



Food security implications of staple food substitution in Sahelian West Africa[☆]



Steven Haggblade, Nathalie M. Me-Nsope^{*}, John M. Staatz

Department of Agricultural, Food and Resource Economics, Michigan State University, East Lansing, MI 48824, United States

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ABSTRACT

Low-income households in Sahelian West Africa face multiple shocks that risk compressing their already-low food consumption levels. This paper develops a multi-market simulation model to evaluate the impact of common production and world-price shocks on food consumption of vulnerable groups in Sahelian West Africa. Empirical analysis confirms that poor households bear the brunt of ensuing consumption risks, particularly in closed markets, where trade barriers restrict imports, and the poor find themselves in a bidding war with richer consumers for limited food supplies. In the absence of trade, a drought that reduces domestic rainfed cereal production by 20% would compress already low calorie consumption of the rural poor by as much as 15%, four times as much as other household groups. Conversely, a 50% spike in world rice prices hits the urban poor hardest, compressing calorie consumption by up to 8%.

Policy responses need to focus on two basic mechanisms that can help to moderate this pressure – consumer substitution among staple foods and trade. Immediately south of the Sahel, coastal West African countries enjoy higher rainfall, dual rainy seasons, more stable staple food production based on root crops (cassava and yams) as well as frequent double cropping of maize.

Our simulation results suggest that regional trade in maize, yams and cassava-based prepared foods like gari and attiéké could fill over one-third of the consumption shortfall resulting from a major drought in the Sahel. Increasing substitutability across starchy staples, for example through expansion of maize, cassava and sorghum-based convenience foods, would further moderate consumption pressure by expanding the array of food alternatives and hence supply responses available during periods of stress.

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1. Introduction

1.1. Motivation

Between 1990/92 and 2014/16, countries of the West African Sahel cut their rates of undernutrition from 23% to 13% (calculated from data in [FAO et al., 2015](#)).¹ Despite this notable progress, food

insecurity remains a serious problem for low-income families in these countries. The prevalence of stunting (an indicator of long-term malnutrition) among children ranges from 29% in Senegal to 55% in Niger ([FAO, 2013](#)).

Threatening this fragile progress, future projections suggest increasing volatility in West African food production as well as in world food prices as a result of climate change. In West Africa, increasing yield variability appears likely to accompany observed decreases in cereal productivity ([Ahmed et al., 2015](#)). At the global level, the increasing frequency of extreme weather events foreshadows increased volatility in world food markets and food prices ([Wheeler and von Braun, 2013](#)). Both sets of shocks – in domestic production and world market prices – will place renewed pressure on the food security of vulnerable groups in the Sahel.

Low-income households in Sahelian West Africa face multiple shocks that risk compressing their already-low food consumption levels. Two shocks, in particular, impose significant pressure on vulnerable households

- Reductions in staple-food production due to drought, flooding, insect attacks and plant diseases. Given thin markets for many

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^{*} Corresponding author at: 308 Manly Miles Bldg., 1405 s. Harrison Rd, East Lansing, MI 48823, United States.

E-mail address: mensopen@msu.edu (N.M. Me-Nsope).

¹ The West African Sahel spans the interior middle belt of West Africa, from Senegal and Mauritania in the west to Mali, Burkina Faso, Niger and northern Nigeria in the east. Because many of the nutrition and trade data discussed in this paper are reported only on a national basis, we do not include data from northern Nigeria in the figures cited above, including instead only data from Burkina Faso, Mali, Mauritania, Niger and Senegal. Undernourishment is defined here as “food intake that is insufficient to meet dietary energy requirements for an active and healthy life. Undernourishment, or hunger, is estimated by FAO as the prevalence and number of people whose food intake is insufficient to meet their requirements on a continuous basis; dietary energy supply is used as a proxy for food intake” ([FAO et al., 2015, p. 13](#)).

of the region's basic rain-fed staples (millet, sorghum and maize) and negligible imports of these products into the region, production shocks can lead to strong price spikes, limiting the poor's access to food.

- World price shocks, especially for rice, the main imported staple food in the region. During the 2008 world price spike, the FOB price of the benchmark Thai 5% broken milled rice nearly tripled from US \$316/mt in April 2007 to \$907/mt in April 2008 (World Bank, 2016), leading to severe pressure on the Sahel region, which relies on rice imports for nearly 60% of its total rice consumption and close to 10% of its total cereal consumption).²

Poor households face limited options in dealing with these shocks. They can draw down their meager savings, which may prove effective in the short-run if market supplies increase, for example through imports. However, in situations where trade barriers restrict imports, the poor find themselves in a bidding war with richer consumers for limited food supplies. Alternatively, where diversity of food supply permits, the poor can potentially shift food consumption to alternative food commodities, such as roots and tubers, whose prices are not highly correlated with the poor's habitual staples. A third option, often witnessed in the coping-strategies literature (e.g. Camara, 2004; Tall, 2013; WFP, 2012; Hazard et al., 2008) is simply to cut back on consumption. This reduction in consumption can take many forms – reductions in the consumption of nutrient-dense foods such as animal products, fruits and vegetables in order to “defend” staple-food consumption; lower expenditures on non-food items, such as health and education expenditures; and a decrease in the number of meals eaten per day. Such self-imposed consumption restrictions of high-protein and high-vitamin foods risk eroding the family's human capital and perpetuating long-term, inter-generational poverty.

Increasingly erratic weather patterns, together with recent world food crises in 2008 and 2011, have convinced West African policy makers of the growing need to understand the effects of major food shocks on the food security of poor households. Developing adequate policy responses to these shocks requires a better understanding of the pathways through which these shocks affect the food consumption of different groups in the population.

1.2. Contributions

This paper contributes to a growing literature assessing the impact of climate-induced changes in food production and food markets on vulnerable groups. It takes as given the emerging consensus about the likelihood of growing instability in staple food production in West Africa and price volatility in global markets that have historically provided import relief in times of stress in the Sahel (Wheeler and von Braun, 2013; Ahmed et al., 2015; EU, 2016).

The present work expands on a handful of prior efforts to empirically evaluate the impact of food system shocks on vulnerable groups in West Africa. Prior work by Joseph and Wodon (2008) examine the impact of spiking cereal prices on poor households in Mali, focusing on cereals. Since Sahelian consumers enjoy a growing variety of food choices, our analysis expands the food basket to consider substitution among all foods, including not only major cereals but also roots and tubers (potatoes, sweet potatoes, cassava), other common staples such as cowpeas, groundnuts and oils as well as animal products and fresh fruits and vegetables. Work by Nogue and Wodon (2008) has likewise expanded the commodity mix to include all major foods. However, their analysis relies on a standard computable general equilibrium (CGE) model with a

linear expenditure system (LES) which, in turn, places severe constraints on the consumption elasticities that lie at the heart of estimating consumer responses. In particular, the LES implies linear Engel functions, proportional expenditure and price elasticities and disallows complements and inferior goods (Deaton and Muellbauer, 1991; Sadoulet and de Janvry, 1995).

Fundamentally, food system shocks (either an abrupt shortfall in domestic production or a spike in import prices) lead to a series of consumer adjustments, measurement of which depends on capturing as accurately as possible the responsiveness of food demand to income and food prices. During times of stress, a bidding war takes place pitting poor households against higher income nonpoor groups. To capture this substitution among food groups and competition across household groups requires a multi-market model (multiple food groups) as well as a flexible formulation of demand responses that enables us to incorporate the best available evidence (from recent AIDS model estimates, for example) on consumer income, price and cross-price elasticities of demand.

1.3. Objectives

This paper addresses two principal objectives. First, it estimates empirically the impact of increasingly common food system shocks on food and calorie consumption of poor households in Sahelian West Africa. Second, the analysis aims to identify practical policy options for moderating compression of food consumption.

The paper begins by quantifying, in the context of a “typical” West African Sahelian country, current consumption patterns across rural and urban household groups, as well as differences in purchasing power and willingness to substitute among staple foods in response to key food-security shocks. These consumption parameters permit quantification of the consumption changes expected among key household groups following two major supply shocks – staple-food production shortfalls and spikes in world rice prices. By highlighting critical factors influencing consumption outcomes, the paper draws implications for food and trade policies, including efforts to develop new technologies and markets for processed products. Ultimately, this analysis aims to identify policy tools that can help to broaden the ability of poor families to deal with these shocks in order to soften the deterioration in food consumption they currently endure following major supply shocks.

2. Data and methods

2.1. Multi-market simulation model

The paper develops and applies a multi-market simulation model to evaluate the impact of common production and world-price shocks on food consumption of vulnerable groups in the West African Sahel. Following in the tradition of Braverman and Hammer (1986), the model measures staple food consumption responses to price and income shocks of differing household groups using available estimates of key consumption parameters. The multi-market model provides a flexible framework best suited to the core task at hand, which focuses on measuring consumer reactions to price and income shocks using best available estimates of consumer demand parameters from recent Almost Ideal Demand System (AIDS) studies. Neither a single-market partial equilibrium model nor economy-wide CGE model would suffice for the current purposes. While the single-market models miss out on key food substitution possibilities across a full range of food groups available, CGE models using LES place undue restrictions on the consumer response parameters. For useful reviews of multi-market models and their broad range of applications, see Sadoulet and de Janvry (1995) and Croppenstedt et al. (2007).

² Over the period 2006–09, imports accounted for 59% of the total rice supplies of Burkina Faso, Mali, Mauritania, Niger and Senegal and 9.7% of those countries' total cereal supplies (FAOSTAT, 2016).

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