A realistic view on increasing fertiliser use in sub-Saharan Africa*

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(*Picture© author: Threshing of rice in a small irrigated rice scheme in southern Togo, where farmers could apply relatively high doses of mineral fertilisers due to KR2 Japanese Aid.*)

Abstract

Fertiliser application rates per rural capita have decreased in sub-Saharan Africa (SSA) between 1986 and 2002. Value cost ratios of fertiliser use have declined in the past twenty years in almost all fertiliser-crop combinations of SSA. Especially the liberalization of the maize and fertiliser sectors in East and Southern Africa from 1986 onwards did not stimulate farmers to use fertilisers. Private sector involvement in these sectors appears not to be able to maintain or improve farmer demand for fertiliser use in maize. In fact liberalization seems to decrease fertiliser use in food crops in favour of cash crops.

To reverse these trends a realistic view on increasing fertiliser use in SSA is needed. Strategic site selection is then a way to make fertiliser use interventions more efficient. After selecting the most promising areas for increased fertiliser use and the fertiliser-crop combinations with the most promising value cost ratios (not excluding main food crops) one can look for ways how to increase the product price, lower the fertiliser price and/or increase the fertiliser response rate. To reduce risk and uncertainty related to the use of fertilisers it is important to make credit available at reasonable interest rates, to stabilize and forecast crop and fertiliser prices, and to guarantee reliable markets for surplus productions of the involved crops in the long-term. A stepwise strategic site selection provides policy makers in sub-Saharan Africa with a more solid basis for making decisions on the urgency, type and scale of fertiliser interventions and how to present these to the international donors.

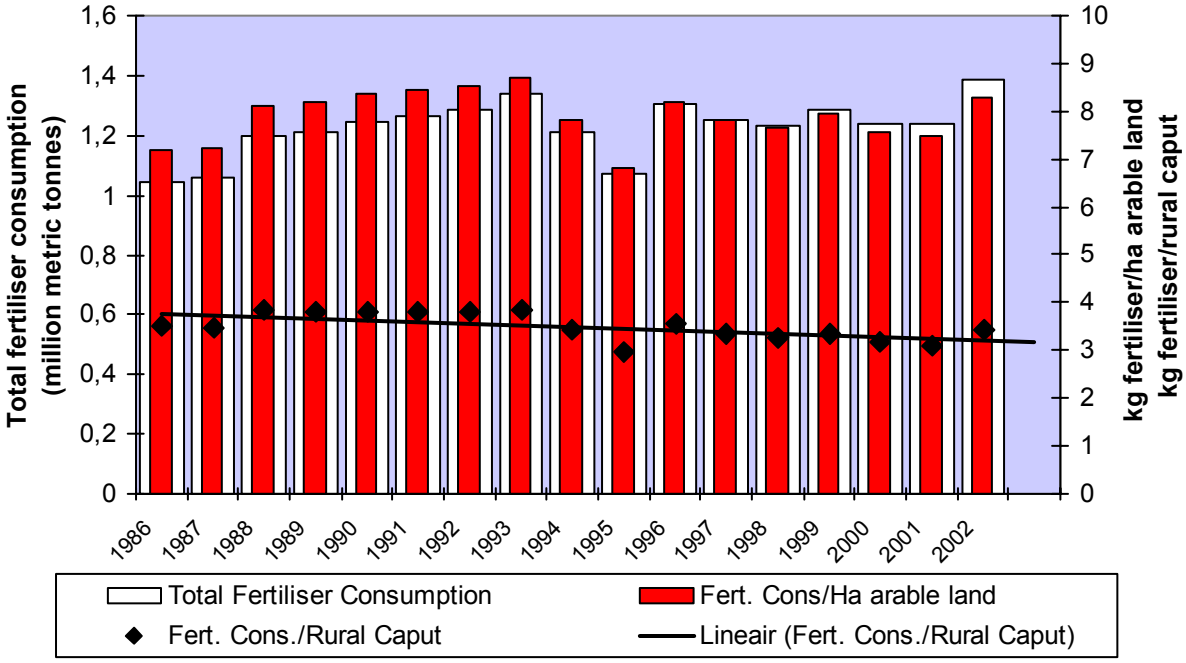
Introduction

During February and March 2005 the World Bank and DFID organised an e-forum on increasing fertiliser use in Africa as part of an ongoing Africa Fertiliser Strategy Assessment. The principal output of the Africa Fertiliser Strategy Assessment is a policy maker's toolkit that will provide guidance on how to promote economically rational and/or socially justifiable fertiliser use in Africa. The e-forum was managed by NR International, a UK based development research and knowledge management company, and moderated by staff from the Imperial College London.

These activities to promote efficient fertiliser use in Africa are based on the general believe that it will not be possible to reduce poverty in Africa and bring about sustainable increases in food production without solving the problem of low and declining soil fertility. Use of organic material alone will not be enough to support the yields that will be needed to feed future generations. Judicious, efficient, and sustainable use of chemical fertiliser will be necessary as well. During the 1965-2000 period China and India nearly tripled their food production through only the adoption of improved seeds, fertilisers, and related agronomic practices to feed over 2 billion people in 2000 (IFDC, 2003). Fertiliser use is believed to account for one-third of the increase in world grain production in recent decades (Kherallah et al., 2002).

While fertiliser application rates per unit of land doubled in East Asia and Southeast Asia and almost tripled in South Asia it remained almost stable in sub-Saharan Africa (SSA) between 1980 and 1997 (Kherallah et al., 2002). With a growing rural population and more rural households this has actually led to a decrease in fertiliser use per rural capita in sub-Saharan Africa as shown in Figure 1. In other words, rural households in sub-Saharan Africa currently use the same amount of fertiliser on their fields from which they have to feed an increased rural population and an even more rapidly growing urban population.

Figure 1: Fertiliser consumption trends in sub-Saharan Africa during 1986-2002



Source: FAOSTAT (2005). Figures are on the basis of plant nutrients. Arable land including permanent crops. Total fertiliser consumption for 1989 lowered by 244,900 metric tonnes because consumption in Tanzania was 45,000 (see Meertens, 2000) instead of the given 299,900 metric tonnes.

The trends displayed in Figure 1 disguise the differences in fertiliser consumption which do exist between individual SSA countries. In fact the majority of SSA countries had modest annual growth levels in total fertiliser consumption during the 1986-2002 period while some had even impressive annual growth levels. On the other hand, one third of SSA countries had practically zero or even negative annual growth levels during that period. Amongst these are some of the main fertiliser consuming countries in SSA such as Zimbabwe and Nigeria.

One of the background papers for the e-forum (Crawford et al., 2005) stated that debates over the most effective ways to promote fertiliser use in Africa may be meaningfully informed by studying the areas of Africa where fertiliser use has risen impressively over the past decade and in previous decades. In fact this very same background paper together with the other two background papers (Kelly et al., 2005 and Bumb and Gregory, 2005) and additional information from Townsend (1999) and Kherallah et al. (2002) do already provide sufficient information for explaining why in certain parts of Africa fertiliser use has risen or decreased in the past decades. The following sections of this paper will show this through analysing the specific circumstances in the main fertiliser consuming countries of sub-Saharan Africa.

Which factors affect fertiliser use in the main fertiliser consuming countries of sub-Saharan Africa ?

The period starting from 1986 was characterized by a gradual withdrawal of interventions from SSA governments in fertiliser markets due to structural adjustments programmes from the World Bank. The idea behind this was that the private sector could perform better in

fertiliser markets than governments and make fertilisers more available to farmers at the right time and with the correct market price. Townsend (1999) looked into how some SSA countries had followed the liberalization of their fertiliser markets in the 1990s and gave these countries so called fertiliser policy scores on the basis of a number of critical variables. If the assumption of the World Bank is valid then countries with high fertiliser policy scores should equally have high fertiliser consumption growth figures from 1986 onwards. Table 1 presents these fertiliser policy scores in combination with the annual growth rates in fertiliser use for the main fertiliser consuming countries in sub-Saharan Africa.

Table 1 Growth in fertiliser consumption and conformity with fertiliser market liberalization in the main fertiliser consuming countries of SSA

Country	Period	Growth fertiliser consumption[a] (%/year)	Mean annual total fertiliser consumption (metric tonnes)	Fertiliser Policy Score[b]	Link Growth with Policy?
Benin	1986-2002	14.38	24,537	60	No
Côte d'Ivoire	1986-2002	9.05	58,706	87	Yes
Mali	1986-2002	8.95	28,865	80	Yes
Burkina Faso	1986-2000[c]	7.45	26,352	73	No
Ghana	1986-2002	6.60	14,056	80	Yes
Senegal	1986-2002	5.11	23,225	67	No
Ethiopia	1986-1992	8.21	70,200	na	-
	1993-2002	4.99	140,995	na	-
Togo	1986-2002	3.94	14,365	67	No
Kenya	1986-2002	2.43	122,019	87	Yes
Cameroon	1986-2002	2.07	35,253	80	Yes
Sudan	1986-2002	0.03	60,707	na	-
Zimbabwe	1986-2002	- 0.01	156,536	87	No
Malawi	1986-2001[d]	- 1.15	50,943	93	No
Nigeria	1986-2002	- 4.99	271,016	73	Yes
Zambia	1986-2002	- 5.26	62,121	na	-
Tanzania	1990-2002[e]	- 12.87	31,081	80	No

[a] *Source*: FAOSTAT (2005). Exponential annual growth rates are given for the periods indicated.
[b] *Source*: Townsend (1999). Countries with fertiliser policy scores of 80 and above (the maximum is 100) are regarded as being in line with the liberalization guidelines for fertiliser markets from the World Bank. However, countries with scores beneath 80 are regarded as not being in line with these guidelines.
[c] Total fertiliser consumption FAOSTAT figures for Burkina Faso in 2001 and 2002 are totally out of line with the fertiliser consumption trend during 1986-2000 and seem to be not the actual consumption figures. A much higher total gross fertiliser consumption for 2001is reported from another FAO source (http://www.afamin.net/burkinafaso/engrais_conso_bf_fr.htm).
[d] The total fertiliser consumption FAOSTAT figure for Malawi in 2002 is totally out of line with the fertiliser consumption trend during 1986-2001 and therefore 2002 is not included in the calculation of the exponential annual growth rate.
[e] The total fertiliser consumption FAOSTAT figure for Tanzania in 1989 is very far away from the actual figure and therefore the calculation of the exponential growth rate starts from 1990.

Table 1 shows that there is no link between fertiliser policy scores and fertiliser consumption growth figures. Countries like Malawi, Zimbabwe and Tanzania, that implemented structural adjustment measures in fertiliser markets such as the phasing out of fertiliser subsidies and gradual government withdrawal from fertiliser importation and distribution had negative growth figures in total fertiliser consumption from 1986 onwards. On the other hand, countries like Benin, Burkina Faso, Senegal and Togo, that did not really comply with the liberalization guidelines from the World Bank had positive growth figures in total fertiliser consumption in the past two decades. Clearly other factors than compliance with liberalization

policies in fertiliser markets play their part in explaining why fertiliser use increases or decreases in SSA countries. These factors will differ from one country to another due to their differences in fertiliser policy histories and their differences in agroecological, economic and political circumstances. A brief description of the specific circumstances in most of the main fertiliser consuming countries in sub-Saharan Africa will be given in the following section to get a better view of what type of factors have a significant impact on fertiliser consumption.

With help from donors *Tanzania* had started its own production of fertiliser in 1972 and until 1981 this own production contributed around half of Tanzania's total fertiliser consumption (World Bank, 1994). The other half of the total consumed fertiliser was provided by donors in the form of aid. In 1975 the government started the National Maize Programme with the support of international donors. The objective of this programme, which focused on small-holder maize production, was to come closer to the goal of domestic self-sufficiency. For that matter inputs such as hybrid seeds, fertilisers and pesticides were provided at pan-territorial, subsidized prices in ten selected regions. A system of pan-territorial producer and consumer food crop prices was installed in 1974-75 to encourage production in potentially productive but remote areas and to guarantee a more equitable distribution of welfare. Inputs were furthermore distributed on a credit basis by government controlled cooperatives in combination with a government purchasing guarantee from the National Milling Corporation (NMC). The pan-territorial pricing system was an indirect subsidization of maize production in the more remote Iringa, Mbeya, Ruvuma and Rukwa regions in the Southern Highlands, since transport costs were paid in the end by the government (Geier, 1995). As a result maize production increased sharply in the Southern Highlands, which provided a large share of the maize purchased by NMC (Delgado and Minot, 2000). The Southern Highlands consumed about 60-70% of total fertiliser in the country of which more than 70% was used for maize production (Hawassi et al., 1998). The remaining fertiliser was consumed in tobacco, cotton, tea, rice and coffee at the same pan-territorial subsidized prices. Apart from rice these fertilisers were also supplied on a credit basis.

Structural adjustment measures from 1984 onwards with the devaluation of the Tanzanian Shilling gradually reduced government interventions in food crop and inputs markets. At the end of the 1980s the pan-territorial producer prices were abandoned and the NMC was not able anymore to buy maize from farmers due to financial problems. At the same time the inputs credit programme of the regional cooperatives had to be abandoned due to poor repayment and the absence of refinancing options. Fertiliser subsidies, which had amounted to an implicit level of 80% in the 1988/89 season, were gradually phased out and finally reached zero in the 1994/95 season. During 1994 the subsidy on fertiliser imports by the parastatal Tanzania Fertilizer Company was eliminated and pan-territorial pricing was discontinued. Technical problems, increasing with time, caused a reduction in the own production of fertilisers and finally it became zero in 1996 (World Bank, 1994). International donors, apart from Japan, stopped the provision of fertiliser in the form of aid. Tanzania was the second largest African recipient of the KR2 Japanese aid programme in the form of fertilisers, pesticides and machinery in 1996 (Townsend, 1999). However, in those years the absolute quantities of this aid programme were much lower as they used to be (MAC, 1997).

An optimistic view on the role the private sector could play in fertiliser distribution caused some to believe that the removal of the fertiliser subsidy would eventually lead to a net increase in total fertiliser use and reach 200,000 metric tonnes of gross fertiliser[1] (World Bank, 1994). Figures from FAOSTAT (2005) show, however, that total fertiliser nutrient consumption declined from 46,800 metric tonnes in 1990 (70% implicit subsidy) to 35,900

[1] This amount of gross fertiliser consumption is comparable to about 75,000 metric tonnes nutrients.

metric tonnes in 1994 (zero subsidy) and to 7,148 metric tonnes in 2002. In fact the government had created an artificial demand for fertilisers in many parts of the country due to the pan-territorial, subsidized prices. When the private sector entered the fertiliser market many farmers were not interested anymore in buying fertilisers due to the sharp increased price and the fact that private traders were generally not supplying fertilisers on credit. Moreover, private traders could not profitably supply fertilisers to more remote villages due to high transport costs and low demands (Meertens, 2000).

In the early 1980s *Zambia* had a highly overvalued exchange rate, providing a large implicit subsidy on imported goods such as fertiliser, that could count on foreign exchange allocations (Kherallah et al., 2002). Similar measures as the ones in Tanzania were taken by the government to increase domestic maize production with the objective of self-sufficiency in white maize. The expansion of state buying stations in remote areas under pan-territorial pricing encouraged a notable increase in smallholder maize production. Fertilisers and other inputs were supplied at subsidized, pan-territorial prices on a credit basis (Jayne and Jones, 1997). Almost all fertiliser consumed in Zambia is applied to maize (Kherallah et al., 2002). Structural adjustment programmes in the mid-1980s led to a huge devaluation of the national currency, the abolition of pan-territorial prices, the elimination of fertiliser subsidies and a gradual liberalization of food crop and input markets. As a result fertiliser consumption started to decrease since the late 1980s (Jayne and Jones, 1997). The private sector's response to the reforms, in terms of new entry and investment in fertiliser markets, had been limited (Jayne et al., 2003). During the 1990s Zambia was, however, still one of the main African recipients of the Japanese KR2 aid programme (Townsend, 1999).

Also in *Malawi* the government was actively involved in promoting smallholder maize production during the 1970s/1980s. Pan-territorial pricing was used to encourage production in the more remote Northern districts and maize producer prices and fertiliser were subsidized through taxation of smallholder cash crops (Jayne and Jones, 1997). All fiscal and economic subsidies on fertiliser were completely removed in 1995/96 leading to an increase in fertiliser prices varying between 200 and 300 percent. As a result fertiliser consumption started to decline despite the fact that one third of it was distributed for free by the government (Townsend, 1999). At the end of the 1990s the commercial fertiliser market was dominated by a few private sector importers/wholesalers and an expanding network of small stockists but government institutions still continued to import fertiliser (Townsend, 1999). Moreover, the parastatal maize marketing board continues to exist in Malawi (Kelly et al., 2005).

In *Nigeria* fertiliser subsidies have been as high as 85 percent from 1976 until 1989 (Kherallah et al., 2002). As a result fertiliser consumption increased substantially. In 1986 a factory for nitrogenous fertiliser started production, which gave another boost to the total fertiliser consumption. Maximum fertiliser production was reached during the 1992/93 season with 371,200 metric tonnes of fertiliser nutrients (inluding other than nitrogen). Thereafter production declined and reached finally zero in 2000. Exports of nitrogenous fertiliser, which amounted to 122,100 metric tonnes in 1990/91, continued until the 1996/97 season and then became zero (Bumb and Gregory, 2005). Between 1994 and 1997 the fertiliser subsidies were removed but in 1999 a 25 percent subsidy was reintroduced (Kherallah et al., 2002). Immediately fertiliser consumption decreased tremendously and recovered only slightly during 2000 and 2001. Due to the large differential between border price and official price created by past subsidies distributors smuggled fertiliser out of Nigeria to be sold on neighbouring markets at large profits (Townsend, 1999). However, despite announced policies, the private sector has not been encouraged to participate in the supply of fertiliser for the internal market (Townsend, 1999).

A factory for phosphate fertiliser in *Zimbabwe* started already production in 1927 followed by a factory for nitrogenous fertiliser in 1969. From that moment until now total annual production has been around 100,000 metric tonnes of fertiliser nutrients, which covered an average 65-75% of the total fertiliser consumption (FAOSTAT, 2005). In the 1970s the fertiliser produced by two state enterprises was distributed mainly to large-scale commercial farmers by a cooperative and a state enterprise. In the 1980s the government stimulated maize production by smallholders through channelling inputs, credit and extension to this group. As a result maize production doubled (Kherallah et al., 2002). Just as in Tanzania and Zambia state buying stations in remote areas under pan-territorial pricing were used for that matter. From 1986 onwards this government maize policy was gradually dismantled by market liberalization and privatization. As a result maize production and fertiliser consumption in the smallholder sector started to decline in the 1990s (Jayne and Jones, 1997). However, despite structural adjustment programmes Zimbabwe has retained its parastatal maize marketing board to stabilize maize prices (Kelly et al., 2005). Moreover, own production of fertilisers is protected against importation of fertilisers and this had negative effects on private sector development in the fertiliser market (Townsend, 1999).

Fertiliser subsidies were already phased out by the mid-1970s in *Kenya*, but price controls continued to hold prices below market levels. Maize production by small-scale producers was stimulated by the government through pricing and market support policies (Jayne and Jones, 1997). During the late 1980s donor aid was in fact accounting for over half of total fertiliser imports (Jayne et al., 2003). In 1990 fertiliser prices were finally decontrolled and in 1993 fertiliser import restrictions were eliminated (Kherallah et al., 2002). Donor imports declined to 5% of total fertiliser consumption, and small-scale farmers relied exclusively on the private sector and cooperatives for fertiliser. By 1996 there were 12 major private importers, 500 wholesalers, and about 5000 retailers distributing fertiliser in the country. It is estimated that the number of retailers rose to between 7000 and 8000 by 2000 (Jayne et al., 2003). However, Kenya was still the largest African recipient of Japanese KR2 aid in 1996 (Townsend, 1999).

Total fertiliser consumption increased gradually in *Ethiopia* since 1970 when the fertiliser market was totally controlled by the state owned parastatal. In 1992 fertiliser subsidies and pan-territorial prices had been removed and, with the currency devaluation, fertiliser prices increased sharply (Townsend, 1999). However, total fertiliser consumption increased sharply from 1994 onwards. In 1993 Sasakawa Global 2000, an international NGO, had successfully introduced the use of improved maize technologies involving improved seeds and fertiliser on credit. In 1994 the government extended this concept nationally through the introduction of government-guaranteed credit at low interest rates with the National Extension Program as major buyer and distributor of fertiliser (Kherallah et al., 2002). Moreover, Ethiopia was the third largest African recipient of Japanese KR2 aid in 1996 (Townsend, 1999). Credit repayment had been initially very high (usually > 98%) due to the government's very strong stand on repayment, with arrests or confiscation of assets where necessary (Kelly et al., 2005). However, Kherallah et al. (2002) mentioned that the National Extension Program was later plagued with unrecoverable debts and favoritism in procurement.

Between 1977 and 1982 there were explicit fertiliser subsidies of about 50% in *Cameroon*. These fertiliser subsidies were gradually phased out between 1987 and 1993 (Kherallah et al., 2002). As a result total fertiliser consumption fell down from 49,800 metric tonnes nutrients in 1987 to 22,300 metric tonnes nutrients in 1993 (FAOSTAT, 2005). From 1994 onwards total fertiliser consumption has gradually climbed back to the 1987 level when the devaluation of the CFA franc, which made cotton and coffee exports more profitable, stimulated fertiliser

demand. In Cameroon a relatively large share of fertiliser is allocated to cash crops such as cotton, coffee and cocoa (Kherallah et al., 2002).

In *Togo* explicit fertiliser subsidies were as high as 80% during the late 1970s but were gradually phased out during 1980-1987 (Kherallah et al., 2002). However, total fertiliser consumption during 1987-1994 remained stable (FAOSTAT, 2005). Togo is a large African recipient of Japanese KR2 aid (Townsend, 1999), certainly on a per caput basis, and therefore fertiliser prices did not raise as much as in other countries. From 1995 onwards total fertiliser consumption started to increase again due to the devaluation of the CFA franc, which made cotton farming more profitable. Cotton is the main crop fertilised in Togo (Kherallah et al., 2002). In principle the fertiliser market is nowadays open to private traders, but government institutions, such as the cotton marketing board SOTOCO, dominate the distribution of fertilisers due to subsidized fertiliser prices from Japanese KR2 aid (Townsend, 1999).

Fertiliser subsidies ranged between 50% and 70% in *Senegal* during 1975-1983, but were phased out in the following years and absent in the 1990s apart from an incidental 40% subsidy in 1992 (Kherallah et al., 2002). Senegal is producing its own nitrogen and phosphate fertilisers and is even exporting these fertilisers to other countries. Total fertiliser production was higher than total consumption and export combined until 1999 (FAOSTAT, 2005). In recent years the share of fertiliser used on groundnuts has fallen relative to that used on cotton (Kherallah et al., 2002). The devaluation of the CFA franc in 1994 is probably the main reason for this change. Although the private sector has been allowed to enter the fertiliser market government instititions continue to dominate the distribution of fertiliser (Townsend, 1999).

Due to a highly overvalued exchange rate of the national currency *Ghana* had implicit fertiliser subsidies of between 45% and 85% during 1975-1985. These subsidies were gradually phased out during the next years and reached zero in 1990 (Kherallah et al., 2002). As a result total fertiliser consumption started to decrease in the following years. This trend reversed in 1996 when fertiliser consumption started to increase again, especially in the recent 2001 and 2002 years (FAOSTAT, 2005). Presently there are about 30-40 registered fertiliser wholesalers/retailers and probably about 600-800 rural retailers of fertiliser and other agro-chemicals spread over the country.[2] It appears that the share of fertiliser used on maize has fallen relative to that used on cotton, pineapple and oil palm.[3]

In *Benin, Burkina Faso, Côte d'Ivoire* and *Mali* total fertiliser consumption rates started to increase sharply in the years following the devaluation of the CFA franc in 1994 (FAOSTAT, 2005). All four countries are characterized by a high consumption rate of fertiliser on cotton and by parastatal cotton marketing boards, which provide fertiliser on credit and maintain a monopsony on cotton marketing (Kherallah et al., 2002). Although fertiliser markets are liberalized in these countries, cotton marketing boards and other government institutions continue to regulate and dominate these markets which inhibits private sector entry (Townsend, 1999).

In the case of Benin, the recent growth in fertiliser use may well be overestimated due to former informal, unrecorded fertiliser imports from Nigeria (Kherallah, 2002). Although Côte d'Ivoire is not producing anymore fertilisers it has been exporting substantial amounts of fertiliser from the 1997/98 season onwards. In fact imports have largely surpassed total fertiliser consumption from that moment on (FAOSTAT, 2005). Farmers growing irrigated

[2] Source: http://www.afamin.net/ghana/fert_dist_gh_en.htm

[3] In 1991 64% of total fertiliser was used on maize (Kherallah et al., 2002), but during the 1995-99 period an estimated 30% of total fertiliser was used on cotton, 15% on pineapple, 10-15% on oil palm and a further 30% divided between cereals and horticultural crops (http://www.afamin.net/ghana/fert_conso_gh_en.htm).

rice or horticultural crops in Burkina Faso and Mali appear to be the main buyers of fertilisers exported by private companies from Côte d'Ivoire.[4] In Mali and Côte d'Ivoire substantial amounts of fertiliser are respectively applied to irrigated rice and rainfed rice next to cotton. The devaluation of the CFA franc in 1994 immediately doubled the price of imported rice and made local rice more competitive. In Mali this led to an intensification of the cultivation of irrigated rice in the l'Office du Niger (Egg and Deme, 2002). Apart from an increased use of fertiliser per unit land there was also an increase due to an expansion in cultivated area (Crawford et al., 2003). Fertilisers are given to the rice farmers on a credit basis by several credit-savings networks (Traoré and Spinat, 2002).

This overview of fertiliser consumption trends for the SSA countries discussed above shows that the most important factors in explaining why fertiliser use increases are:

- Pan-territorial crop and fertiliser prices
- Subsidized fertiliser prices
- High share of donor-funded fertiliser imports to total imports
- Fertilisers provided on a credit basis to farmers
- Devaluation of the CFA franc in francophone West Africa

The removal of pan-territorial prices, fertiliser subsidies and credit opportunities due to liberalization has caused a decrease in fertiliser consumption in Tanzania, Zambia, Malawi, Zimbabwe and Nigeria. The descriptions above in these countries have shown that the private sector was not able to stop this decrease in total fertiliser consumption. In fact only in Kenya and Ghana private sector involvement in the fertiliser market seems to be an important factor in explaining fertiliser consumption growth. The next section shows in which ways various factors can increase the demand of farmers for fertilisers.

How to increase farmer demand of fertilisers ?

In SSA profitability is, as stated by Townsend (1999), one of the key factors determining the quantity of fertiliser used. Profitability is determined by the price of the crop grown, the price of the fertiliser used and the output response of the crop to the fertiliser application. The for that matter much used Value Cost Ratio (VCR) can alternatively be defined as the product unit price to fertiliser unit price multiplied by the fertiliser response rate, which is the amount of additional kg's output from a kg of fertiliser nutrient. In formula form:

$$VCR = \frac{\text{Product price (kg)}}{\text{Fertiliser price (kg nutrient)}} \times \text{Fertiliser response rate (kg/kg nutrient)}$$

Higher VCR's will induce farmers to buy fertilisers. A ratio equal to two is generally considered as the minimum requirement for a farmer to adopt fertiliser and a ratio of three to four to be necessary when production or price risk is high (Kelly et al., 2005). Higher VCR's can be obtained through increasing the product price, lowering the fertiliser price and/or increasing the fertiliser response rate.

The *farmgate price of the crop* can be raised through improving the marketing infrastructure (roads, railways etc.), more reliable marketing facilities, more efficient marketing channels,

[4] Sources: http://www.afamin.net/burkinafaso/engrais_dist_bf_fr.htm and Ani et al. (2002).

better access of farmers to information about prices, improved storage capacities and a better negotiating position of farmers in relation to private traders. The use of pan-territorial and pan-seasonal prices is another way of increasing the farmgate crop price in remote areas.

The *farmgate fertiliser price* can be lowered through reducing the costs of port clearance, reducing the costs of transportation and distribution (improving roads, railways, port etc.), pooling of import transactions across countries (Bumb and Gregory, 2005), selection of fertiliser types with high nutrient contents, better access of private traders to market and finance information, collective farmer action in fertiliser purchase via farmer associations or cooperatives (Kelly et al., 2005), the use of fertiliser subsidies and the provision of fertilisers on credit at low interest rates. The use of pan-territorial prices is another way of lowering the farmgate fertiliser price in remote areas.

The *fertiliser response rate* can be increased through the selection of crops which are more responsive to fertiliser application such as maize and rice, the selection of areas with more reliable rainfall patterns and soils which are more responsive to fertiliser application (e.g. less leaching due to higher organic matter content and/or higher clay/loam content), the use of more responsive, improved varieties, the selection of the most appropriate type of fertiliser (percentages and types of nutrients), the use of the most efficient application method (type, number and timing of applications), the use of the most performing dose of the fertiliser involved, an improved water control (e.g. small-scale irrigation) and through a better management of the fertilized crop involved (timely weeding, adequate pest control, timely harvest and proper post-harvest techniques).

However, VCR's above two or even three to four are no guarantee that farmers will start applying fertilisers in their fields. Kelly et al. (2005) state correctly that reducing risk and uncertainty plays an important part in improving fertiliser incentives in SSA. Highly volatile output prices from one season to another make it very difficult for farmers to assess the eventual benefit of fertiliser use. A VCR of two to four during last season is under such conditions no guarantee for a profitable use of fertiliser during this season. The same applies to areas plagued by highly unpredictable rainfall patterns. Profitable use of fertiliser during a season with good rainfall can be followed by a season with even a negative effect of fertiliser application due to several prolonged dry spells. Another type of needed certainty is that there has to be a market for the surplus production due to fertiliser application. Imported food crops which appear to be cheaper on the large urban markets than the locally produced food crops form therefore a disincentive for fertiliser use by local farmers in SSA countries.

Table 2 presents changes in VCR's for the main fertilized crops in the main fertiliser consuming countries in SSA from the early 1980s to the early 2000s. This table shows that in general VCR's have declined in the past twenty years in almost all cases. The only exception appears to be the VCR for using fertiliser on maize in Kenya. During the early 2000s VCR's have even become lower than 2 and thus unprofitable for the use of fertilisers on maize in Malawi, Zambia and Tanzania. For Tanzania this was already the case halfway the 1990s. The liberalization of the maize and fertiliser sectors in these countries during the past twenty years clearly did not stimulate farmers to use fertilisers and the decline of fertiliser consumption presented in Table 1 is due to a logical reaction of farmers to unprofitable value cost ratios.

In Nigeria and Zimbabwe, however, fertiliser consumption declined or remained stable despite the fact that VCR's for fertiliser use in maize during the 1990s and early 2000s had values above 2 comparable to the ones for fertiliser use in cotton in West Africa.[5] Fertiliser use on cotton in West Africa is stimulated by the fact that cotton and fertiliser prices are

[5] In fact the VCR for fertiliser use on maize in Nigeria in the early 2000s was in reality lower than the value used in Table 2, which is based on retail maize and fertiliser prices instead of farmgate prices.

Table 2 Changes in value cost ratios for the main fertilized crops in the main fertiliser consuming countries of SSA from early 1980s to early 2000s

Country	Crop-Fertiliser combination	VCR during early 1980s[a]	VCR in 1986[b]	VCR during mid-1990s[a]	VCR during early 2000s[c]
Benin	Cotton-NPKSB	5.1	-	2.6	3.2
Côte d'Ivoire	Rice-Urea	-	4.1	-	2.3
	Cotton-NPKSB	-	-	-	2.7
Mali	Rice-Urea	6.7	-	5.7	3.3 [d]
	Cotton-NPKSB	-	-	-	3.0
Burkina Faso	Cotton-NPKSB	-	2.8	-	2.2
Ghana	Maize-AS	6.8	-	1.5	2.2
Senegal	Groundnuts-Mixed Fertilisers	15.0	-	9.0	3.0
Ethiopia	Maize-Urea	2.7	-	9.0	2.5
Togo	Cotton-NPKSB	-	-	2.7 [e]	3.0
Kenya	Maize-Urea	2.6	-	3.5	2.8 [f]
Cameroon	Cotton-NPKSB	-	4.6	-	1.7
Zimbabwe	Maize-Urea	3.1	-	2.5 [g]	2.6 [h]
Malawi	Maize-Urea	7.4	-	3.3 [i]	1.3 [J]
Nigeria	Maize-Nitrogen	7.5	-	2.1	3.1 [k]
Zambia	Maize-Nitrogen	5.2	-	3.1	1.1 [l]
Tanzania	Maize-Nitrogen	6.5	-	1.1 [m]	1.1 [n]

[a] Based on fertiliser/crop price ratios mentioned in Kherallah et al. (2002) and typical fertiliser response rates of maize, rice, cotton and groundnuts in different parts of SSA from Kelly et al. (2005), unless otherwise stated.
[b] Based on crop and nutrient prices per kg in 1986 mentioned in FAO (1989) and a fertiliser response rate of 8 kg/kg nutrient for rainfed rice and 5 kg/kg nutrient for cotton in West-Africa.
[c] Based on crop and nutrient prices per kg for the early 2000s found in FAO (2004) or FAOSTAT (2005) and typical fertiliser response rates of maize, rice, cotton and groundnuts in different parts of SSA from Kelly et al. (2005), unless otherwise stated.
[d] Farmgate price of paddy rice and urea in the l'Office du Niger from Ani et al. (2002)
[e] Source: FAOSTAT (2005)
[f] Based on average farmgate maize price of 11.2 KShs/kg and average farmgate fertiliser (CAN and DAP) price of 68.2 Kshs/kg nutrient mentioned in Salasya (2005).
[g] Based on 1995 maize producer price of 1.05 Z$/kg (FAOSTAT, 2005) and 1995 farmgate price of 120 Z$/bag of 50 kg AN or Compound D (8-14-7), which is equal to 7.3 Z$/kg nutrient (Chibudu et al., 2001).
[h] Based on 2000 farmgate maize price of 5.00 Z$/kg and an estimated farmgate price of 500 Z$/bag of 50 kg AN or Compound D mentioned in Twomlow and Ncube (2001).
[i] Source: FAOSTAT (2005)
[j] Farmgate maize price of 10 MK/kg (RATES, 2003a) and a price of 3000 MK/bag of urea (USAID, 2005).
[k] Retail 2004 maize price of 23 N/kg and retail 2004 urea price of 52 N/kg in Kano State (AFAMIN, 2005).
[l] Retail 2002 maize price of 200 ZMK/kg and farmgate 2002 urea price of 1,400 ZMK/kg (FAO/WFP,2002).
[m] Average 1995/96 farmgate maize price of 50 TShs/kg in Southern Highlands and 1995/96 farmgate price of 751 TShs/kg nutrient on the application basis of 2 bags CAN and 1 bag TSP (MAC, 1997).
[n] Farmgate 2002 maize price of 55 TShs/kg (RATES, 2003b) and CAN price of 850 TShs/kg N (FAO,2004).

announced before planting, that fertiliser is provided on credit which is only paid later when the farmer sells his/her cotton and the fact that cotton farmers are sure of selling their crop. Fertiliser use on maize in Nigeria and Zimbabwe is much more risky due to volatile und uncertain prices for maize and fertiliser, the absence of credit opportunities such as for cotton and the uncertain market for surplus maize production. Furthermore fertiliser use in maize is very much related to the use of improved and hybrid maize varieties. Liberalization policies, however, also increased the price of improved and hybrid maize seeds which caused a decrease of their use in maize farming. As a consequence fertiliser response rates in maize have equally decreased and are actually lower than the value used in Table 2 for the

calculation of VCR's. A VCR calculation for the combined use of fertiliser and improved seeds in maize might very well be under 2 in the current situation of Zimbabwe and Nigeria.

Fertiliser use in maize, wheat or teff, the main fertiliser consuming cereal in Ethiopia (Kherallah et al., 2002), was less risky for Ethiopian farmers since the early 1990s due to the availability of credit at low interest rates and a government guaranteed market for cereals. Although the VCR for fertiliser use on irrigated rice in the l'Office du Niger of Mali during the early 2000s was only half the level of the early 1980s (Table 2), fertiliser consumption is now much higher than before due to the good market for rice produced in the l'Office du Niger in the capital Bamako and due to the availability of credit at reasonable interest rates.

What kind of fertiliser policies have to be followed ?

Kherallah et al. (2002) stated that it is difficult to find evidence of any adverse impact of fertiliser market liberalization on agricultural production in SSA because the aggregate effect of fertiliser use on production is rather small due to the very low application rates. However, even for countries with relatively high application rates (25-50 kg fertiliser/ha) such as Zimbabwe, Malawi and Kenya it is difficult to see clear correlations between fertiliser use and agricultural production. In fact many other factors than fertiliser use influence agricultural production in SSA countries. Townsend (1999) mentioned that most of the growth in cereal production in Africa between 1980 and 1997 has been from an expansion in area planted.

Table 3 shows that an expansion in maize area was the main growth factor in Tanzania, Zimbabwe and Malawi before liberalization. A good example of this trend is provided by Rukwa region, the most remote part of the Southern Highlands in Tanzania. The government support for maize production from 1975 onwards caused a sharp increase in production and turned maize into being the most important cash crop (Geier, 1995). Due to the abundance of land and the availability of oxen and ploughs this increase in production was mainly due to an expansion of the area cultivated. Maize production increased, however, also due to the use of improved seeds, fertilisers and pesticides, which raised the production per unit land (Table 3).

Table 3 Changes in maize production growth characteristics in some SSA countries before and during structural adjustment programmes

Country	Period	Total maize production growth rate (%/year)	Average maize yield growth rate (%/year)	Total cultivated maize area growth rate (%/year)
Tanzania	1974-1986	5.64	2.67	2.89
	1987-2004	0.53	1.32	- 1.28
Zimbabwe	1974-1986	0.53	- 2.99	3.63
	1987-2004	- 2.60	- 3.76	1.20
Malawi	1974-1986	1.40	0.16	1.25
	1987-2004	2.80	1.58	1.20
Kenya	1974-1986	0.81	2.55	- 1.70
	1987-2004	- 0.30	- 1.41	1.13
Zambia	1974-1986	- 3.35	3.58	- 6.70
	1987-2004	- 3.02	- 1.37	- 1.68

Source: FAOSTAT (2005). Figures are exponential annual growth rates.

In Zimbabwe maize growth originated from an expansion of maize cultivation by smallholders. The much lower yield levels in smallholder maize fields in comparison to the commercial, large-scale farmers, despite an increased use of fertilisers, caused a decrease in the average yield level (Table 3). In Kenya and Zambia, however, there was a reduction in total maize acreage before liberalization, which was more or less compensated by an increase in average maize yields due to the use of improved seeds, fertilisers and pesticides.

Average maize yield levels in Tanzania, Zimbabwe, Kenya and Zambia appear to have decreased during the structural adjustment programmes in comparison to the period prior to liberalization. The only exception is Malawi (Table 3). It is surprising to see that this is also the case in Kenya despite an increase in fertiliser consumption during liberalization (Table 1). In fact the largest importers of fertilisers in Kenya during liberalization were cooperatives and estate firms which supplied mainly to small-scale farmers participating in tea, coffee, and sugarcane outgrower schemes (Crawford et al., 2005). Just as in the case of cotton in West Africa farmers are stimulated to use fertilisers in these cash crops due to the fact that crop and fertiliser prices are announced before planting, that fertiliser is provided on credit which is only paid later when the farmer sells his/her crop, and the fact that farmers are sure of selling their crop. The maize crop in Kenya, in contrast, is faced by uncertain markets and lack of credit opportunities with reasonable interest rates for the purchase of inputs. Many cash constrained small-scale maize farmers are forced to borrow money from informal credit lenders at interest rates of between 50 to 100% in order to buy inputs such as fertilisers. The household's shadow price of fertiliser is thus in reality much higher (Salasya, 2005). Together with the high increased price of improved seeds this higher shadow price of fertiliser will most probably lead to a VCR below 2 for the use of fertiliser in maize. As a result fertiliser use on maize in Kenya is declining in comparison to higher value crops such as tea, coffee and sugarcane. Similar developments are observed in Ghana.[6] To safeguard their food requirements households are actually compensating the decline in yield with an increase in maize acreage (Table 3). Others state that liberalization is encouraging Kenyan farmers to switch out of maize into higher value crops (Lewa, 2003).

Growth rate in total cultivated maize area appears to have shrunk in Tanzania and Zimbabwe during structural adjustment in comparison to the period prior to liberalization. During structural adjustment Tanzanian farmers were forced to sell their maize to a limited number of private traders who paid far less than the official purchase price. At the same time the majority of farmers had no longer access to credit to buy inputs as private traders were not willing to supply inputs on a credit basis. Furthermore, prices of inputs had risen sharply, especially in remote areas such as Rukwa region. The production of maize with and without fertilisers was not profitable anymore and a number of farmers shifted their attention to other crops (Meertens, 2000). Similar developments took place in the smallholder maize sector of Zimbabwe.

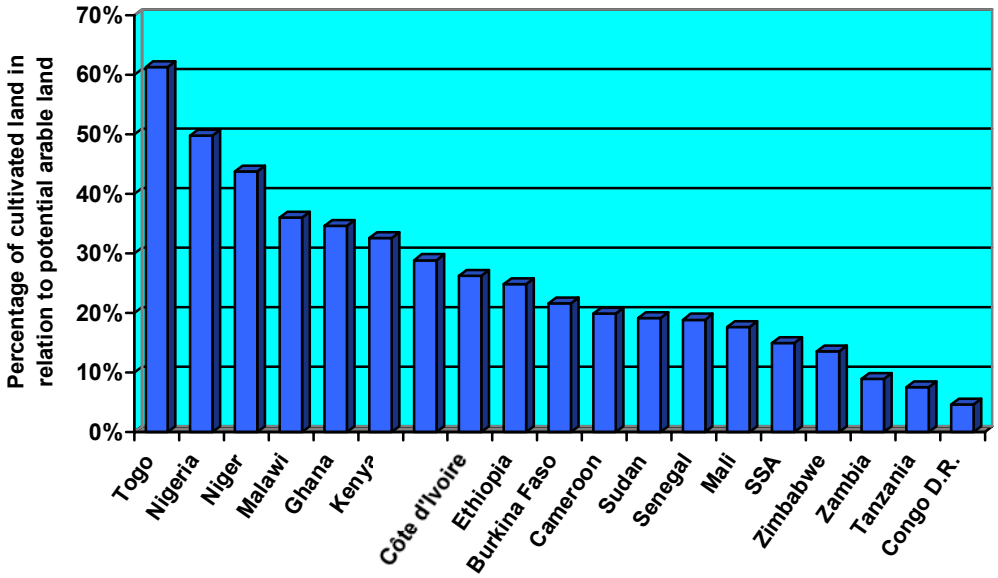
It is alarming to see in Table 3 that growth rates in maize production are not keeping up with population growth rates[7] in four out of the five countries in which maize is the main food staple. Liberalization of maize and fertiliser markets in these countries is apparently not meeting its objectives almost twenty years after its introduction. Is it then a surprise that the government of Zambia still intervenes in the fertiliser market as it distributes fertiliser through

[6] The Sasakawa Africa Association Newsletter of November 2002 (SAA, 2002) states that fertiliser use on maize in Ghana is in decline in favour of high value crops, notably export horticultural crops such as pineapples.
[7] On the basis of estimated data from FAOSTAT (2005) the exponential annual total population growth rate in the 1987-2003 period was 1.93% in Zimbabwe, 2.17% in Malawi, 2.38% in Zambia, 2.60% in Kenya and 2.89% in Tanzania.

the Food Reserve Agency, although the private sector is able to operate (Kherallah et al., 2002)? In that way the government supplied targeted farmers with 48,000 metric tonnes of gross fertiliser at half the price in 2003 (Bumb and Gregory, 2005). Or that in 2003 the government of Tanzania has reinstalled fertiliser subsidies in the Southern Highlands in order to ensure national food security (Amani, 2004)? In Malawi both government and donors are still involved in free or subsidized distribution of fertilisers and improved seeds (Bumb and Gregory, 2005). Since the 1998/99 season the Starter Pack Initiative and its successor, the Targeted Inputs Programme, provided in its initial years of operation almost every rural smallholder household with a free package (fertilisers, seeds) for the cultivation of 0.1 hectares of maize/legumes (Crawford et al., 2005). Together with the fact that liberalization of the maize and fertiliser markets only took place in Malawi since 1995 this can explain why Malawi is the only country with increased maize production and yield growth rates during structural adjustment in comparison to the period prior to liberalization (Table 3).

There are quite some development workers, researchers and policy makers (e.g. Cleaver, 1993) who think that the high population growth in SSA during the past decades has led to a decline in fallow land which already necessitates an intensification of farming based on the use of inputs such as fertilisers. However, this assumption is not in line with the available data on land use in SSA. Verheye (1997) shows that in fact only 23% of the potential arable area in Africa was cultivated in 1992. Estimated data on potential arable land from TERRASTAT (2005) and data on land under cultivation (arable and permanent crops) from FAOSTAT (2005) show that this percentage was even only 15% for SSA in 2002. There are, however, huge differences in percentages of potential arable land used for cultivation between SSA countries as is shown in Figure 2. In the selected group of SSA countries this percentage varies from just above 60% in Togo to below 5% in the Democratic Republic of Congo. Figure 2 shows that all West African countries have percentages above the SSA average and that mainly countries from East and Southern Africa have values below the SSA average.

Figure 2: Cultivated arable land in relation to potential arable land in a number of SSA countries in 2002



Source: TERRASTAT (2005) for estimated data on potential arable land and FAOSTAT (2005) for data on cultivated land (under arable and permanent crops) in 2002.

Another widespread idea among development workers, researchers and policy makers is that still available land for cultivation in SSA is of marginal quality or under forest. Crawford et al. (2005) state that households with infertile land may have to move into marginal or forested areas thus causing land degradation and deforestation. There are indeed many hectares of marginal land in the Sahel, Sudan, Ethiopia and Kenya due to unsufficient and erratic rainfall and many hectares of forests in Cameroon and the Democratic Republic of Congo. Apart from that there are large wildlife parks and game reserves in Tanzania, Zambia, Kenya and Zimbabwe. However, from the remaining 85% of potential arable land in SSA there are also huge stretches of land with medium to high quality which are not under forest. One can think here of the many still unexploited valley bottoms (bas fonds) in West Africa. Often tsetse infestation or difficult soils are the reasons why farming households have not yet started to exploit these parts of land in SSA. Moreover lack of capital for putting potential arable land into cultivation at government level (large investments such as irrigation schemes), and at household level (no money for tractor or ox-plough) restrict the exploitation of these areas. Land/man ratios in SSA countries where little prospects exist for the commercialization of excess crop production or for the extensification of landuse have to be taken with care because the acreage used for cropping is then often determined by the direct family needs (Verheye, 1997).

A large part of the remaining 85% of potential arable land in SSA is currently used by farmers as grazing areas or as fallow land. Although reliable data are lacking one can say that there are still many farming systems with fallow land in SSA at this moment and in the nearby future. These type of farming systems normally do not have serious soil fertility problems due to the soil fertility restoring effect of the fallow period. The involved farming households generally regard problems such as weed infestation, delayed land preparation and delayed harvesting as more disturbing than poor soil fertility management. Only heavily subsidized fertiliser programmes can arouse their appetite for mineral fertilisers. In such circumstances it is doubtful if fertilisers are the best option to increase agricultural output. Extensification of landuse seems then to be a more practical way of increasing output and as already mentioned most of the growth in cereal production in Africa between 1980 and 1997 has indeed been from an expansion in area planted (Townsend, 1999).

Apart from the fact that it is understandable that countries such as Zambia, Tanzania and Malawi still continue or have resumed subsidizing fertiliser prices one has to look into the effectiveness of such government policies. It would be not advisable to return to the 1980s situation of pan-territorial, subsidized fertiliser and crop prices which created artificial demands for fertiliser use. Targeting of fertiliser interventions has to keep in mind that there are still areas in sub-Saharan Africa where soil fertility management is not the key issue and where farmers' demand for mineral fertilisers is very weak.

Strategic site selection is then a way to make fertiliser use interventions more efficient. One key variable in this strategic site selection is the intensity of the farming system with regard to land use (in other words the proportion of fallow land to total cultivated land). Other key variables are population density, market access (location, market infractructure, future market developments), public policy environment (price policies, road infrastructure) and agro-ecological conditions (soils, climate). The most promising parts of Africa for increased fertiliser use are the ones with high population densities over prolonged periods (related to strongly reduced or absence of fallow periods), with good and stable market access, with conducive public policy environment and with favourable agro-ecological conditions. A number of examples are to be found in western Kenya. No wonder that Kenya is one of the leading countries in SSA with regard to intensity of mineral fertiliser use.

Conclusions

This paper has shown that the majority of SSA countries had modest and some even impressive annual growth levels in total fertiliser consumption during the 1986-2002 period. However, one third of SSA countries had practically zero or even negative annual growth levels during that period. The most important factors which explain fertiliser use increases before and during structural adjustment programmes are pan-territorial crop and fertiliser prices, subsidized fertiliser prices, a high share of donor-funded fertiliser imports to total imports, fertilisers provided on a credit basis to farmers, and the devaluation of the CFA franc in francophone West Africa. The removal of pan-territorial prices, fertiliser subsidies and credit opportunities due to liberalization has caused a decrease in fertiliser consumption in Tanzania, Zambia, Nigeria, Malawi and Zimbabwe. The private sector was not able to stop this decrease in total fertiliser consumption. In fact only in Kenya and Ghana private sector involvement in the fertiliser market seems to be an important factor in explaining fertiliser consumption growth.

In general value cost ratios of fertiliser use have declined in the past twenty years in almost all cases of SSA. Especially the liberalization of the maize and fertiliser sectors in East and Southern Africa during the past twenty years did not stimulate farmers to use fertilisers due to unprofitable value cost ratios or due to volatile und uncertain prices for maize and fertiliser, the absence of credit at reasonable interest rates, and the uncertain market for surplus maize production. In other words, private sector involvement in the maize and fertiliser sectors was not able to maintain or improve farmer demand for fertiliser use in maize. It is therefore incorrect to blame the continual or renewed government involvement in the fertiliser sectors of Zambia, Tanzania and Malawi for the poor performance of the private sector.

As a consequence fertiliser use on maize is declining in comparison to higher value crops such as tea, coffee, sugarcane (Kenya), cotton, pineapple and oil palm (Ghana). Furthermore growth rates in maize production are not keeping up with population growth rates in almost all countries of East and Southern Africa where maize is the main food staple. Liberalization of maize and fertiliser markets in these countries is apparently not meeting its objectives almost twenty years after its introduction. It even seems to decrease fertiliser use in food crops in favour of cash crops.

From the remaining 85% of potential arable land in SSA there are still huge stretches of unexploited land with medium to high quality which are not under forest. A large part of the remaining potential arable land in SSA is, however, currently used by farmers as grazing areas or as fallow land. As a consequence there are still many farming systems with fallow land in SSA. Farming households in these type of farming systems normally do not have serious soil fertility problems due to the soil fertility restoring effect of the fallow period. Problems such as weed infestation, delayed land preparation and delayed harvesting are generally regarded as more disturbing than poor soil fertility management. Extensification of landuse is then a more practical way of increasing output in comparison to fertiliser use.

Since the 1992 UNCED meeting in Rio de Janeiro donors and development agencies have been reluctant to stimulate the use of mineral fertilisers in developing countries. Certainly for SSA this was based on the wrong assumption that fertiliser use was already causing widespread environmental damage. The abolition of fertiliser subsidies due to structural adjustment programmes in SSA from 1986 onwards made it even more difficult for farmers to obtain fertilisers. The e-forum on increasing fertiliser use in Africa organised by the World Bank and DFID in the beginning of 2005 indicates a renewed interest in the role fertilisers

can play to reduce poverty in Africa and bring about sustainable increases in food production. The UN Millennium Project has even recently called for a reversal of the policies of slashing subsidies for fertilisers and other critical inputs. It strongly recommends smart subsidies targeted to very poor regions partly financed by market-oriented smart vouchers to food-insecure farmers (UNDP, 2005). The question remains if it is really smart to use fertiliser subsidies for poverty alleviation in the short run instead of a more efficient use of fertiliser interventions on the basis of strategic site selection which will lead to a more sustainable poverty reduction due to agricultural development.

A realistic view on increasing fertiliser use in SSA leads to a strategic site selection in order to make fertiliser interventions more efficient. Due to budget constraints fertiliser interventions have to be targeted and strategic site selection can be used for that matter. This can be done stepwise as the example below shows:

Step 1: Select the most promising areas for increased fertiliser use. Look for regions with high population densities over prolonged periods (related to strongly reduced or no fallow periods), good and stable market access, conducive public policy environments and favourable agro-ecological conditions.

Step 2: Select the crop-fertiliser combinations with the most promising value cost ratios and make sure that the main food crops are included in this selection.

Step 3: Select the most cost-effective measures which can improve the value cost ratios. Look for ways how you can increase the product price, lower the fertiliser price and/or increase the fertiliser response rate.[8]

Step 4: Select the most efficient and sustainable measures of reducing risk and uncertainty related to the use of fertilisers. Look for ways how credit can be made available at reasonable interest rates and how crop and fertiliser prices can be stabilized and forecasted.

Step 5: Select the most realistic and economic measures which can guarantee reliable markets for surplus productions of the involved crops in the long-term. Look for ways of protecting domestic markets or of stimulating export to other countries.

A stepwise strategic site selection as in the example above provides policy makers with a more solid basis for making decisions on the type and scale of fertiliser interventions. It also enables policy makers to value fertiliser interventions in relation to all kind of other measures which can improve the agricultural sector. When certain fertiliser interventions are finally selected in accordance with budget possibilities it also gives African governments a better negotiating position with international financial organisations and donors.

[8] The simplest way to improve the price ratios for African farmers and to allow agriculture to develop is according to Koning (2002) to introduce or raise protective import duty on agricultural imports.

References

AFAMIN (2005) The African Agricultural Market Information Network. (http://www.afamin.net/nigeria/mis_nigeria_jan04.htm)

Amani, H.K.R. (2004) Agricultural Development and Food Security in Sub-Saharan Africa: Tanzania Country Report (final draft). Economic and Social Research Foundation (ESRF), Dar es Salaam, Tanzania. (http://www.fao.org/tc/Tca/work05/Tanzania.pdf)

Ani, S., Sourou, K. and B. Meertens (2002) Voyage d'échange d'expérience sur les périmètres irrigués du Niger, du Burkina Faso et du Mali et des recommandations pour le périmètre irrigué de la vallée de Zio au Togo. Projet GIFS: ITRA/CRA-L, ICAT-RM et IFDC-A, Lomé, Togo. (http://www.meertensconsult.nl/)

Bumb, B. and I. Gregory (2005) Factors Affecting Fertilizer Supply in Africa. Draft Paper prepared for the World Bank by IFDC, Muscle Shoals, Alabama. (http://www.nrinternational.co.uk/uploads/documents/BP3D2150215.pdf)

Chibudu, C., Chiota, G., Kandiros, E., Mavedzenge, B., Mombeshora, B., Mudhara, M., Murimbarimba, F., Nasasara, A. and I. Scoones (2001) Soils, Livelihoods and Agricultural Change: The Management of Soil-Fertility in the Communal Lands of Zimbabwe. In: Scoones, I. (Ed.), *Dynamics & Diversity: Soil Fertility and Farming Livelihoods in Africa.* Earthscan Publications Ltd., London, pp. 116-163.

Cleaver, K.M.(1993) A Strategy to Develop Agriculture in Sub-Saharan Africa and a Focus for the World Bank. World Bank Technical Paper 203, World Bank, Washington D.C.

Crawford, E., Kelly, V., Jayne, T.S. and J. Howard (2003) Input use and market development in Sub-Saharan Africa: an overview. *Food Policy* **28**, pp. 277-292.

Crawford, E.W., Jayne, T.S. and V.A. Kelly (2005) Alternative Approaches for Promoting Fertilizer Use in Africa, with Particular Reference to the Role of Fertilizer Subsidies. Draft Paper prepared for the World Bank by the Department of Agricultural Economics, Michigan State University, East Lansing. (http://www.nrinternational.co.uk/uploads/documents/BP1D2100205.pdf)

Delgado, C.L. and N.W. Minot (2000) Agriculture in Tanzania since 1986: Follower or leader of growth? A World Bank Country Study, World Bank, Washington D.C. Government of the United Republic of Tanzania, World Bank and IFPRI. (http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/08/14/000094946_00072105320 53/Rendered/PDF/multi_page.pdf)

Egg, J. and M. Deme (2002) La libéralisation du marché du riz. Un succès combinant progrès technique, politiques économiques et organisation des acteurs. In: Bonneval, P., Kuper, M. and J-P. Tonneau (Eds), *L'Office du Niger, grenier à riz du Mali*. CIRAD/Karthala, pp. 88-92.

FAO (1989) Fertilizers and Food Production. Summary Review of Trial and Demonstration Results 1961-1986. FAO Fertilizer Programme, FAO, Rome.

FAO/WFP (2002) Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Zambia, 18 June 2002. Economic and Social Department, FAO, Rome. (http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/005/y6997e/y6997e00.htm)

FAO (2004) FAO Fertilizer Yearbook, Vol. 53-2003. FAO Statistics Series No. 183. FAO, Rome.

FAOSTAT (2005) The Food and Agriculture Organization of the United Nations Statistical Database. (http://faostat.fao.org/faostat/collections?version=ext&hasbulk=0&subset=agriculture)

Geier, G. (1995) Food security policy in Africa between disaster relief and structural adjustment. Reflections on the conception and effectiveness of policies: the Case of Tanzania. German Development Institute (GDI) Book Series No.5, Frank Cass & Co Ltd., London.

Hawassi, F.G.H., Mdoe, N.S.Y., Turuka, F.M. and G.C. Ashimogo (1998) Efficient Fertiliser Use in the Southern Highlands of Tanzania and Implications for Development Policies. *Quarterly Journal of International Agriculture* **37** (3), pp. 222-237.

IFDC (2003) Input Subsidies and Agricultural Development. Issues and Options for Developing and Transitional Economies. IFDC, Muscle Shoals, Alabama.

Jayne, T.S. and S. Jones (1997) Food Marketing and Pricing Policy in Eastern and Southern Africa: A Survey. *World Development* **25** (9), pp. 1505-1527.
Jayne, T.S., Govereh, J., Wanzala, M. and M. Demeke (2003) Fertilizer market development: a comparative analysis of Ethiopia, Kenya and Zambia. *Food Policy* **28**, pp. 293-316.
Kelly, V., Jayne, T. and E. Crawford (2005) Farmers' Demand for Fertilizer in Sub-Saharan Africa. Draft Paper prepared for the World Bank by the Department of Agricultural Economics, Michigan State University, East Lansing. (http://www.nrinternational.co.uk/uploads/documents/BP2VALPg360205.pdf)
Kherallah, M., Delgado, C., Gabre-Madhin, E., Minot, N. and M. Johnson (2002) Reforming Agricultural Markets in Africa. IFPRI, The Johns Hopkins University Press, Baltimore.
Koning, N. (2002) Should Africa Protect its Farmers to Revitalise its Economy? Gatekeeper Series No. 105, Sustainable Agriculture and Rural Livelihoods Programme, IIED, London.
Lewa, P. (2003) Kenya. In: Hubbard, M. (Ed.), *Developing Agricultural Trade: New Roles for Government in Poor Countries*. Palgrave Macmillan, Houndmills/New York, pp. 92-99.
MAC (1997) Agricultural Inputs Study. Final Report. Agricultural Sector Management Project, Ministry of Agriculture and Cooperatives (MAC), United Republic of Tanzania, Dar es Salaam.
Meertens, B. (2000) Agricultural performance in Tanzania under structural adjustment programs: Is it really so positive? *Agriculture and Human Values* **17** (4), pp. 333-346.
RATES (2003a) Maize Market Assessment and Baseline Study for Malawi. Regional Agricultural Trade Expansion Support Program (RATES) Center, Nairobi. (http://www.ratescenter.org/pdf/reports/maize_malawi_sep03.pdf)
RATES (2003b) Maize Market Assessment and Baseline Study for Tanzania. Regional Agricultural Trade Expansion Support Program (RATES) Center, Nairobi. (http://www.ratescenter.org/pdf/reports/maize_tanzania_may03.pdf)
SAA (2002) Newsletter of the Sasakawa Africa Association (SAA): Feeding the Future, Issue 18, November 2002. (http://www.saa-tokyo.org/english/newsletter/pdf/issue18.pdf)
Salasya, B.D.S. (2005) Crop Production and Soil Nutrient Management: An Economic Analysis of Households in Western and Central Kenya. Ph.D. Thesis, Development Economic Group, Wageningen University, Wageningen.
TERRASTAT (2005) FAO/Land and Water Development Division TERRASTAT database. (http://www.fao.org/ag/agl/agll/terrastat/wsrout.asp?wsreport=7&region=7&search=Display+statistics+%21)
Townsend, R.F. (1999) Agricultural Incentives in Sub-Saharan Africa.: Policy Challenges. World Bank Technical Paper No. 444, The World Bank, Washington D.C.
Traoré, B. and J-B. Spinat (2002) Le crédit. Des institutions de proximité pour résorber un endettement durable. In: Bonneval, P., Kuper, M. and J-P. Tonneau (Eds), *L'Office du Niger, grenier à riz du Mali*. CIRAD/Karthala, pp. 196-200.
Twomlow, J.S. and B. Ncube (2001) Improving Soil Management Options for Women Farmers in Malawi and Zimbabwe: Proceedings of a Collaborators' Workshop, 13-15 September 2000, ICRISAT, Bulawayo.
UNDP (2005) Investing in Development: A Practical Plan to Achieve the Millennium Development Goals. Report to the UN Secretary-General, Millennium Project, Earthscan Publications Ltd., London. (http://www.unmillenniumproject.org/ documents/MainReportComplete-lowres.pdf)
USAID (2005) The Governance Dimensions of Food Security in Malawi. (http://pdf.dec.org/pdf_docs/PNADE034.pdf)
Verheye, W.H. (1997) Land Use Planning and National Soils Policies. *Agricultural Systems* **53**, pp.161-174.
World Bank (1994) Tanzania Agriculture: A Joint Study by the Government of Tanzania and the World Bank. A World Bank Country Study, World Bank, Washington D.C.