# Markets, Climate Change and Food Security in West Africa

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| Journal: | *Environmental Science & Technology* |
| Manuscript ID: | draft |
| Manuscript Type: | Feature |
| Date Submitted by the Author: | |
| Complete List of Authors: | Brown, Molly; NASA Goddard Space Flight Center, Biospheric Sciences Branch<br>Hintermann, Beat; ETH Zuerich, Centre for Energy Policy and Economics<br>Higgins, Nathaniel; University of Maryland, College of Agriculture & Natural Resources |
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# Markets, Climate Change and Food Security in West Africa

A Feature article submission to Environmental, Science and Technology Journal

Authors:
Molly E. Brown, PhD
NASA Goddard Space Flight Center
Greenbelt, MD 20771
molly.brown@nasa.gov

Beat Hintermann, PhD
Centre for Energy Policy and Economics (CEPE)
ETH Zuerich
Zurich, Switzerland

Nathaniel Higgins
University of Maryland
College Park, Maryland

## Abstract

West Africa is one of the most food insecure regions of the world. Sharply increased food and energy prices in 2008 brought the role of markets in food access and availability around the world into the spotlight, particularly in urban areas. The period of high prices had the immediate consequence of sharply increasing the number of hungry people in the region without boosting farmer incomes significantly. In this article, the interaction between markets, food prices, agricultural technology and development is explored in the context of West Africa. To improve food security in West Africa, sustained commitment to investment in the agriculture sector will be needed to provide some protection against global swings in both production and world markets. Climate change mitigation programs are likely to force global energy and commodity price increases in the coming decades, putting pressure on regions like West Africa to produce more food locally to ensure stability in food security for the most vulnerable.

## Introduction

In 2009, chronic and abrupt food security crises continue to plague many regions around the world, despite the technical capacity to feed every person adequately. Food security, the ability of all people to have enough food for an active and healthy life, has not been attained for all for many reasons, including broad issues of poverty, geopolitical inequities, natural resource disparities, unequal global trading arrangements, and poor or corrupt government, among others. In 2008, the Global Hunger Index found that West Africa is a region with some of the most severe hunger in the world (Grebmer et al., 2008). This paper will explore the relationships between global environmental change, food prices and food insecurity in West Africa, and the role that technology can play in ameliorating these problems.

The use of technology in agriculture has transformed food production in many parts of the world during the past century. Irrigation, improved seeds, chemical fertilizers and pesticides, and the use of large machinery have massively increased worker productivity and yields. Industrial farming systems also stress the water, soil and ecology of the regions where it has been implemented. These industrial production systems, coupled with tightly integrated shipping and transportation networks, grain storage and processing systems have kept global food prices steady or declining since 1950 despite massive increases in population (Figure 1).

Technological change has not reached most West African farmers, however. In that region, farms are small, primarily cultivated with hand tools, are planted with seeds with a wide genetic diversity, and crops are produced using little or no chemical fertilizer. Consequently, most small farms are only able to attain the yields they had fifty years ago, which are one seventh of those regularly achieved in industrialized systems (Breman, 2003, Taylor et al., 2002). In most of the region, purchasing food takes up more than fifty percent or more of most household's income (Jayne et al., 1995).

Climate change is likely to further threaten the ability of the region to compete in a global food system. Although the likely impact of climate change on rainfall in the region is currently unclear, increases in temperature globally will undoubtedly reduce yields in many of the key production areas of the world (Lobell et al., 2008). The advent of large scale use of food commodities in biofuels means that the surplus previously seen in the United States is rapidly disappearing (Cassman, 2007, Gilland, 2002). This has put significant pressure on markets that is likely to again produce high commodity prices sometime in the near future.

This transformation of global food markets in the past few years to be more closely aligned with energy has had a huge impact on the food security of the world's poor, particularly those living in Africa (OXFAM, 2006). This article will describe how climate and global commodity prices affect local food prices in West Africa, and how these variations combine with local growing conditions to cause significant problems of household food security. Globally, there are many fewer food insecure people in the world than there were twenty years ago because of the economic expansion and agricultural efficiency in South and East Asia. In Africa, however, the number of poor and food insecure is still rising and is likely to continue to rise because of the lack of economic and agricultural growth coupled with an increasing population (Devereux and Maxwell, 2001).

## West Africa and Food Prices

West Africa is a semiarid region with a rapidly growing population and a very low gross domestic product. To provide for a growing population, farmers in many parts of Africa have expanded the amount of area in cultivation to compensate for static yields. With a few significant exceptions, most farmers in West Africa have small plots of rainfed crops of less than an acre, and most use little or no fertilizer, pesticides or improved seeds. In the past few decades, farming families have diversified their income sources, working in markets, livestock production, crafts and wage labor markets (Abdulai and CroleRees, 2001). Although these activities have improved cash flow, they draw off any available capital from agriculture, leading to yield stagnation (Yamoah et al., 2002, Gandah et al., 2000). Cash and labor used in livestock or market schemes is diverted from agricultural investments such as purchasing improved seeds and making improvements in fields.

West African farming households experience significant interannual variability in food production, access, and availability. Because the majority of the inhabitants of the region are farmers, grain produced by households across the region is sold on the market at roughly the same time. Proceeds from these sales, which tend to be concentrated around the harvest season, are subsequently used to finance necessary expenditures throughout the year on housing materials, clothes, school expenditures, large feasts during the religious holidays of Ramadan and Tabaski, and when agricultural inputs are being purchased. The simultaneous influx of grain on the market reduces the prices that farmers receive at harvest.

Unlike supply, the demand for grain is fairly steady throughout the year. Farmers in Burkina Faso, for example, sell only 10 to 20% of the cereals produced, consuming the rest within the household or exchanging them for other goods and services with other households in need (Terpend, 2006). Most rural households purchase grain during the rainy season (July and August) because their own stocks are low. These factors of supply and demand and the overall lack of sufficient grain in the market causes the price of food to have a strong seasonal increase at that time of year (Figure 2).

Because rural farmers cannot store grain beyond some small amount that they store in their homes for personal consumption, they sell most of their grain in a period of the year when prices are lowest. These low prices are counterbalanced to some extent by high prices later in the year. Even though farmers are selling relatively little grain during the period of higher prices, they are receiving relatively more for each unit. However, the high prices are capped by the imports of substitute commodities on the international market. Because most rural farmers sell their grains into a local urban market, and because these local urban markets have access to international grains, periods of low local productivity do not result in prices high enough to make up for the low prices farmers experience just after harvest.

Food prices are influenced by a diversity of factors, including social unrest, macro-economic policies of the governments, food and income assistance often from multiple sources, regional price and crop production variations, and demand and other market factors. However, when weather reduces agricultural production over large areas, the resulting widespread reductions in food production cause immediate increases in local food prices (Brown et al., 2006).

The effect of increased crop prices on farmer income is ambiguous in principle. If prices increase proportionally more than output decreases (inelastic demand), farmers could be more than compensated for the reduced harvest, and vice versa. However, farming households that produce only a small surplus during a normal year can sell little or nothing at all after a poor harvest, but they have to pay higher prices when they purchase food later in the year. This makes them vulnerable to high food prices in spite of the fact that they themselves are food producers.

Figure 3 shows the relationship between satellite-derived estimates of local growing conditions and the price of millet in Niger, Mali and Burkina Faso in West Africa from 1982 to 1999. In years with positive vegetation production anomalies, prices tend to be low due to above average production and surplus grain flooding on the markets. In years with negative production anomalies, prices can grow by 100% of average due to simultaneous supply shortages across broad regions. Thus local prices, and consequently the ability of a household to have enough food to eat in this region, are highly reliant on local production. The consequence of these fluctuations in prices is food insecurity during times of drought, reduction in profitability of agriculture in the region, and increased dependence on global markets for urban areas.

## Global Markets

Like in many regions around the world, West African markets have recently become more integrated with each other and with the global commodity markets. This has meant that the increase in maize prices in 2008 did have an influence on the price of grain in the rural, informal commodity markets in West Africa, despite their relative isolation.

Rapidly expanding urban markets in West Africa rely on global commodities for affordable food. Low tariffs, poor interior transportation systems and efficient global commodity markets have made rice imported from China, Malaysia and Indonesia extremely competitive with corn, millet and sorghum grown locally. Conversely, many of the same factors restrict the ability of rural farmers in West Africa to access international commodity markets. Because there is a high cost to move grain from the interior of the continent to the capital cities and ports on the coast, local food prices in rural areas tends to be very high and sensitive to climate variability. When rural markets have a deficit or prices are high, grain is imported from the capital city and thus local prices are affected by global fluctuations.

Figure 4 shows the international price of corn plotted with the millet price from the capital cities of Mali, Burkina Faso and Niger. Because millet is the primary coarse grain in West

Africa and is a staple, we use it here to represent the broader variation in food prices in the region. It is also highly correlated with the price of maize and sorghum, the other two primary cereal crops grown in the region. Figure 5 shows the correlation between the local and global prices during the past 25 years. The impact of global maize prices is very small during the same month (zero month lag), which is understandable since transportation of grain is usually done with ships and trucks and is thus slow to arrive. At a lag of 15 months, however, the international price of maize is a significant factor on millet prices in Niamey Niger, but is less important in Mali or Burkina Faso. Niamey is the least self-sufficient in grain and is thus most integrated with the international markets. In Mali and Burkina Faso, however, the influence of international maize prices peaks at 3 and 6 months respectively. After that, the correlation is negative, but not statistically significant.[1]

## Climate Change and Agricultural Productivity

The Intergovernmental Panel on Climate Change (IPCC) 2007 report estimated that warming global temperatures are likely to reduce West African agricultural production by up to 50 percent by the year 2020 (IPCC, 2007). The impact of climate change on rainfall is far less certain, particularly because global climate models often have difficulty reproducing West Africa's complex monsoonal rainfall which is dominated by waves of moisture moving east across the continent (Cook and Vizy, 2006). Large changes in the global water cycle are anticipated with increases in energy in the atmosphere due to increasing temperatures, but exactly how these changes will affect West Africa is very unclear.

West Africa will not be the only region suffering from a changing climate. Primary grain producing areas in semi-arid regions of Australia, the United States and southern Africa will all be significantly impacted by drought and water scarcity. Food production is unlikely to increase further in these regions while the demand for food will likely double in the next four decades, resulting in higher food prices in the long run (IAASTD, 2008).

The growing awareness of the severity of the threat that climate change poses to society means that it is increasingly likely that there will be some kind of global mitigation policy that will increase the price of non-renewable carbon-based energy sources, primarily petroleum and coal. Industrial agriculture, which uses high levels of machinery, fertilizer and complex transportation systems is highly reliant on petroleum products. There is a strong relationship between petroleum and corn on the international market (Figure 6).

The linkage between food and fuel spells trouble for the capital-poor countries that will need to buy food from the international market when they are affected by drought, flood or economic crisis. Investment in the agriculture sector by West African countries has focused in past decades on export products, leaving them vulnerable to high international food prices (IAASTD, 2008). The world will eventually adjust to the rising cost of carbon-based fuels, but in the next few decades it is likely that the link between food and fuel will challenge West African nation's ability to raise sufficient foreign currencies to finance

[1] For Niger, lags 11-26 are significant at $p<0.05$; in Mali, lags 2-5 are significant at $p<0.05$; and for Burkina Faso, only lags 5-6 are significant at $p<0.1$. All other correlations are not statistically different from zero.

food imports. Thus a critical priority should be increasing the productivity of local agricultural systems that produce far less than they could (Funk et al., 2008).

**Technology to increase local production**

Former world bank economist William Easterly points out that despite spending $568 billion (in today's (2004? 2003?) dollars) to end poverty in Africa between 1960 and 2003, poverty has risen steadily over the past five decades (Easterly, 2005). Providing technology, financial assistance, even free agricultural seeds and fertilizer will not dramatically improve yields in the region. The poverty of farmers, traders and their customers in urban areas in West Africa is a primary source of the problem of food insecurity and low productivity. This poverty, as is pointed out in their 2006 article by Broad and Cavanaugh, is caused by 'a complex, multidimensional maze of power relations' that has at its roots massive inequality in access to resources, power over marketing and structural issues in the economies themselves (Broad and Cavanagh, 2006, IAASTD, 2008). Simply trying to implement a 1960s style green revolution in Africa may increase production but is unlikely to improve food security, as it is the poorest with the least land, fewest resources and poorest connections that are food insecure. The dependency on petroleum-based fertilizers and water intense agricultural systems is unlikely to be sustainable in the long term for these already poor countries.

Technology to improve agricultural productivity in the region needs to be small scale, tailored to the region and sustainable in the long run without huge corporate or IMF-style loans to the top. Local farmers need to be empowered through appropriate policies that give them rights to improvements they make to land, the trees they nurture, and the water underneath. Crop diseases like the parasitic plant striga and the maize contaminant Aspergillus reduce both yield and the nutritional safety of agricultural products in the region (Bandyopadhyay et al., 2007). Local research agencies, such as the Nigerian IITA and its funder CGIAR can produce low cost strains of maize, millet and sorghum that are disease resistant and higher yielding to farmers which are grown and bred in the local West African context.

Other examples of technology that can reduce long term vulnerability include cell phone fund transfers that can move a dollar or two from one local customer to another to provide funds for agricultural costs with virtually no fee. Programs that provide microloans for agricultural inputs coupled with crop insurance programs, paid out when satellite remote sensing shows crop failure, can provide both loan coverage and funds to support the household after crop failure (Carriquiry and Osgood, 2006). Community based natural resource programs, such as the one that has dramatically increased tree cover in Niger, provide other ways that both empower the farmer and local community to raise incomes of the poorest while enabling the country to remain debt-free (Polgreen, 2007). These examples show the way to improving the food security of a region while adapting to a changing climate.

**Conclusions**

Despite the challenges, much can be done to increase agricultural productivity in West Africa, a region that currently produces 10 percent or less of its theoretical potential (Brown and Funk, 2008). Massive new aid and food assistance programs are not the answer to persistent food insecurity, as they usually end up in the hands of the wealthy not the poor who are food insecure.

In this article we have shown that local cereal prices in West Africa are strongly connected to local variations in production. Because the region is dominated by rainfed agriculture, climate variability and climate change will continue to impact the ability of local residents to grow enough food to feed their families. International prices also influence the price of food in the region, with Niger being the most exposed to the international market. As the region urbanizes, more residents will need to purchase food, providing an opportunity for increased production in the rural areas.

Global climate change will impact the region in several ways. First, increasing temperatures and changes in the water cycle are likely to require adaptations in the local agricultural system. Second, mitigation strategies implemented by the developed world are likely to increase energy prices, which will have a spillover effect on food due to the coupling of the food and energy markets. Only through increased investment in the agriculture sector and in their natural resources will West Africa be able to cope with these two threats, as most of the poor and food insecure in the region are rural farmers. Local, small scale productive projects and appropriate technology that are sustainable without significant outside investments will be critical to improve productivity in the region and reduce vulnerability of some of the world's poorest citizens.

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Figure 1. Coarse grain yield statistics from five selected countries from the United Nations Food and Agriculture Organization.

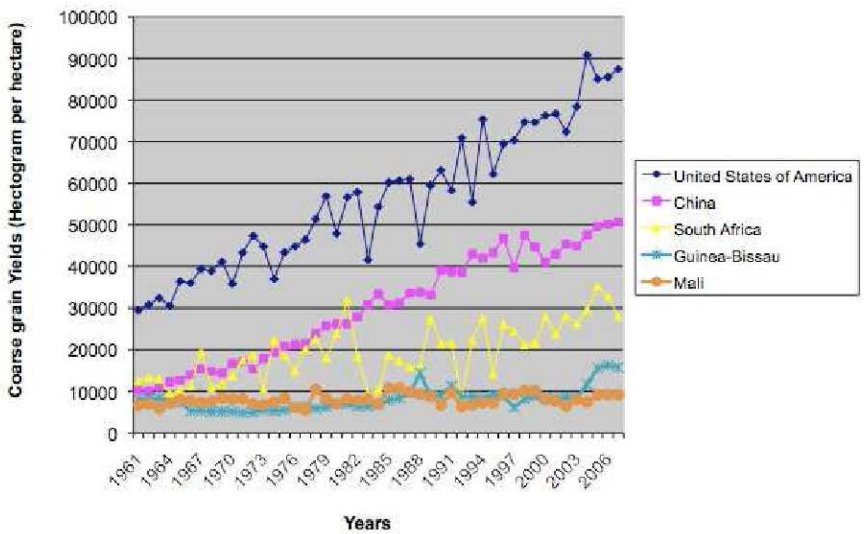


Figure 2. Average monthly price of Millet in Mali, Burkina Faso and Niger from 1982 to 1999 from 372 markets.

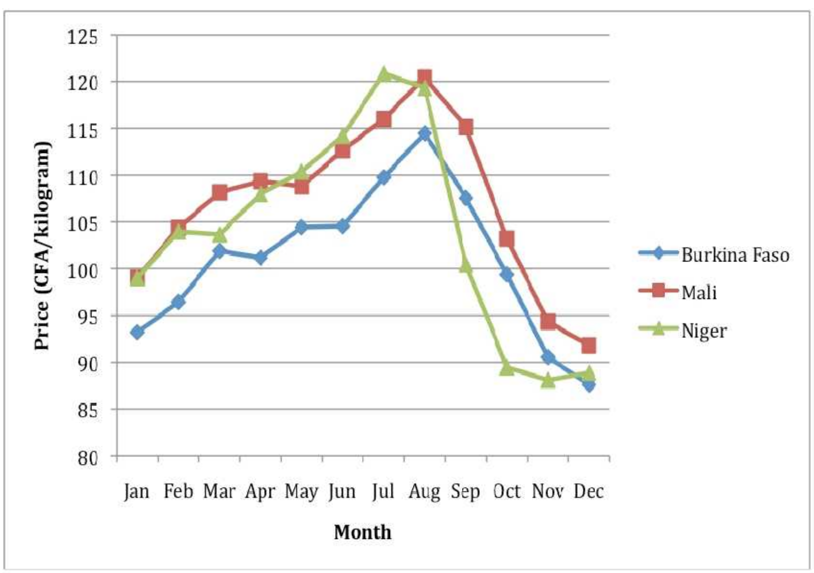

Figure 3. Relationship between environmental productivity as measured using satellite remote sensing and average millet prices in Niger from 1982 to 1999 during three periods.

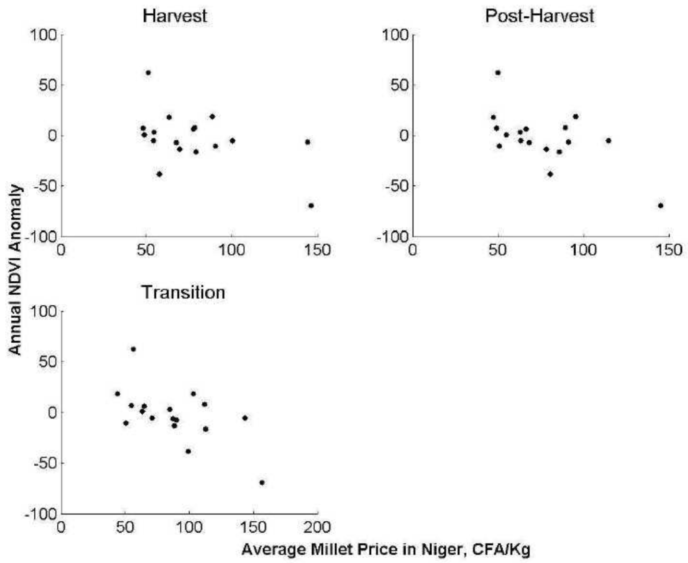

Figure 4. Millet prices in Bamako Mali, Niamey Niger and Ouagadougou Burkina Faso plotted with World Corn prices.

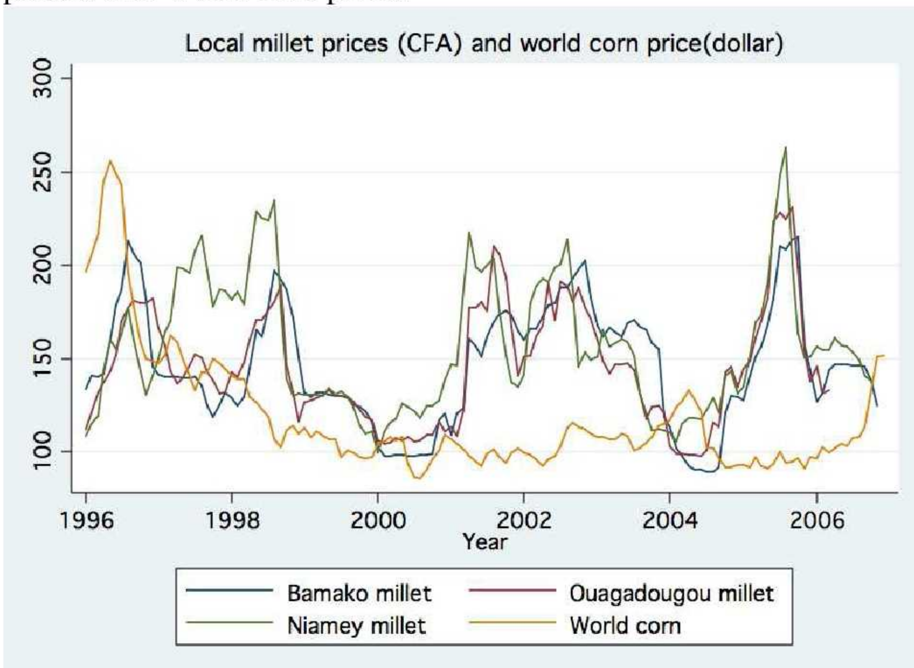


Figure 5. Correlation coefficient relating world corn prices to millet price in Bamako, Burkina Faso and Niamey, Niger

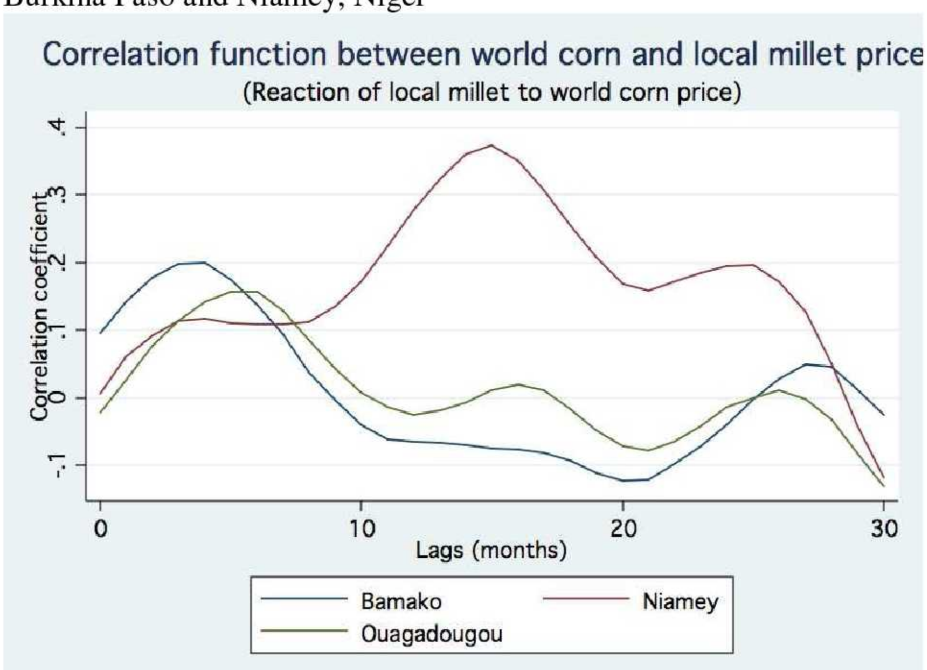

Figure 6. Deflated crude petroleum prices plotted against yellow maize from 1986 to 2009, indexed to the year 2000, which shows a positive relationship between the two commodities.