Beyond the Food Crisis: Trade, Aid and Innovation in African Agriculture

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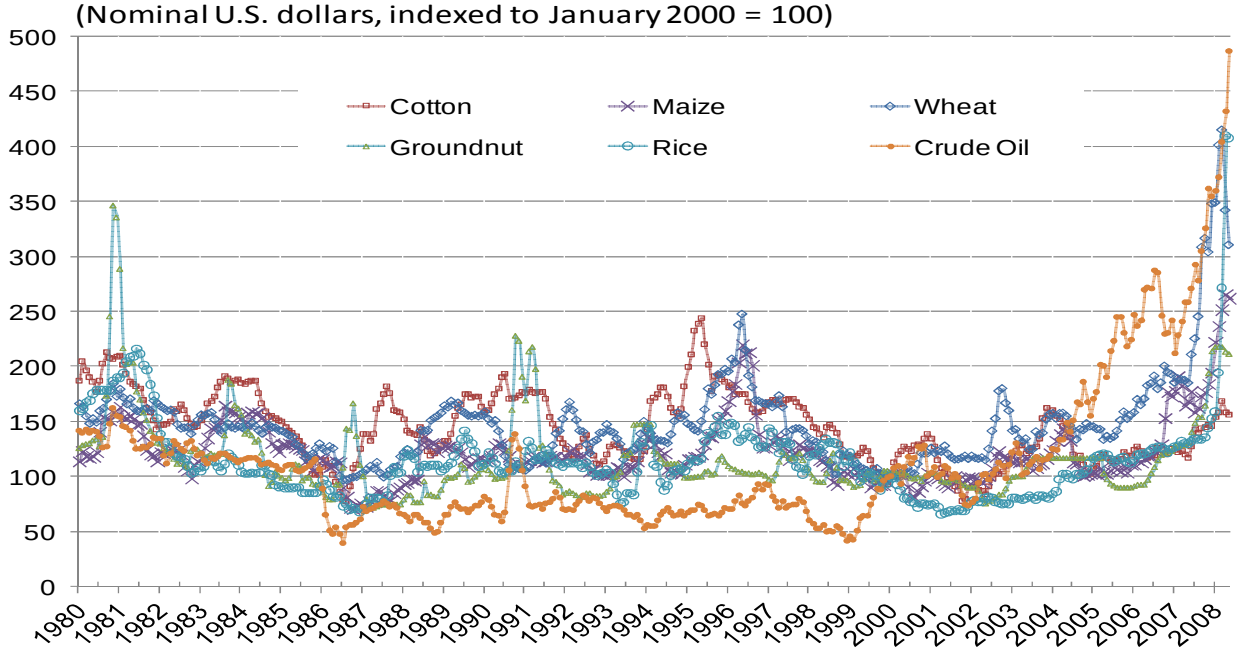
Abstract

The world food crisis of 2007-08 has hit hard in Africa, which is the region of largest cereal-grain imports per capita in the world. This paper helps document the crisis and the way forward with new data on food prices, production and trade at the aggregate and household level, focusing particularly on the influence of Africa's own agricultural policies and the role of foreign aid. Despite twenty years of steadily declining agricultural aid per capita in Africa, the continent's production of cereal grains per capita has grown rapidly and is now catching up to South Asian levels. The price rise plus continued improvements in trade policy could help accelerate this trend, particularly if combined with interventions to recognize and scale up the new technologies now being adopted by African farmers.

Beyond the Food Crisis: Trade, Aid and Innovation in African Agriculture

A rapid rise in food prices causes great hardship. Although many people are net food sellers who benefit from higher prices, on balance the world's poor are harmed: one estimate suggests that the price increases from 2005 to 2007 pushed about 100 million people below the dollar-a-day poverty line (Ivanic and Martin 2008). By June 2008, all major aid institutions had published preliminary analyses of the food crisis, such as FAO (2008), IFPRI (2008) and World Bank (2008). We will not repeat their arguments here, but focus on new data to document the unfolding tragedy in the aggregate (section 1) and at the household level (section 2), before turning to the role of African government policies (sections 3), foreign aid (section 4), and technological innovation (section 5).

Figure 1.
Monthly Prices of Select Commodities on World Markets, Jan. 1980 - May 2008
(Nominal U.S. dollars, indexed to January 2000 = 100)



Source: Author's computation, from IMF data (www.imf.org/external/data.htm).

Figure 1 shows the emergence of the crisis, month by month, in nominal U.S. dollar prices for key products on world markets. After the last commodity price spike in 1973-74, prices declined steadily for most of the 1980s. From about 1996 to 2001 food prices were generally falling, but in 2002 when oil prices started their meteoric rise food prices followed, particularly for rice and wheat but also for maize, groundnuts and cotton.

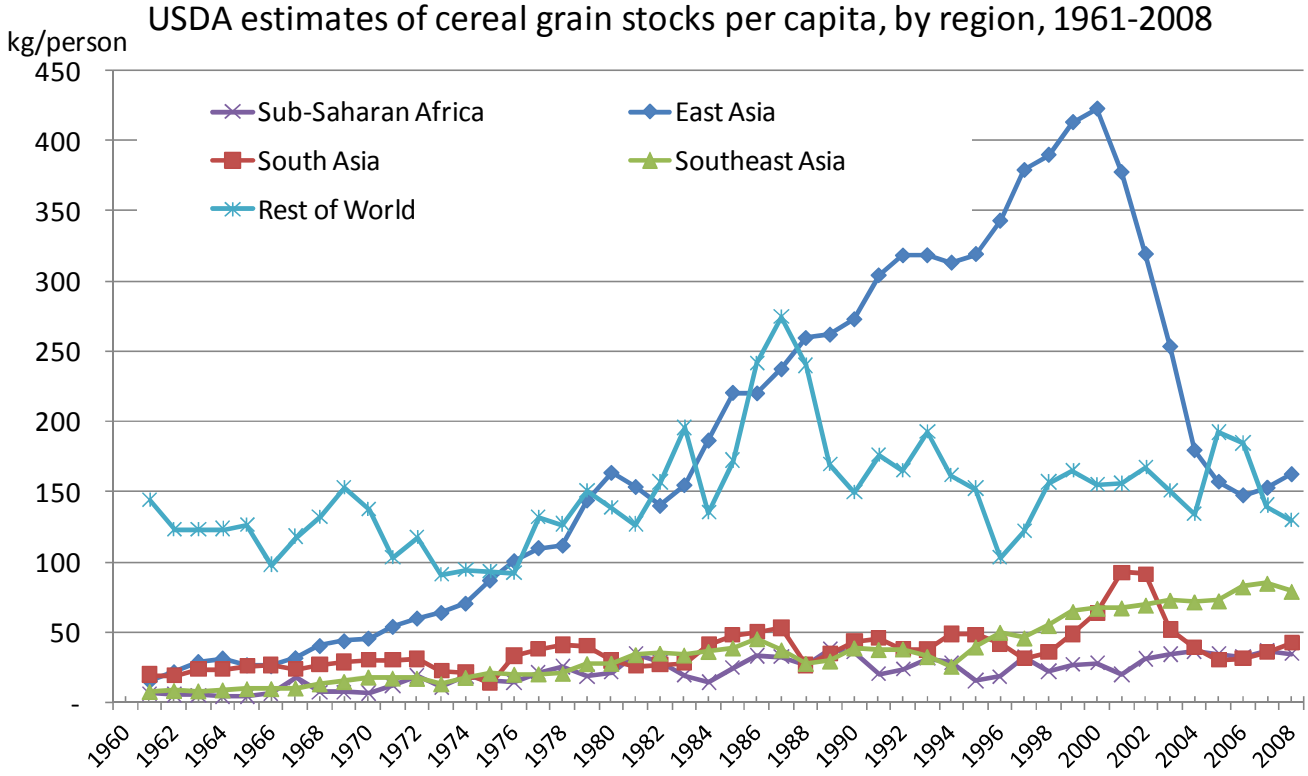
1. Behind the food crisis: stocks, production and trade

As shown in Figure 1, the food price spike of 2007-08 dramatically worsened a trend that began around 2002. But why did prices rise so fast? Normally, short-term shocks to supply and demand are absorbed by stocks, but as shown in Figure 2 a sharp draw-down of the previously massive stocks left the world with very little cushion from 2005 onwards.

Since 2005, world cereal grain markets have been operating with almost no shock absorber, in a state of unusual sensitivity to short-term changes in either supply or demand. Demand growth due to dietary changes and biofuels clearly played some role as argued elsewhere (e.g. Runge and Senauer 2008), but here we focus on the supply-side story illustrated in Figures 3 and 4: per-capita production of cereal grains fell sharply in South Asia in 2001, on top of earlier declines in East Asia since 1999. In the rest of the world, previously rapid output growth had ended around 1991, and after a rise in 2005 fell sharply in 2006 and 2007. This is primarily due to yield rather than area changes.

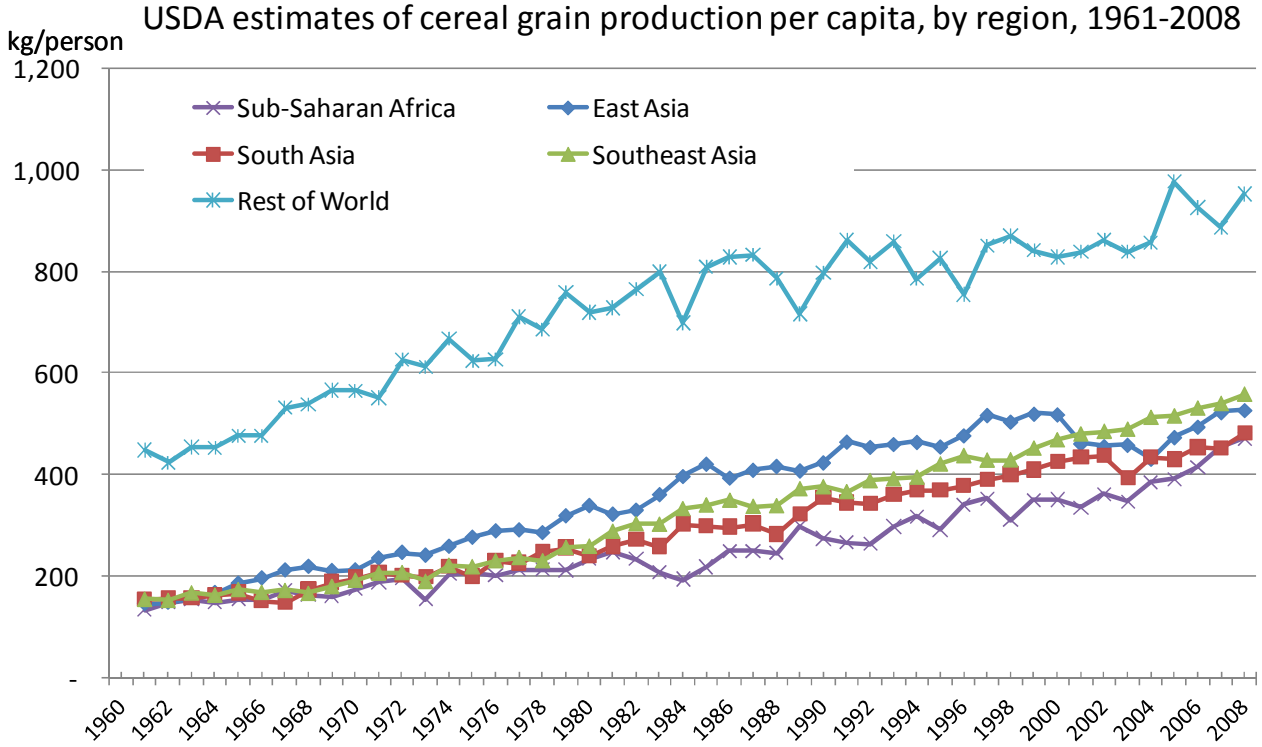
A remarkable aspect of the data shown in Figures 3 and 4 is the steady rise of cereal grain yields in Africa over the past decade, which combined with steady growth in cropped area has sustained 25 years of growth in cereals output per capita in Africa, catching up to South Asia

Figure 2.
USDA estimates of cereal grain stocks per capita, by region, 1961-2008



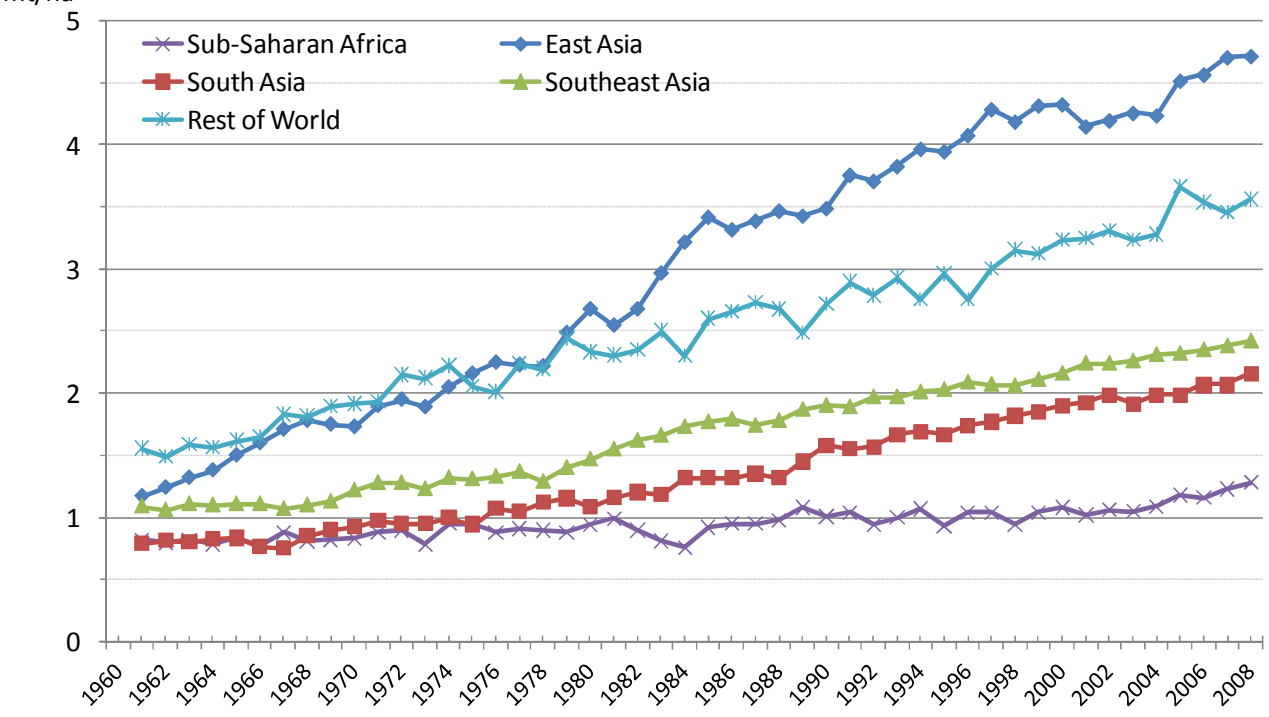
Source: Author's calculations. Grain stock estimates are for the end of the marketing season in the year shown, from USDA PS&D database (www.fas.usda.gov/psdonline), matched with mid-year population estimates from US Census Bureau, International Database (www.census.gov/ipc/www/idb).

Figure 3.
USDA estimates of cereal grain production per capita, by region, 1961-2008



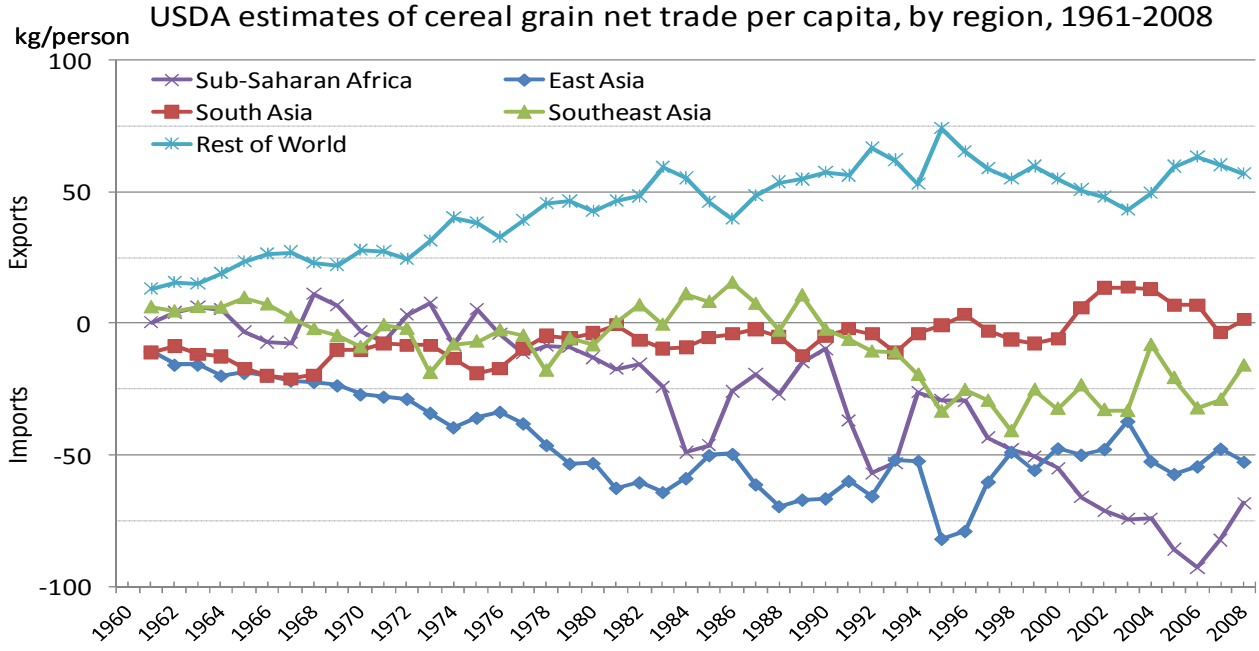
Source: Author's calculations. Grain production estimates are for the country's harvest in the year shown, from USDA PS&D database (www.fas.usda.gov/psdonline), matched with mid-year population estimates from US Census Bureau, International Database (www.census.gov/ipc/www/idb).

Figure 4.
USDA estimates of cereal grain average yield, by region, 1961-2008



Source: Author's calculations, from grain production and area estimates for harvests in the year shown, from USDA PS&D database (www.fas.usda.gov/psdonline), matched with mid-year population estimates from US Census Bureau, International Database (www.census.gov/ipc/www/idb).

Figure 5.
USDA estimates of cereal grain net trade per capita, by region, 1961-2008



Source: Author's calculations. Data are for standard trade years over a 12-month season ending in the year shown, from USDA PS&D database (www.fas.usda.gov/psdonline), matched with mid-year population estimates from US Census Bureau, International Database (www.census.gov/ipc/www/idb).

in 2007 at a level of about 450 kg per person. Despite these increases in African production, consumption has increased even more and Africa has been an increasingly large net importer of cereal grains since the 1970s. As shown in Figure 5, Africa's imports per capita have grown sharply since 1990, and since 2001 Africa has imported more cereal grain per capita than any other region.

The large net imports shown in Figure 5 make price increases for cereal grains especially costly for Africa. As detailed by Ng and Aksoy (2008), Africa is a net exporter of other agricultural commodities and of farm products generally, but the increasing prices of imported cereal grains relative to cotton, groundnuts and other exports as illustrated in Figure 1 is clearly unfavorable for Africa as a whole.

2. Household-level impacts of price changes

There is surprisingly little data on vulnerability to higher food prices at the individual level. The Ivanic and Martin (2008) paper cited at the start of this paper aims to take account of changes in both food expenditure and household income. The three African cases they examined were Madagascar, Malawi and Zambia, where they estimate that the 2005-07 increase in prices of major foods caused increases in the population under dollar-a-day poverty of 3.6%, 4.0% and 4.9% respectively (Ivanic and Martin 2008, Table 5). This is consistent with the incidence of food price changes found by crop-specific studies such as Levinsohn and McMillan (2005) for wheat in Ethiopia or McMillan et al. (2005) for maize in Mexico.

Price increases may worsen poverty, but some poor people do benefit from them. After all, most Africans are farmers. Table 1 provides data from three major surveys on how many Africans actually participate in food production and sales, thus potentially gaining from higher prices. A large majority of people in all three countries produce some food, but a smaller share produce the staple food and less than half are net sellers.

Comparing the third and fourth rows of the total-population columns in Table 1 reveals that the poor are generally more likely to be net sellers of food, mainly because they are more likely to be farmers. Among farmers, however, poorer households tend to be those with

less land and other productive resources per person, and so have relatively little to sell. Production also varies significantly from year to year, further clouding the picture. Figure 6 summarizes the data from consecutive surveys in the Kagera region of Tanzania, where most farmers are net sellers, showing a clear positive correlation between the magnitude of net sales and the household's real income, as measured by consumption expenditure per capita in that year. Poorer farmers sell less, and the poorest are sometimes net buyers – particularly in a year of unfavorable weather, such as 1992-93, when the whole curve shifts down as people produce and sell less.

3. African governments' agricultural policies

The prices received by farmers depend on government policies as well as market conditions. Here, we present results of a remarkable new study of policy choices across 16 African countries from 1960 through 2004, conducted as part of a worldwide project on agricultural incentives led by Kym Anderson and others at the World Bank. The full dataset is forthcoming as Anderson et al. (2008a), and follows a methodology detailed in Anderson et al. (2008b). Details on the results for Africa are forthcoming in Anderson and Masters (2008). Here, we provide only the simplest summary of the data, with government intervention measured as the tariff-equivalent difference between domestic prices and international opportunity costs, after adjusting for transaction costs. National consultants were employed to obtain these estimates, often from unpublished file data, for each of a country's major agricultural commodities by year. The project produced more than 6,000 observations of this Nominal Rate of Assistance (NRA) in Africa.

Figure 7 shows the evolution over time of product-level NRAs, first for all products (left panel) and then separately for importable and exportable products (right panel). An NRA of zero implies that government allows competitive pricing; an NRA below zero implies farmers are taxed to benefit consumers and/or taxpayers, whereas an NRA above zero implies that farmers are

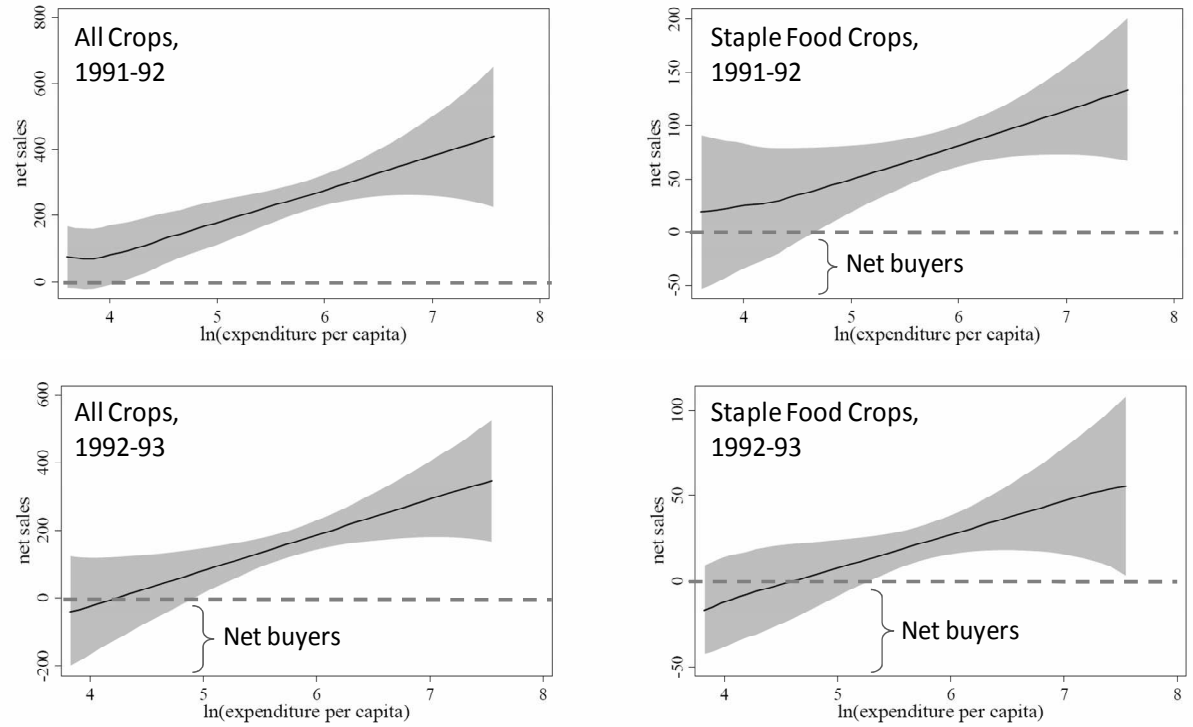
Table 1. Proportion of households who produce, sell or are net sellers of food, 1998-2001

		Ethiopia (2000)		Madagascar (2001)		Zambia (1998)	
		Total	Rural	Total	Rural	Total	Rural
Rural population (% of total)		50.7		75.8		47.8	
All foods							
producers	(% of all hhlds)	78.1	97.0	71.2	83.1	66.5	89.4
sellers	(% of all hhlds)	68.4	87.9	58.1	68.5	36.7	53.9
net sellers	(% of all hhlds)	40.6	53.2	41.4	49.1	7.9	12.6
net sellers	(% of poor hhlds)	44.3	51.5	54.5	56.2	10.6	12.5
Main staple foods							
producers	(% of all hhlds)	55.4	71.5	64.4	75.7	47.5	69.5
sellers	(% of all hhlds)	28.5	36.9	35.1	41.7	28.8	42.5
net sellers	(% of all hhlds)	23.1	27.3	31.7	37.6	19.1	29.6
net sellers	(% of poor hhlds)	21.8	24.3	41.0	42.7	23.9	28.1

Note: Poor households are defined as the lowest 40% of income per capita; staple crops are wheat and maize (Ethiopia), rice, maize, groundnut and beans (Zambia) and rice and maize (Madagascar).

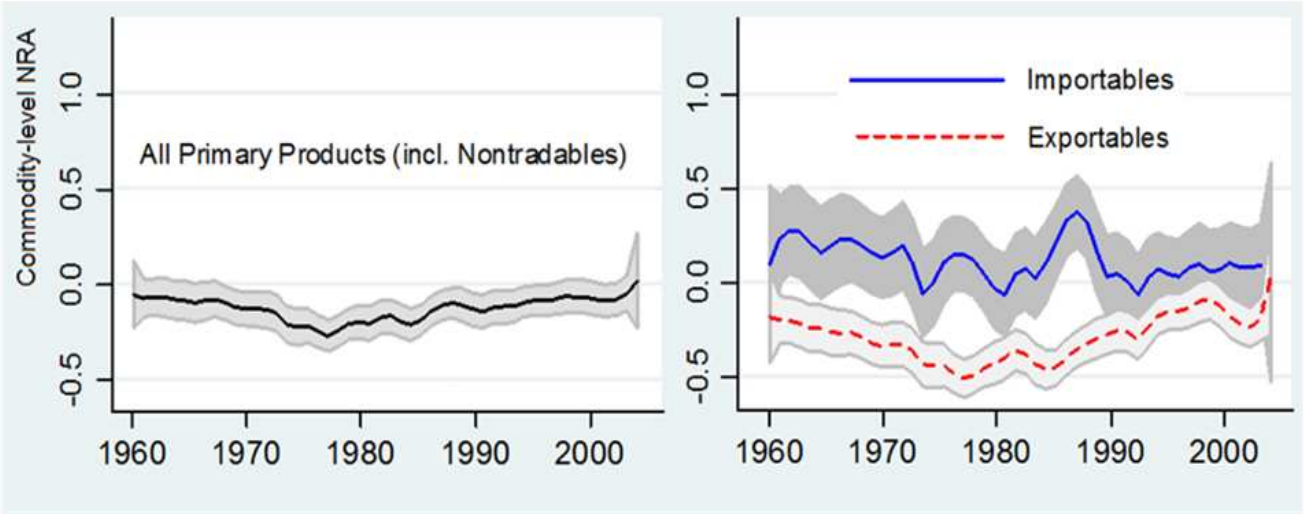
Source: Data shown are compiled from M.A. Aksoy and A.Isik-Dikmelik (2008), "Are Low Food Prices Pro-Poor? Net Food Buyers and Sellers in Low-Income Countries" Policy Research Working Paper 4642. Washington, DC: The World Bank, June 2008 (30 pages).

Figure 6.
Farm household net crop sales in Tanzania, by income level



Note: Lines shown summarize the value-weighted NRA for all agriculture in 16 African countries and 52 other countries, observed in each year from 1960 through 2005 and smoothed over per-capita income with 95% confidence intervals around a local polynomial regression.
Source: Author's computation from preliminary file data collected for the World Bank. Final data will be available in late 2008 at www.worldbank.org/agdistortions, and forthcoming in K. Anderson and W.A. Masters (2008), *Distortions to Agricultural Incentives in Africa*. Washington, DC: World Bank.

Figure 7.
Average NRA by type of product in Africa over time, 1960-2005



subsidized at the expense of consumers and/or taxpayers. Clearly, African government policies imposed an increasingly heavy burden on farmers from 1960 to the late 1970s, particularly through taxation of exportable products. After 1985 that tax burden was gradually lifted, and the domestic prices of these products rose and has been at nearly free-trade levels since the late 1990s.

The historical increase and then decrease in African governments' taxation of exportable crops coincided with stagnation and then recovery in cereal-grains production. It may be that farmers' earnings from exportables helped them finance input purchases for food products – future research using these data is needed to investigate whether one caused the other, when controlling for other factors. Here, we note only that African governments' agricultural trade policies are not chosen arbitrarily: governments in countries that are poor for whatever reason generally impose heavy taxes on farmers, as a result rather than a cause of their poverty.

Figure 8 illustrates the link between agricultural policy and national income, using 95% confidence intervals to show variation in the data around a local polynomial regression. Governments in countries whose income falls below about $1,000 in PPP terms tend to tax their farmers, while governments in countries above about $7,000 in PPP terms provide increasingly large subsidies. The data show slightly more taxation of farmers in Africa than elsewhere at intermediate income levels, which Masters and Garcia (2008) explain in terms of factors such as land abundance and alternative targets for taxation.

4. Foreign aid to Africa

Local governments, business enterprises, farmers and consumers drive the evolution of African agriculture, but foreign aid donors also have a role to play. Figure 9 shows the magnitude and allocation of official development assistance (ODA) from all donors to all African countries, as compiled by the OECD's Development Assistance Committee (DAC), per person in Africa. The top line on the right axis shows total ODA per capita, which more than doubled in real terms from 1973 to 1990, before falling back during the 1994-2001 period and then more than doubling again from 2002 to 2006. The sectoral allocation of this aid is shown on the left axis: agriculture was an increasingly important target

Figure 8.
Average country-level NRAs in Africa and the rest of the world, by income level

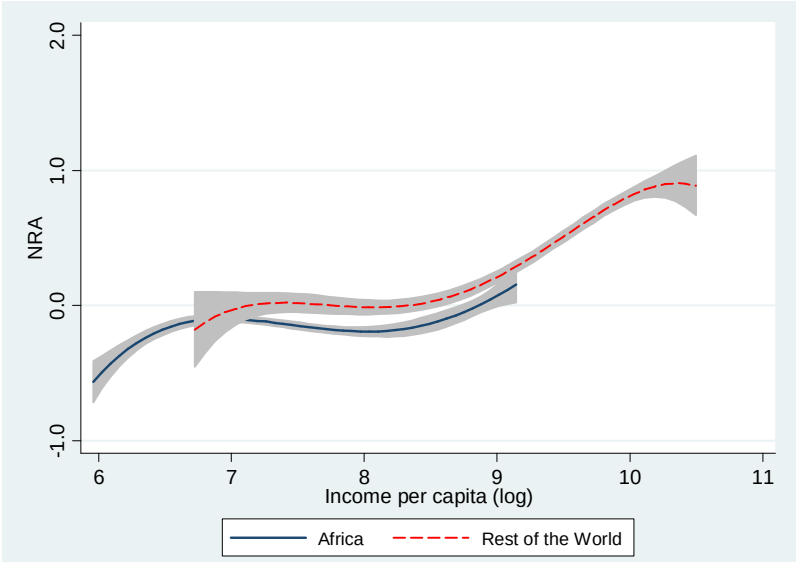
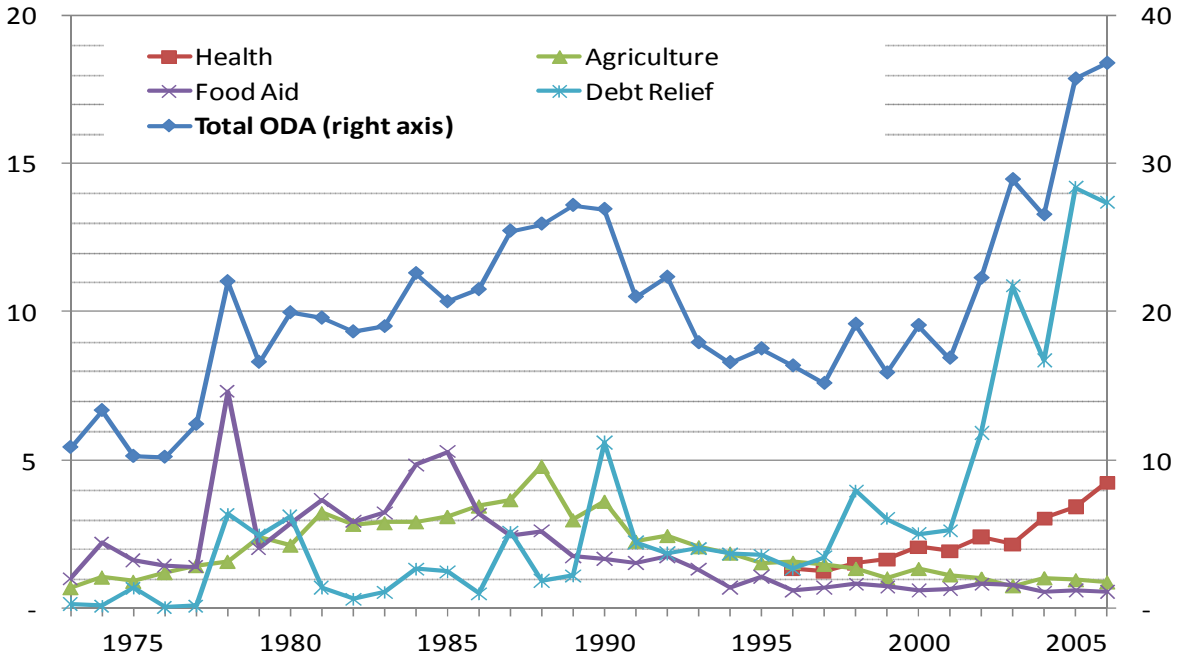


Figure 9.
ODA commitments to Africa in selected sectors and total, 1973-2006
(real US dollars per capita)



Source: Author's calculations, from OECD Development Assistance Committee (2008), *Bilateral ODA commitments by Purpose* (www.oecd.org/dac), deflated by OECD deflator (2005=100) and divided by midyear population estimates for Sub-Saharan Africa from the U.S. Census Bureau, International Database.

from 1973 to 1988, but then declined sharply in importance and has not been a significant recipient of the post-2001 increase, which went to health, debt relief and other goals.

5. Technology and innovation

The data presented above show that well before the current rise in world food prices, there were substantial and sustained increases in African production and yields of cereal grains per capita, despite steady declines in per-capita foreign aid for the sector. Reduced taxation of farmers played an important role, as did farmers' adoption of new crop varieties and other innovations developed by public R&D programs.

The impact of R&D and new technology adoption was first identified through case studies of particular programs (e.g. Masters et al., 1998). Econometric studies linking aggregate output to R&D activity include Evenson and Gollin (2003), who showed that Africa benefited from international crop breeding both later and to a lesser degree than other regions. Africa's lower level of R&D impacts was due primarily to lower spending: the proportional return on investment has been similar in Africa as elsewhere (Alston et al., 2000) while poverty reduction per dollar of investment has actually been greater (Thirtle et al., 2003).

The role of agricultural R&D in Africa is surveyed by Masters (2005), concluding that much higher levels of investment are needed but are politically very difficult to achieve and maintain. One fundamental cause of low investment is that the gains from agricultural R&D are hard to predict *ex-ante* or even to observe *ex-post*, making it particularly difficult to mobilize political support. In this context, a useful intervention to help investors identify and replicate the most successful innovations is to offer prize-type awards, so as to recognize approaches that can then be scaled up using grants and contracts, intellectual property rights (IPRs), or hybrid public-private partnerships that combine those two instruments.

Masters and Delbecq (2008) describe how prize contests have worked for other sectors in the past, and pro-

vide details on how a new kind of prize reward program could help accelerate innovation in African agriculture. The goal of this new program would be to identify any and all innovations that have successfully met farmers' needs, so that observers could compare their impacts and replicate them elsewhere. Offering prize funds would entice innovators to assemble the required data and submit them to a prize secretariat, who would audit each submission and compare the results. A key innovation in the proposal is to disburse prize funds proportionally to measured impact, and thereby align the value of winning with the gains actually achieved by farmers.

Figure 10 shows how the new "prize reward" concept differs from traditional prizes. Traditional approaches rely either on purely subjective criteria (in the top-right corner), or a discrete criterion for awarding fixed sums such as the X Prizes for civilian space flight (in the middle-left cell). The bottom-left cell offers an example of prizes that reward incremental achievements with incremental payments, as advocated for example by Kremer and Glennerster (2004) in their proposal for an Advance Market Commitment (AMC) to purchase vaccines for otherwise-neglected diseases. Kremer and Zwane (2005) propose this type of incentive for African agriculture, but its design is appropriate for a "one problem, one solution" kind of technology. In agriculture, appropriate technologies solve a bundle of problems simultaneously, to varying degrees in different locations. To fit this situation, we need a "prize reward" type program that would fit in the bottom-right cell, paying out a fixed sum in proportion to value creation, thus combining the flexibility to reward all kinds of new technology with the objectivity of a fixed criterion for success.

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6. Conclusions

This paper surveys some of the background, impacts and possible responses in Africa to the current world food crisis. Numerous official reports have attempted a comprehensive view, so we are more selective and focus on new data and results of recent research regarding Africa as a whole, the impacts of price changes at the household level, changes in African governments' price policies, and the role of technological innovation in raising output.

Figure 10. A new typology of prize designs

	New technology's characteristics are pre-specified	New technology's characteristics are to be discovered
Success is a matter of opinion		*Achievement awards (e.g. Nobel Prizes, etc.)*
Success is a discrete, yes/no achievement	*Traditional prizes (e.g. X Prizes)*	
Increments of success can be measured	***AMC for medicines (fixed price per dose times no. of doses)***	***Prize Reward (fixed sum divided in proportion to impact)***

Our main findings are that, at the aggregate level, despite twenty years of steadily declining in agricultural aid per capita in Africa, the continent's production of cereal grains per capita has grown steadily over the past decade and is now catching up to South Asian levels. Thanks to economic growth and a variety of policy reforms, however, consumption has grown even faster and the continent now imports more cereal grains per capita than any other region. Higher food prices are therefore costly for Africa as a whole, and on average are particularly harmful for Africa's poorest people, who often grow some food but have no surplus to sell. It is higher-income farmers who benefit most from high grain prices – but their experience offers valuable lessons regarding what technologies are most useful for increasing agricultural production in these environments.

In response to the extreme challenge posed by the world food crisis, African agriculture can build on its recent successes and accelerate total output growth by spreading the use of successful innovations. That process could be facilitated by a program of prize rewards

paid to innovators, in proportion to the measured impact of their new technologies after adoption. Such prize rewards would identify the most successful innovations recently adopted by some African farmers, and help others scale up those achievements across the continent. The dramatic food price increases of recent years call for equally dramatic measures to raise productivity, particularly among the lowest-income farmers who cannot benefit and are often harmed by higher food prices.

About the author

Will Masters is a Professor and Associate Head of the Department of Agricultural Economics at Purdue University. He is co-editor of the journal *Agricultural Economics*, and author or co-author of several books including *Economics of Agricultural Development* (Routledge, 2006) as well as many scholarly articles. Links to his work are available at http://ww.agecon.purdue.edu/staff/masters.

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