were privatized on a large scale in Africa. Private research boards took over research financing through levies on cash crops. Immediately, research on non-cash crop systems and traditional livestock systems became a burden for national governments. The decentralization of non-commodity research followed on the privatization of commercial commodity research. The agricultural research system disintegrated within a period of only five years. A dualistic system evolved in which private funds were used for commercial agriculture and public funds for food production. This trend is definitely not the answer to the call for more impact from research on poverty reduction and rural development. Instead of taking a final step from FSA to demand-driven research, a big leap back into history took place. Will this premature divorce of a promising marriage between commodity research and FSA become another historical tragedy for Africa?

[14] In Benin, Mucuna (fertilizer bean) was investigated for its positive effect on the low soil fertility of the red plateau soils. For administrative reasons it was tested in three villages in different zones, one in an area with vertic soils infested with Imperata grass (but without a real soil fertility problem). Farmers there reported the Mucuna able to suppress the Imperata infestation. Mucuna is now being adopted especially for this purpose and much less for fertility management (Manyong at al, 1996).

The link between scientists and producers is in the process of being re-established in the commercial commodity-based research system. A convergence is taking place between the funding of research and decision making, resulting in an adaptation of research priorities geared to the needs of local producers. More integration of private entrepreneurs into this research system will further enhance the effectiveness and efficiency of research. In the parallel food production research system, local governments and civil society contribute more and more resources to adaptive research. Similar to the commercial commodity system, research is becoming increasingly demand-driven. All over Africa, regional research centres are adapting their management to the new situation. It must be concluded that the principles of research do not differ much between research on commodities and food production, but that they are divided by the mechanisms of funding, information flows and levels at which planning and priority setting can take place.

Table 1 Overview of trends in agricultural research and extension in sub-Saharan Africa

Period	Source of information and research priority setting	Source of finance
Colonial era (till 1960)	Scientists and private stakeholders	Public & private partnerships along lines of commercial interests
Early Independence (1950-1970)	Scientists and public institutions	Public funds (national governments & donors)
1970-1980: Farming System Research	Scientists and public institutions	Public funds (contribution by donors increases)
1980-1990: Farming System Approaches to research & extension, and participatory technology development	Scientists, public institutions and private consultations	Public funds (donor contributions dominate)
1990-present: privatization and decentralization of research and extension	Cash commodities: private stakeholders Non-cash commodities: public stakeholders and civil society	Cash commodities: private funds Non-cash commodities: public and civil funds (donor contributions decline)

ACT II Review of the present situation

ACT II, SCENE I REALIGNMENT OF THE ROLE OF CENTRAL GOVERNMENT

Governments in sub-Saharan Africa have been under pressure to concentrate public spending on essential services such as health and education, security and public infrastructure. This trend, together with the need to improve the output of development research institutions, has led governments to review the need for public support to agricultural service delivery. The proportion of the

national budgets being spent on support to the economic sector (apart from infrastructure and fundamental research, education and training), including the agricultural sector, has been dwindling. Privatization and government withdrawal from input supply and credit systems were the first 'targets', now followed by central government divestiture from agricultural research and extension (World Bank Group, 2001).

Privatization and decentralization of research are normally pursued for two strategic reasons:
- To improve the performance of research, namely to enhance the emphasis on demand-driven, adaptive agricultural research with a strong output orientation.
- To concentrate central government expenditures on essential social tasks and policy issues. Given the increasing urbanization of Africa and the reduced contribution of agriculture to the national GDP, farmers are no longer considered the principle target group in the population. Education and health services are generally considered to benefit the whole population, while agricultural services only address the needs of a declining part of the rural population.

In the economic sector (World Bank Group, 2001), central governments increasingly play a policy-making role (as in the formulation of National Visions or Poverty Reduction Strategies or National Agricultural Development Plans) rather than directly implementing action plans. In order to improve the efficiency and effectiveness of agricultural research, central governments, backed up by multilateral donors such as the World Bank and bilateral donors, embarked on programmes to privatize and decentralize agricultural research (and extension) services. Two main objectives are hereby included:
- Decentralization in order to bring technology development closer to the beneficiaries and empower clients on research boards for priority setting and resource allocation.
- Privatization to ensure that the benefiting sector pays for the research, as in the case of export commodities and the dairy industry.

Act II, Scene II Rural service delivery and decentralization

The decentralization of adaptive and applied research often coincides with the decentralization of government authority to the district level, namely local government levels. Decentralized research is horizontally organized, is close to the clients and addresses a wide range of researchable problems. In practice, research in the public domain focuses on food crops with strong socio-economic dimensions and on problems raised by other stakeholders, such as natural resource management. The research agenda is partly influenced by farmers through representatives or through participatory rapid rural appraisals. Sub-national research centres are more and more responsive to priority setting by local government. This often aggravates their existing mode of operation, which is isolated from national and international research institutes. A 'strengths, weaknesses, opportunities, threats' (SWOT) analysis of decentralized agricultural research can be seen in Table 2.

Table 2 SWOT analysis of decentralized agricultural research

Strengths	Weaknesses
- More cost-effective - Research focused on local (area) needs - Relationship between client contribution and research outputs - Enhanced 'ownership' of results	- Disconnected from national and international research - Duplication due to lack of co-ordination - Financial resources limited - Prevalence of short-term, adaptive research rather than long-term, strategic research
Opportunities	**Threats**
- Research agenda determined by clients (demand-driven) - Research agenda more holistic - Stakeholder control leads to efficiency	- Representation of peasant community by dominant farmers - Long-term constraints (e.g. ecological and social sustainability) are neglected - Career development research at risk

Act II, Scene III Rural service delivery and privatization

The privatization of agricultural research involves whole sub-sectors such as tea or tobacco research, or specific components such as pesticide research. Privatized research is traditionally organized in a vertical way because it is based on support to an economic chain, often including export dimensions. The provision of research services, such as new technologies that enhance the yield and quality of the produce, is strongly encouraged, particularly by traders and processors. In the context of small-scale producers, little attention is given to constraints that are specific to particular farming systems or to the long-term perspective. This is mainly due to the top-down approach often applied in privatized agricultural research. Moreover, economic interests may dominate the research agenda, which may result in a focus on the development of commercial hybrids, for example, instead of open pollinating varieties, or the promotion of chemical pesticides instead of integrated pest management. A SWOT analysis of privatized agricultural research can be seen in Table 3.

Table 3 SWOT analysis of privatized agricultural research

Strengths	Weaknesses
- Leading to efficiency - Reduced public costs - Transparent and accountable systems - Strong link with international research	- Focus of privatized research on cash commodities, input-based production and export - Targeting of richer farmers - Loss of holistic approach
Opportunities	**Threats**
- Strong role of producer organizations - Strengthening of economic chains	- Research agenda determined by traders and industry - Short-term issues addressed rather than long-term constraints

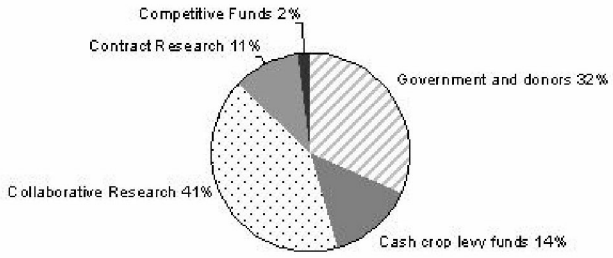
ACT III Restructuring agricultural research systems in Tanzania and Mali

Act III, Scene I Tanzania

In Tanzania the government has strongly embarked on the path of decentralization of all sector ministries. Administrative, democratic and financial functions have been decentralized to the district level (URT, 2003). The Ministry of Agriculture and Food Security and the Ministry of Water and Livestock Development have transferred management of all services to local governments with the exception of sanitary services and certain research functions. After the initial unification of agricultural extension related to commercial commodities, livestock and food crops, the actual extension service provision was fully decentralized to the district level. Only extension policy development is still maintained within the Ministry of Agriculture at the national and regional/provincial levels. All input supply services, whether fertilizers, seeds or credit, have been fully privatized, as well as most of the research on commercial commodities (tea, coffee, cotton, coffee, sisal, etc.).

Public agricultural extension is presently fully managed and financed by districts, comprising the local governments, and this is also increasingly the case with agricultural research conducted by means of contract research and competitive research funds to which districts contribute. In Tanzanian agricultural research, privatization has developed in a number of forms, varying from complete privatization in separate research institutes (coffee, tea, sugarcane and tobacco) to the full financing of commodity programmes in public institutions with crop levy funds (cotton, cashew, sisal). Both agricultural research and extension have moved into various forms of public-private partnerships, including the outsourcing of certain functions, joint development of proposals for competitive technology, and commodity-based funds. They have abandoned the traditional top-down forms of planning: the training and visit system for extension and commodity focused planning for research. Non-traditional sources of funding for public research programmes, namely competitive technology development funds, contract research, cash crop levy funds and collaborative research with supra-national programmes and universities, are slowly replacing the funds from government and bi-lateral donors (see Figure 1).

Figure 1 Contributors to adaptive agricultural research in Tanzania (Lake Zone, 2000)

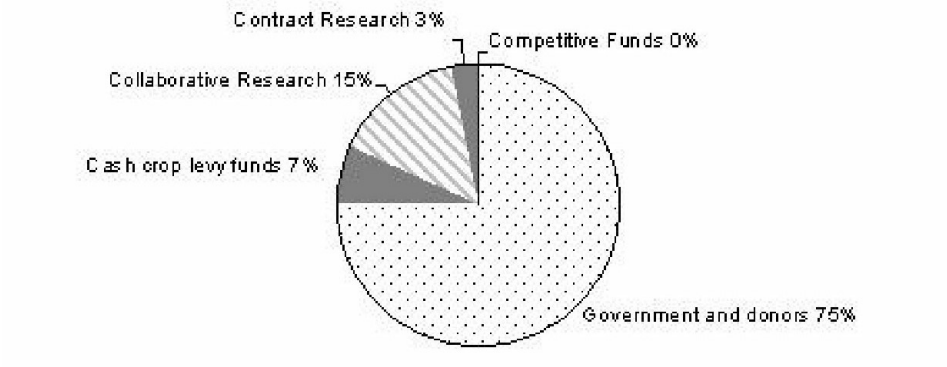


Concerns relating to social inclusion still exist, such as whether small-scale tea producers are also part of the target group for privatized tea research and whether systems constraints are still addressed in the same way, given that cash crop research has now been taken out of the public research arena (DRD, 2003).

Act III, Scene II Mali

In Mali, a strong institute for agricultural research exists, exerting a quasi-monopoly on the execution of agricultural research. Some donor organizations (especially the Netherlands' bilateral donor) have stimulated Mali's client orientation of research by requiring signed contracts between potential clients and the institution before contributing additional funds. These contracts were signed with large institutional clients, such as the Cotton Company, the service for rice growers in the Niger polders, and producer organizations around the capital city of Bamako. This construction is considered a transition to the direct funding of research by these organizations. Furthermore, user committees were established at the local level, thus engaging most stakeholders in the setting of research priorities. Government subsidies cover around one third of the institute's budget, one third is covered by formal donors and the rest is financed via contracts and other sources. The Cotton Company normally finances cotton research (Figure 2).

Figure 2 Contributors to adaptive agricultural research in Mali



Technical information is shared between staff members. Key staff annually review the institute's research programme to maintain quality and avoid duplication. As a result of the obligation to sign contracts, the influence of potential institutional clients in priority setting and research management is increasing. However, questions can be asked concerning the willingness and ability of these organizations to finance research on their own budgets, especially since their missions have been reduced and stripped of social development functions as a consequence of structural adjustment. In 2003, for the first time, the Cotton Company seriously cut its research budget allocated to the institute.

With respect to research for the rural poor, the organization of financial flows has yet to be established. While under general donor and state financing, the information flows were organized to reach the rural poor through participatory approaches in research and extension. However, these flows are now hampered. The local user committees provide upstream information on research activities of interest (priority setting), but an outlet for the information on innovations is lacking as the extension services are no longer functioning properly and contacts with the dispersed range of NGOs and producer organizations have not yet been established. Although an organizational structure has been designed, in practice it is not at all clear how a unique research institute could handle these contacts or how the local user committees could become instrumental to the complete circle of research programming and extension.

There is a risk that the old colonial paradigm is returning. In this situation, research works efficiently as long as institutional clients are involved, but it is less effective for the illiterate and relatively unorganized rural poor. The synchronization of decentralization and privatization on the one hand, and capacity building and empowerment of small farmers on the other, is urgently needed. Thus donor organizations should focus on strengthening producer organizations (Rondot and Collion, 2001) before continuing the process of decentralizing the research system.

Act III, Scene III Consequences for the farmers

The simultaneous decentralization and privatization of agricultural research and extension can lead to fragmentation of the services provided, as illustrated by the case from Tanzania, and to the obstruction of service chains, as illustrated in Mali.[15] This could lead to a dichotomy in technology development in which public decentralized adaptive research becomes disconnected from the national (and international) research system. Public adaptive research would be deprived of financial inputs from the private sector. An agricultural research and extension system that is funded by and answerable to district governments can lead to fragmented services due to the lack of the necessary critical mass and to poor links with national and international knowledge systems.

In this situation, private commercial commodity research would reserved for the richer stratum of smallholders. This research would focus on a few export crops or the use of commercial inputs. Agricultural extension could be organized by the economic chain on an interest basis, in effect merging with research, and ignore constraints related to the entire livelihood system such as soil fertility or the human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) pandemic. A strong influence on the development of the chain by a few powerful stakeholders could lead to an emphasis on priorities that do not benefit all farmers, such as the Bt-gene in cotton varieties or emphasis on tea estate production. This is the case for the institutional

[15] The level of adaptive research resource diversification is lower in Mali than in Tanzania, since the privatization and decentralization process started later in the latter country.

stakeholders in Mali as well as the produce boards of product chains that finance privatized research and extension in Tanzania.

On the one hand, this dichotomy could enhance the market orientation of production systems and more competitive farming. On the other hand, it could lead to enhanced regional and socio-economic inequities in access to research and extension services, accelerated depletion of natural resources and increased rural poverty with the exception of a small minority. Ultimately, the dichotomy of the research system could lead to the following forms of fragmentation:

In the research system:
- Exclusive privatized rural services (research and extension) for special target groups (well-endowed, commercial farmers), with little attention paid to resource-poor farmers.
- The public sector research component would remain constrained by long-term impact or by the effect of community social cohesion (e.g. sustainable natural resource management, gender issues and economic development of disadvantaged groups).
- Research and extension would merge in the privatized sub-sector and remain separate in the public technology development system. Research would then place in semi-autonomous centres and extension in districts or communes.
- Communication and exchange of information between public and private research teams may be hampered. Moreover, a 'brain-drain' from public to private research could occur because of better remuneration and working conditions in the latter.

In the administrative system:
- Sub-national disparities in service provision might occur as a function of the varied resource base and opportunities for commercial agriculture of a given administrative unit, as well as in relation to extension.
- The long-term and more social constraints identified above would have to be addressed by research financed with declining public funds or by NGOs.

In communities:
- Private research would not address major issues such as the empowerment of women, the sustainability of farming, the use of collective natural resources or the impact of the HIV/AIDS pandemic.
- Segregation between commercially viable groups in society and less-endowed groups focusing on self-sufficiency could develop. Private research is not likely to contribute to the strengthening of community-based organizations and the empowerment of producer groups.

It has to be acknowledged here that food production in sub-Saharan Africa is becoming increasingly commercial due to the fast growing demand in urban areas. In this respect, staple food and horticultural production chains will not be excluded from privatization. This may increase production and income

generation by those farmers who can afford new technologies and can bear the risks of market orientation.

Act IV Lessons learned and future challenges

There is the threat that agricultural research systems in sub-Saharan Africa will revert to a pre-Independence institutional setting and mode of operation which only address the income-generating dimension of a limited group of farmers (most of whom are already better-off). In order to avoid exclusivity of agricultural research service provision, strong emphasis should be placed on the role of community and producer organizations, proper joint stakeholder analysis, public-private partnerships and effective communication among all stakeholders in the agricultural knowledge system.

From the Tanzania and Mali experiences, the following lessons can be learned:

a. The rapid urbanization and development of other sources of livelihood in rural areas will lead to increasing pressure to shift technology development from the public to the private domain, while absorbing extension in the same process.
b. Smallholder farmers have a holistic (= livelihood systems) perspective. The proportion of different enterprises and commodities in their system is determined by the availability of resources (land, labour and capital) and the occurrence of risks (climatic as well as socio-economic), among other factors. The integration of inputs and actions takes place at the rural livelihood level. The research system should reflect this integration in order to deliver technologies that are adoptable and affordable, and that respect the internal cohesion of the livelihood systems.
c. At present, community-based organizations are not sufficiently empowered or financially endowed to participate effectively in procedures for defining research priorities and monitoring and evaluating research results. Research priority setting remains basically an external matter as far as these organizations are concerned. Producer organizations seem to participate more effectively in private research, although the true representation of producer groups by a few, well-endowed farmers is questionable.
d. The trend towards a dichotomy of public and private agricultural research is amplified by administrative reforms and the reduction of government expenditures on agricultural development. Emphasis on the market-orientation of agriculture through privatization seems to be a side-effect of these reforms. A more strategic choice for enhanced rural service delivery and effectiveness of research would probably not result in a dichotomy of public and private research.
e. The observed trends could lead to a distortion of rural poverty reduction strategies that are not supported by a comprehensive (public and private) resource allocation and information system.

The potential fragmentation of agricultural service delivery can be reversed by strategic interventions that enhance farmer participation in decision-making

and resource allocation, as well as communication and exchange of information between stakeholders in different sub-sectors. Elements of these strategic interventions could include:

a. Strengthening the role of community- and production-based organizations by enhancing their capacity to participate in agricultural research planning, monitoring and evaluation. This applies to both the public and private research sub-systems.
b. Reinforcing the role of decentralized local government. District governments develop plans on the basis of community action plans and are in the proper position to direct development research, as well as to be part of commodity-based privatized research through district levies on cash crops.
c. Empowering local governments and producer organizations by giving them seats on producer boards, while private sector research representatives sit on district advisory boards.
d. Developing mechanisms for public-private partnerships in agricultural research, including funds for developing sub-national technology, contract research, joint priority setting and resource allocation systems.
e. Giving strong emphasis to horizontal communication systems (between local level stakeholders) and vertical communication systems (stakeholders in the research continuum or innovation chain and product chain approach).

The World Bank's Community Driven Development Programme for sub-Saharan Africa aims at capacity building for community organizations and local governments, emphasizing accountability and participatory monitoring and evaluation. Guidelines for this programme have been developed and are being further elaborated (World Bank/KIT, 2000).

At the same time, there is a need to reform agricultural research centres and strengthen public-private partnerships in agricultural service delivery. The recently developed guide for the Client-Oriented Research Management Approach for sub-national agricultural research and development systems (DRD/IER/KIT, 2003) emphasizes the enhancement of efficiency and effectiveness of agricultural research through the establishment of public-private partnerships and the active participation of research clients. Communication and information exchange platforms need to be established to improve the co-ordination of research and optimize resource allocation. These platforms should have an informal nature in order to avoid bureaucratization of procedures.

The history of agricultural research in sub-Saharan Africa has taught us that financial flows and priority setting should originate from the level of end-users in order to be effective. This leads to the ultimate conclusion that bottom-up approaches to agricultural research remain paternalistic if bottom-up financing and priority setting of research do not accompany them. Both administrative decentralization and privatization of research contribute to more participation by farmers, but these trends tend to divide the poor and obstruct the efficiency and coherence of the entire research system. If no strategic interventions are made, public and private agricultural research will be further estranged from

each other. This would result in a Shakespearean tragedy for sub-Saharan Africa because both public and private research sub-systems have the potential of cross-fertilization and mutual strengthening. The solution may not be an orthodox marriage but continuous lovemaking by the partners involved. In this modern, African version of private Romeo and public Juliet, it is to be hoped that these two may have a long and happy life.

A glooming peace this morning with it brings;
The sun, for sorrow, will not show his head:
Go hence to have more talk of these sad things:
Some shall be pardon'd, some punished:
For never was a story of more woe
Than this of Juliet and her Romeo.

—the End—

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