gtz

TERRAFRICA
REGIONAL SUSTAINABLE LAND MANAGEMENT

Food Crisis & Land

The World Food Crisis, Land Degradation, and Sustainable Land Management: Linkages, Opportunities, and Constraints

EXECUTIVE SUMMARY

A TerrAfrica Partnership Publication

Food Crisis & Land

This document was prepared by the International Food Policy Research Institute (IFPRI) under the direction of John Pender. The author is grateful to the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) and the TerrAfrica partnership for their financial support of this research; to Anneke Trux of GTZ and Christophe Crepin of the World Bank in the context of the TerrAfrica partnership for initiating and providing guidance to the work; and to Anneke Trux, Marlis Lindecke, and Levke Sörensen of GTZ for providing detailed and constructive suggestions on an early draft. Frank Sperling and Stephen Danyo of the World Bank and Martin Bwalya of the New Partnership for Africa's Development (NEPAD) provided additional guidance. Any errors or omissions are solely the responsibility of the author. Download the complete version of this report from the TerrAfrica SLM Knowledge Base at http://knowledgebase.terrafrica.org/

Design: TM Design, Inc.
Front Cover Photograph: © Arne Hoel/The World Bank

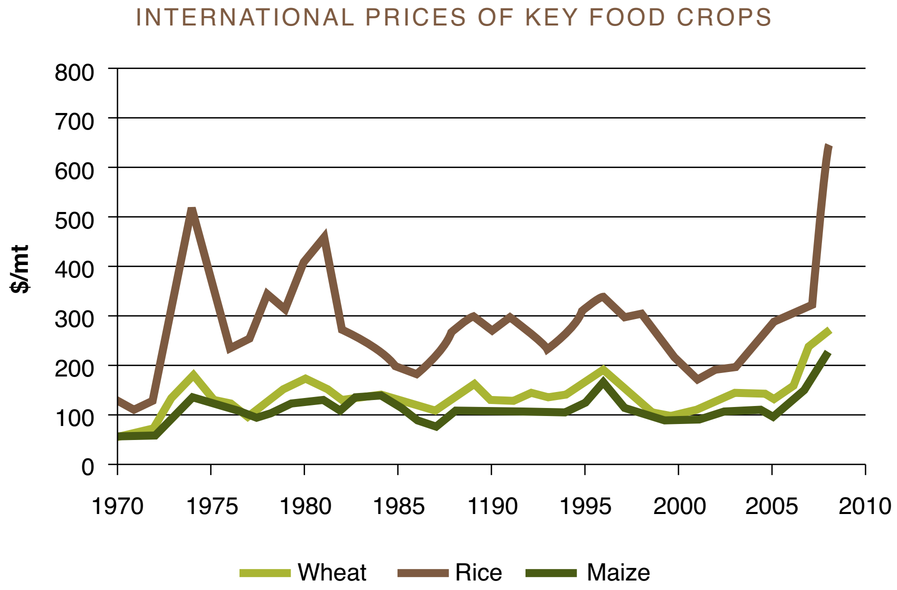
Food Crisis & Land

The World Food Crisis, Land Degradation, and Sustainable Land Management: Linkages, Opportunities, and Constraints

1. Introduction

In recent years, world food prices have skyrocketed, causing severe hardship for poor and vulnerable people throughout the world. Between 2005 and 2008, world prices of rice, wheat, and maize more than doubled (Figure S.1); pushing more than 100 million people into poverty, including nearly 30 million people in Africa. Although food prices have declined from the peaks seen in early 2008, they remained well above the levels seen in recent years in early 2009.

Figure S.1. World prices of key food crops skyrocketed in recent years.



Source: FAOSTAT (2008)

The causes of the food price crisis include many factors affecting the global supply, demand, and trade of food commodities. Among the most important factors were rising oil prices, leading to increased costs of producing, processing, and transporting food; increased use of food crops for biofuel production; poor harvests in some major producing regions; rapid economic growth in many developing countries; and decades of underinvestment in agricultural research and development.

© Ray Witlin/The World Bank

Much less has been said about the role of land degradation in contributing to the food crisis or the potential for sustainable land management (SLM) to help address it. Policy debates on the food crisis, such as the FAO Food Summit in June 2008, failed to identify the role of SLM in ensuring food security. In part, this reflects a recognition that the impacts of land degradation occur over a long term while the surge in food prices occurred fairly rapidly. Nevertheless, land degradation is one of the important long term factors affecting food prices, just like low investment in agricultural research.

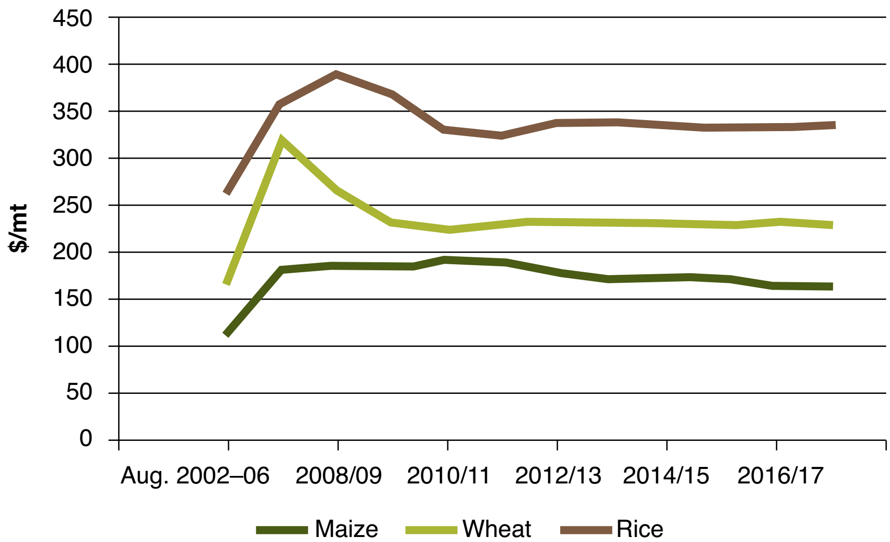
A literature review was conducted to investigate the linkages between food prices, land degradation, and land management in Sub-Saharan Africa, and to answer the following questions:

- What are the prospects for food prices?
- What impacts does land degradation have on food production and prices?
- What impacts do higher commodity prices have on land management and degradation?
- What impacts can sustainable land management have on land degradation and food prices?

2. What are the prospects for food prices?

World food prices are expected to continue to be higher in the next decade than they were in the decade prior to the recent price increases, despite price declines since the peaks of early 2008. For example, OECD and FAO project that international maize prices will average 57 percent higher in 2008/09 to 2017/18 than they averaged in 2002/03 – 2006/07, while wheat prices are projected to average 40 percent higher and rice prices 31 percent higher (Figure S.2).

Figure S.2. Projected future food prices for the next decade are higher than prices in early 2000s.



Source: OECD-FAO (2008)

© Arne Hoel/The World Bank

World food prices are likely to be more volatile in the future. In 2008, global grain stocks were at their lowest level since the early 1970s, and are not expected to increase to previous levels due to stockholding policy changes. Rapidly fluctuating oil prices, unstable global financial markets and economic conditions, climate change, and other volatile supply and demand factors will continue to cause price volatility.

Land degradation is contributing to higher and more volatile food prices, by reducing agricultural production and causing production to be more vulnerable to weather extremes.

3. What impact does land degradation have on food production and prices?

Land degradation is among the greatest environmental challenges facing the world today and is a major impediment to meeting basic human needs, especially in drylands. According to the Millennium Ecosystem Assessment (MEA), 10 to 20 percent of drylands are already degraded, negatively affecting the livelihoods of up to 6 percent of the 2 billion people that live in drylands, while many more people are at risk from further degradation.

Recent evidence using remote sensing techniques confirms that land degradation is a widespread problem, but also shows more degradation in humid areas than previously recognized. According to the recent Global Assessment of Land Degradation (GLADA), nearly one fourth of the land surface of the world degraded between 1981 and 2003, and more than three fourths of this degraded land is outside of drylands.

The impacts of land degradation on food production and prices are subject to intense debate and large uncertainties, and are very context dependent. At one extreme, it has been estimated that nearly one third of the world's arable lands have been lost to erosion during the previous 40 years; while others claim that average production losses due to all forms of soil degradation over 45 years amounted to only 5 percent[1]. A wide ranging review of studies of productivity impacts of soil erosion concluded that impacts range from 0.01 percent per year to 0.9 percent per year across almost all regions and crops, with a global average loss of 0.3 percent per year[2].

Based on available studies, land degradation over the next 25 years may reduce global food production from what it otherwise would be by as much as 12 percent, resulting in world food prices as much as 30 percent higher for some commodities[3]. Impacts on prices in particular regions and countries could be substantially different from this, depending on the local extent of land degradation, interactions with climate change, the extent of tradability of commodities, and other factors.

© Arne Hoel/The World Bank

4. What impacts do higher commodity prices have on land management and degradation?

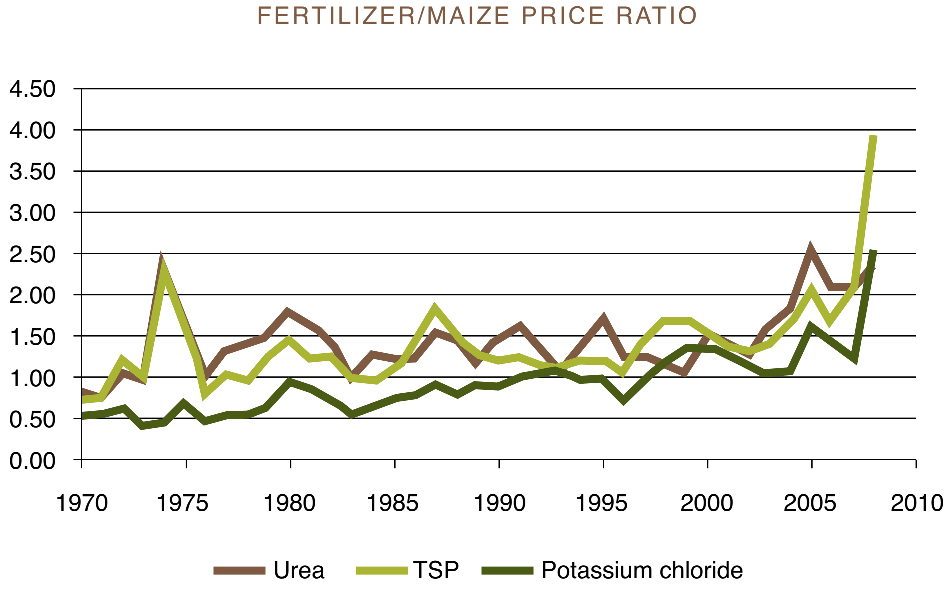
Higher commodity prices affect the incentives of resource users to adopt particular land management practices by affecting their profitability. Prices also can affect land degradation by affecting expansion of agriculture into forests and rangelands. Evidence related to these linkages was investigated.

4.1. Impacts of commodity price changes on the profitability of land management practices

Inorganic fertilizers

Although increased food prices tend to increase the profitability of using fertilizers, this effect has been outweighed by even larger increases in the prices of inorganic fertilizer in recent years, resulting in reduced profitability of inorganic fertilizer use. The ratio of international fertilizer to food prices rose to unprecedented levels in 2008 (Figure S.3). Even with declines in inorganic fertilizer prices since mid-2008, the international fertilizer/commodity price ratio remains above usual historical levels for major commodities.

Figure S.3. The international fertilizer/maize price ratio reached unprecedented levels in 2008.



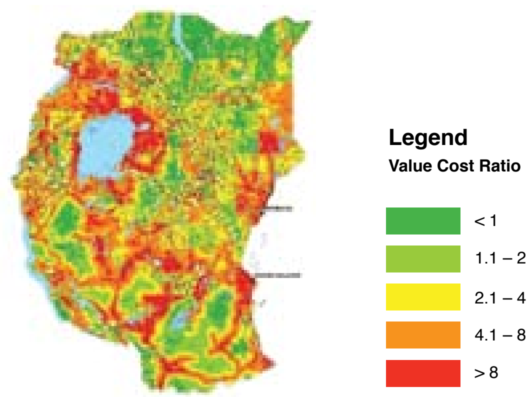
Source: World Bank (2008b)

© Curt Carnemark/The World Bank

The reduction in profitability of inorganic fertilizer in Africa has been in many instances even more pronounced than indicated by changes in international price ratios, because the international prices of imported fertilizers are transmitted to farmers in Africa more completely than the prices of many food commodities.

Even before the recent increase in fertilizer/commodity price ratios, inorganic fertilizer use was not sufficiently profitable for widespread adoption to occur in many areas of SSA. For example, the estimated value cost ratio (VCR) for fertilizer in 2005 was less than 2.0 (considered the minimum level required for widespread adoption) in much of East Africa (Figure S.4). Other studies have also shown large variations in the VCR for fertilizer use across countries and commodities in SSA, and that the VCRs have declined since the 1980s due to reduced fertilizer subsidies, changes in exchange rates, and other factors.

Figure S.4. The predicted value cost ratio for N fertilizer on maize was low in large parts of East Africa in 2005.



Source: Guo, Koo, and Wood (2008)

© Curt Carnemark/The World Bank

Although fertilizer subsidy programs can increase the profitability and uptake of inorganic fertilizer by farmers in SSA, these programs are beset by many challenges, including high budgetary costs, administrative difficulties, negative impacts on private fertilizer market development, low economic rates of return, adverse distributional consequences, and others. Some of these challenges are being addressed by development of "market smart" subsidies, but major challenges remain, and are worsened by rising international fertilizer prices.

Given these considerations, promotion of inorganic fertilizer use will not be sufficient to ensure sustainable land management in SSA.

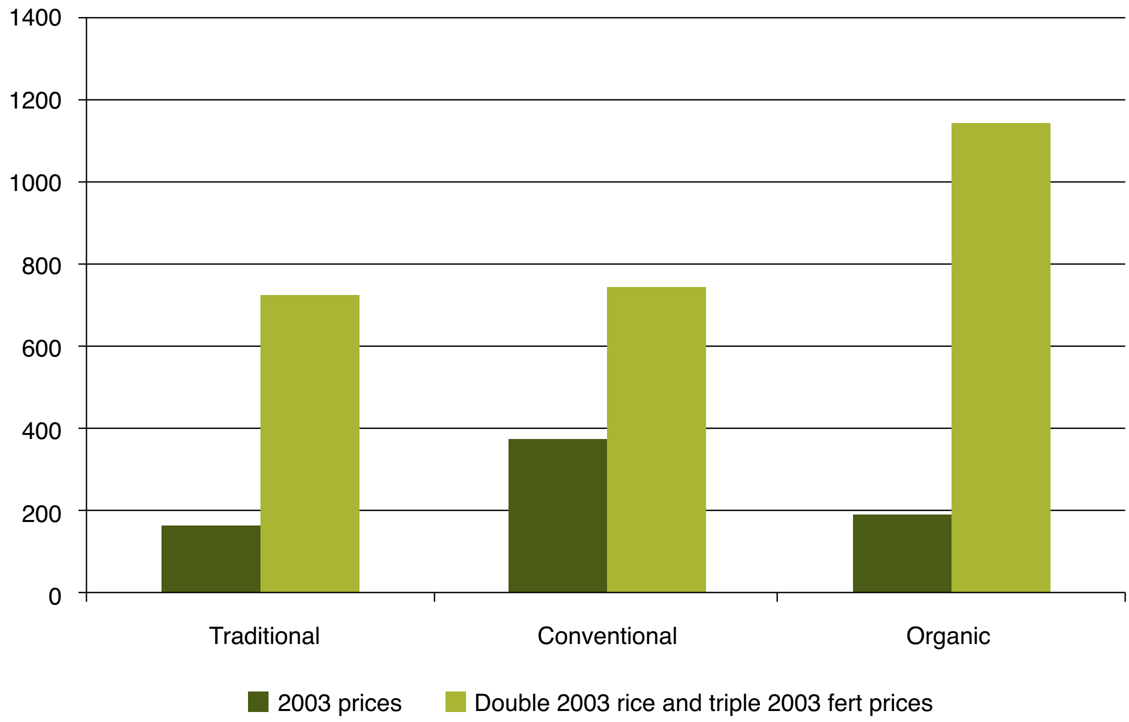
Low external input and integrated approaches to soil fertility management

The use of inorganic fertilizer by itself is not sufficient to sustain and increase productivity; organic means of soil fertility management are also needed. If soil organic matter is depleted, the topsoil is eroded away, or if the soil is compacted, waterlogged, saline or acid due to poor land management, application of inorganic fertilizers will not ensure sustainable production. Evidence from long term trials in Kenya shows that maize yields on continuously cropped plots fell nearly 50 percent over 17 years[4] even with recommended inorganic fertilizer rates; while the decline was much less where both organic and inorganic fertilizers were applied.

Use of organic soil fertility management approaches alone is also insufficient or infeasible in many contexts. Organic inputs may be unavailable in sufficient quantities, and are often too low in the concentration of key nutrients to ensure sustainable production. They are also bulky and can require large amounts of labor to apply, which may be unavailable or too costly to be feasible. Hence integrated soil fertility management, combining inorganic and organic sources of fertility, is therefore required in many contexts for sustainable productivity improvement.

The absolute profitability of using organic low external input land management approaches has increased as a result of increased food prices, and the profitability of such approaches relative to use of inorganic fertilizer has increased as a result of increased inorganic fertilizer prices. For example, evidence on the profitability of organic vs. traditional (low fertilizer use) and conventional (high fertilizer use) upland rice production in China shows that a doubling of the paddy rice price and tripling of the fertilizer price would increase both the absolute and relative profitability of organic production[5] (Figure S.5).

Figure S.5. Doubling the rice price and tripling the fertilizer price would greatly increase the profitability of organic upland rice production relative to traditional and conventional production in China.



Source: 2003 estimates from IFAD (2003); author's estimates for increased price scenario


© Arne Hoel/The World Bank

Soil and water conservation investments

Theoretically, increases in food prices can have ambiguous impacts on the profitability of soil and water conservation (SWC) investments, since the returns to both conserved and un-conserved land are increased. Nevertheless, if investing in SWC is already profitable relative to not investing, increasing food prices will make it more so. Evidence from several studies in SSA, including studies on the profitability of terraces in Kenya, Lesotho, and Ethiopia, supports this conclusion.

Much evidence from SSA shows that the profitability of SWC investments tends to be greater in lower rainfall semi-arid environments than in more humid environments, due to the immediate productivity benefit resulting from soil moisture conservation. Several studies conducted in the Ethiopian highlands demonstrate this, estimating rates of return to SWC investments of 30 percent or higher in semi-arid areas, but much lower in more humid areas. Given this and the previous point, the effects of food price increases on farmers' incentives to invest in SWC are likely greater in semi-arid environments.

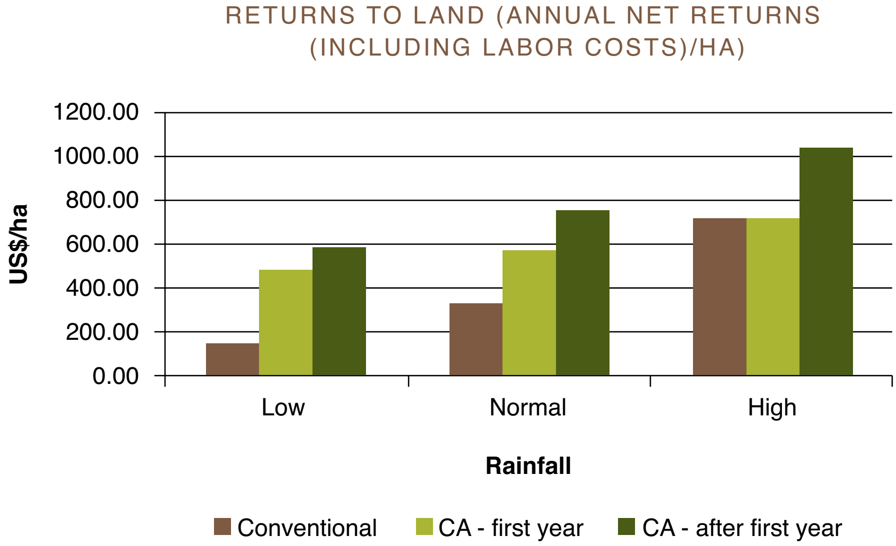
Conservation agriculture

Conservation agriculture has been found to be profitable in many contexts of SSA, and increasing food prices increase its profitability. For example, in Zambia, returns to both land and labor were found to be substantially higher in 2002 for both maize and cotton using conservation farming compared to traditional tillage practices[6]. At the higher food price levels occurring more recently, the profitability of conservation farming would be much higher.

The effect of increasing inorganic fertilizer prices combined with rising food prices on the relative profitability of conservation agriculture could be positive or negative, depend on how much fertilizer is used as a part of conservation agriculture and what alternatives it is compared to. Nevertheless, estimates based on research in Zimbabwe demonstrates that even with high levels of inorganic fertilizer use in conservation agriculture, doubling the maize price and tripling the fertilizer price would increase the absolute and relative profitability of conservation agriculture compared to traditional practices[7] (Figure S.6).

In other African contexts where little inorganic fertilizer is used, increased food and fertilizer prices should have a favorable impact on profitability of conservation agriculture.

Figure S.6. Doubling the maize price and tripling the fertilizer price increases the absolute and relative profitability of conservation agriculture (CA) in Zimbabwe compared to traditional practices.



Source: Based on estimates from Mazvimavi and Twomlow (2008); author's estimates for increased price scenario

Tree planting and protection

High rates of return to tree planting and protection activities have been found in several African countries. For example, estimated internal rates of return to woodlots in northern Ethiopia range from 19 percent to 54 percent[8], depending on variations in the local price of poles, wage rates, and land opportunity costs. Estimated rates of return to community tree plantations in Niger range from 13 percent to 49 percent[9] in different studies.

Where the value of such trees is directly linked to agricultural production and prices, increases in food prices will increase the profitability of such activities. This would be the case for agroforestry trees that increase crop production by improving soil fertility or that produce food or fodder directly. Where trees are not directly linked to agricultural production and prices (e.g., trees used for timber or fuel wood), the impacts of rising food and fertilizer prices are less clear, depending on how these affect the supply of and demand for wood products.

4.2 Impacts of food prices and profitability on adoption of land management practices

Theoretically, increased food prices and profitability of land management practices should lead to greater adoption of such practices. However, few empirical studies have directly investigated the impacts of food prices or profitability on adoption of land management practices. One of the few studies of such impacts found that in Ethiopia the profitability of inorganic fertilizer use is one of the most important determinants of adoption.

Many adoption studies of land management practices find that adoption of improved land management practices is greater closer to markets and roads, possibly due to higher food prices where there is better access. However, this finding is far from universal, and access to markets and roads can affect adoption for other reasons than affecting food prices (e.g., by affecting off-farm opportunities and labor costs).

Although the impacts of food prices and profitability are not fully clear, there are many examples in SSA of widespread adoption of land management practices that are profitable, and no examples of widespread adoption of unprofitable practices. This supports the contention that profitability is a necessary condition for widespread adoption.

While profitability is a necessary condition for widespread adoption of SLM practices, it is not a sufficient one. There are many examples of profitable practices that are not widely adopted, due to lack of awareness, land tenure constraints, limited endowments, or other constraints. Hence, increased food prices will not be sufficient by themselves to ensure widespread adoption of SLM practices in SSA; efforts to address such constraints are also needed.

4.3. Impacts of food and fertilizer prices on agricultural expansion and deforestation

Food and fertilizer price increases could cause land degradation by inducing agricultural expansion and deforestation, although this does not necessarily occur. Theoretically, food and fertilizer price increases can have ambiguous impacts on agricultural expansion, depending on the nature of land users' objectives and of factor and commodity markets, and the degree of substitutability or complementarity between fertilizer and land use.

There is empirical support for the view that higher food prices cause agricultural expansion and deforestation, while there is limited evidence of impacts of fertilizer prices. Two multivariate empirical studies of impacts of price changes in SSA both found that agricultural output price increases contributed to agricultural expansion and deforestation, and that fertilizer price increases had an insignificant impact. Similar impacts of food prices on agricultural expansion and deforestation have been found in studies from other regions of the world, while the impacts of fertilizer prices have been less investigated. Many studies have found that improved access to roads and markets lead to increased deforestation, supporting the view that higher food prices contribute to this (where access improves prices received by farmers). However, access to roads and markets could cause agricultural expansion and deforestation for reasons other than the effect this has on food prices.

© Curt Carnemark/The World Bank

5. What impacts can sustainable land management have on land degradation and food prices?

The impacts of SLM on land degradation and food prices depend on the scale of adoption of the practices, what impact they have on degradation and production where they are adopted, and the aggregate impact of these production impacts on food prices. These effects are considered in turn.

5.1 Scale of adoption of land management practices

There is limited information on adoption of land management practices in SSA, except for use of inorganic fertilizer and certified organic production. Inorganic fertilizer use in SSA averages about 10 kg of nutrients per hectare of cropland; much less than in all other regions of the world. The percentage of farmers or plots using inorganic fertilizer is not known in general for SSA, although studies in particular countries show this to range from as low as 2 percent of plots in Uganda to more than 50 percent of plots in high rainfall areas of the Ethiopian highlands.

There are at least 167,000 certified organic farms operating 231,000 ha using organic methods in SSA. About half of these farms are in Uganda. Other countries in SSA with significant numbers of organic farms (more than 1,000) include Tanzania, Kenya, Zambia, Burkina Faso, Mali, Madagascar, Togo, Ghana, Mozambique, Benin, and Senegal. Despite significant adoption of organic production in these countries, certified organic area accounts for 0.7 percent or less of agricultural area in all countries of SSA (with the maximum in Uganda and substantially less in other countries).

Substantial adoption of other SLM practices has also occurred in SSA. Estimates from various studies imply that at least 6 million smallholders use low external input practices or SWC measures on at least 5 million ha of land, with much of this in Ethiopia. Still, this represents only a small fraction of the total agricultural land or cropland (less than 1 percent of agricultural land and about 5 percent of cropland) in SSA.

5.2. Impacts of sustainable land management practices – micro level

Many studies have reported large impacts of SLM practices on crop yields in SSA, particularly when organic and inorganic sources of soil nutrients are combined with SWC or water harvesting measures in semi-arid areas. In such cases, yield increases of more than 100 percent are commonly reported[10]. However, these increases are relative to a very low base; absolute increases in yields reported are generally less than 1 ton/ha in such environments.

In more humid environments, larger (than 1 ton/ha) absolute increases in yields have often been reported as a result of improved soil fertility management. By contrast, SWC measures typically have less production impact in such environments than in drylands, because of already adequate soil moisture, the space occupied by such measures, and problems caused by waterlogging and pests.

The yield impacts of SLM practices reported in many studies may not be reliable due to problems of self-reporting biases and confounding factors that may account for part of the reported yield increases (e.g., land quality, farmer ability, etc.).

Careful empirical studies that attempt to control for such biases and confounding factors often find smaller, though still substantial yield impacts. For example, a rigorous econometric study of the system of rice intensification in Madagascar found that the system increased yields by 84 percent on average; much less than the impact claimed in some project reports, but still quite large. Similarly, an econometric study of the impacts of zai in Niger compared to similar non-zai plots found 24 percent higher yields with zai and 53 percent higher yields with zai and manure[11]. This impact is substantial, but smaller than the impacts evident from a simple comparison of unmatched plots, or the impacts reported in earlier studies.

SLM measures can have many beneficial impacts besides increased agricultural productivity, such as reduced flooding and sedimentation of waterways, carbon sequestration, biodiversity conservation, and others. Some of these impacts may have feedback impacts on food production and prices, but these have not been quantified.

© Curt Carnemark/The World Bank

5.3. Impacts of Land Management Practices on Food Production and Prices – Aggregate Level

Given the low level of adoption of SLM practices in SSA, these practices are currently increasing food production in SSA by at most a few percent. For example, assuming that SLM practices have been adopted on 10 million ha in SSA (twice the minimum level of adoption estimated) and that this increases yields by 50 percent on average where adopted, the impact would be a 2.6 percent increase in aggregate food production. The impacts of this on reducing food prices are likely less than 5 percent.

The impacts of increased adoption of SLM practices on food production and prices in the near future could be larger, but still are likely to be no more than a 10 percent increase in production or reduction in prices. According to one recent study[12], adoption of organic practices on 50 percent of cropland in SSA could increase production of major food crops in SSA by 4 to 6 percent by 2020, thus reducing world prices by 1 percent (for maize) to 8 percent (for cassava). Adoption would have a greater impact on cassava prices because SSA production accounts for a larger share of world production than for other commodities such as maize.

The impacts of increased adoption of SLM practices on food and nutrition security in SSA could be greater, however. According to another study[13], reducing losses of arable land to land degradation in SSA by 50 percent would reduce the nutritional gap in SSA by 27 percent, the distribution gap by 21 percent, and the number of people with insufficient calories by 8 percent; while reducing degradation induced yield losses by one-third would reduce the nutritional gap by 12 percent, the distribution gap by 9 percent, and the number of people with inadequate calories by 2 percent.[14]

© Curt Carnemark/The World Bank

6. Conclusions and Implications

Several conclusions can be drawn from this review:

- Food prices are likely to be higher and more variable in the next few decades than they have been for the past few decades, although prices are declining from the high levels seen earlier in 2008.

- Land degradation is contributing to higher food prices by reducing available land and agricultural productivity over the long term. Current world food production may be as much as 12 percent lower and food prices may be as much as 30 percent higher as a result of land degradation that has occurred over the past several decades. Land degradation also contributes to vulnerability to extreme weather events and to variability of production and food prices. The impacts of land degradation on food prices may be even larger for particular commodities and countries, and are likely to increase in the future, unless substantial up-scaling of SLM occurs.

- Higher food prices are increasing the profitability of many improved land management practices. Inorganic fertilizer is an exception, because fertilizer prices have risen even faster than food prices. Even when fertilizer subsidies are used, the ability to dampen impacts of rising fertilizer prices is limited by the high costs of such subsidies and the difficulties of implementing them cost-effectively. By contrast, the profitability of organic or integrated soil fertility management, SWC investments, conservation agriculture, and other practices that economize on energy-intensive inputs is increasing relative to conventional technologies.

- The impacts of increased profitability on adoption of sustainable land management approaches and practices is uncertain, although some increase in adoption is likely to occur. Many other factors constrain adoption of such approaches in particular contexts, such as farmers' lack of awareness or training in use of improved practices; lack of access to organic materials or other inputs; land tenure insecurity; labor constraints; poverty and other constraints. Hence, although increased food prices will help to promote up-scaling of sustainable land management practices, it is unlikely to be sufficient to ensure widespread adoption.

- Increased food prices also may cause increased expansion of agricultural activities into forests, rangelands, and wetlands, causing land degradation and environmental damages in these areas. Available evidence from several studies in developing countries shows that higher food prices are generally associated with expansion of agricultural area and deforestation. Increased fertilizer prices appear to have a more limited impact on agricultural expansion.

© Curt Carnemark/The World Bank

- Increased adoption of organic or improved low external input land management practices can help to boost and stabilize agricultural production, buffer rising food prices, and improve food security in SSA. Improved land management approaches have been reported by many studies to increase yields by 50 percent or more where these replace traditional production practices. However, the scale of adoption of such practices is still relatively small, and the reported yield impacts in many studies may be overstated. Hence, such measures likely are increasing aggregate agricultural production in SSA by no more than a few percent. Studies of the potential impacts of future adoption of SLM measures in SSA predict that this could increase food production by 4 to 6 percent and reduce the number of people with caloric deficiencies by as much as 8 percent.

These conclusions imply that sustainable land management can play an important role in helping to mitigate the impacts of rising world food prices on poor people in Africa, although major impacts on food prices in the near term cannot be expected.

Promotion of the use of inorganic fertilizers through subsidies and other programs will not be sufficient to address problems of land degradation, low productivity, and rising food prices in Africa. Given the low and declining profitability of fertilizer use in many areas of Africa, and the prevalence of other land management problems not addressed by inorganic fertilizer, a broader integrated approach to soil fertility management is needed.

Higher food prices can facilitate increased adoption of many low-external input sustainable land management approaches by increasing their profitability. This will help improve the sustainability and productivity of agricultural production, reduce poverty, and preserve important ecosystem services, even if it does not have large impacts on world food production and prices.

Although the potential of adoption of improved land management approaches has increased as a result of rising food prices, achieving this potential will require identifying and addressing the key constraints that limit adoption of sustainable land management practices where they are profitable. As these constraints are usually very context and household dependent, a uniform top-down approach to promoting SLM is unlikely to be effective. Rather, a demand-led approach is needed to identify profitable opportunities for improved land management and the key constraints preventing realization of these opportunities in particular contexts. This requires increased investment by governments and development partners to develop the capacity to identify key SLM opportunities and constraints, implement interventions to overcome the most critical constraints, monitor and evaluate the performance and impacts of such interventions, synthesize context-specific lessons learned, and use these lessons to improve the effectiveness of future interventions through a continuous investment and learning cycle. Such a process is being pursued in SSA through the Country Strategic Investment Frameworks for SLM supported by TerrAfrica partners and other stakeholders.


© Curt Carnemark/The World Bank

In addition to promoting investments to overcome constraints to profitable SLM, governments and development partners must also pursue measures to limit the ecological damages caused by agricultural expansion. The extent of agricultural expansion and the damages caused can be limited by well-implemented land use policies and planning, with local resource users given a major role in developing and implementing such plans, and an economic stake in preserving resources that provide valuable services. Such efforts can build upon the process of decentralization of development planning and natural resource management taking place in much of SSA, by also implementing a continuous cycle of planning, implementation, learning, and adaptation.

ENDNOTES:

1 Crosson, P. 1997. Will erosion threaten agricultural productivity? Environment 39(8): 4-31.

2 Wiebe, K. 2003. Linking Land Quality, Agricultural Productivity, and Food Security. Agricultural Economic Report No. 823, Economic Research Service, U.S. Department of Agriculture. Washington, D.C.

3 Agcaoili, M., N. Perez, and M.W. Rosegrant. 1995. Impact of Resource Degradation on Global Food Balances. Paper presented at the workshop on Land Degradation in the Developing World: Implications for Food, Agriculture, and the Environment to the Year 2020, Annapolis, MD, April 4-6.

4 Nandwa, S.M. and M.A. Bekunda. 1998. Research on nutrient flows and balances in East and Southern Africa: state of the art. Agriculture, Ecosystems and Environment 71:5-18.

5 IFAD (International Fund for Agricultural Development). 2005. Organic agriculture and poverty reduction in Asia: China and India Focus. Thematic evaluation. Report No. 1664, IFAD, Rome.

6 Haggblade, S. and G. Tembo. 2003. Conservation farming in Zambia. Environment and Production Technology Division Discussion Paper No. 108, International Food Policy Research Institute, Washington, D.C.

7 Mazvimavi, K. and S. Twomlow. 2008. Conservation farming for agricultural relief and development in Zimbabwe. In: T. Goddard, M. Zoebisch, Y. Gan, W. Ellis, A. Watson, and S. Sombatpanit (eds.). No-Till Farming Systems. World Association of Soil and Water Conservation Special Publication No. 3. Bangkok, Thailand.

8 Jagger, P. and J. Pender. 2003. The role of trees for sustainable management of less-favored lands: The case of eucalyptus in Ethiopia. Forest Policy and Economics 3(1): 83-95.

9 Pender, J. and J. Ndjuenga. 2008. Impacts of sustainable land management programs on land management and poverty in Niger. Reports I and II. International Food Policy Research Institute, Washington, D.C.

10 Pretty, J.N., A.D. Noble, D. Bossio, J. Dixon, R.E. Hine, F.W.T. Penning de Vries, and J.I.L. Morison. 2006. Resource-conserving agriculture increases yields in developing countries. Environmental Science and Technology 40(4): 1114 – 1119.

11 Pender, J. and J. Ndjuenga. 2008. Ibid.

12 Halberg, N., T.B. Sulser, H. Hogh-Jensen, M.W. Rosegrant, and M. Trydeman Knudsen. The impact of organic farming on food security in a regional and global perspective. In: Halberg, N., Alrøe, H.F., Knudsen, M.T. and Kristensen, E.S. (eds.) Global Development of Organic Agriculture: Challenges and Prospects. CABI Publishing.

13 Wiebe, K. 2003. Ibid.

14 In this study, Wiebe (2003) defined the nutritional gap as the difference between the amount of available food and the amount of food needed to meet the minimum daily caloric intake requirements estimated by FAO, implicitly assuming that the available food is distributed according to caloric need. He defined the distribution gap as the amount of food needed to raise the food consumption of each income quintile to the nutritional standard, helping to account for differences in distribution of food resulting from income differences. He estimated the number of people with nutritionally inadequate diets based on the distribution gap and projected population.

TerrAfrica is a partnership that aims to address land degradation in Sub-Saharan Africa by scaling up harmonized support for effective and efficient country-driven sustainable land management (SLM) practices.

OUR LAND—OUR WEALTH, OUR FUTURE, IN OUR HANDS

TERRAFRICA
REGIONAL SUSTAINABLE LAND MANAGEMENT

TerrAfrica Secretariat

The World Bank
1818 H Street, NW
Washington, DC 20433
(P) 202.473.6179
(F) 202.473.5147
www.worldbank.org

NEPAD
1258 Lever Road, Headway Hill
P.O. Box 1234 Halfway House
Midrand 1685 South Africa
(P) +27 11 256 3600
www.nepad.org

gtz

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Convention Project to Combat Desertification (CCD Project)
Dahlmannstr. 4
53113 Bonn, Germany
(P) +49 228 24934 264
(F) +49 228 24934 256
ccd-projekt@gtz.de
www.gtz.de/desertification