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Staple Food Market Sheds in West Africa

by

Steven Haggblade, Steven Longabaugh, Duncan Boughton, Nango Dembelé, Boubacar Diallo, John Staatz, and David Tschirley

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Department of Agricultural, Food, and Resource Economics
Department of Economics
MICHIGAN STATE UNIVERSITY
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Haggblade is professor, Longabaugh is specialist, Boughton is associate professor, Dembelé is assistant professor, Diallo is assistant professor, Staatz is professor, and Tschirley is professor, all in International Development, Department of Agricultural, Food, and Resource Economics, Michigan State University.

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EXECUTIVE SUMMARY

This paper aims to identify the geographic extent of major staple food market sheds in West Africa as well as the major trade corridors that link surplus producing areas with the deficit markets they serve. The method employed combines data on the spatial distribution of rural and urban population, maps of differing food staple zones, crop production data and consumption patterns as described in an array of recent household surveys to map major urban food markets as well as principal surplus production zones. Expert knowledge from traders and other market monitors in the region enable the authors to identify the major commodity flows linking the markets with their major supply zones. These efforts aim to summarize a large volume of information simply and clearly in market shed maps. The paper applies this method to map foodsheds for the region's major domestically produced food staple, sorghum and millet, and the major imported food, rice.

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ACRONYMS

CILSS	*Comite permanent Inter-Etats de Lutte Contre la Secheresse*
CIRAD	*Centre de cooperation international en recherche agronomique pour le developpement*
COMESA	Common Market for Eastern and Southern Africa
DSDI	Direction des Statistiques, de la Documentation et de l'Informatique
FAOSTAT	Food and Agricultural Organization Online Statistical Database
FEWSNET	Famine Early Warning System Network
GIS	Geographic Information System
GRUMP	Global Rural-Urban Mapping Project
IFPRI	International Food Policy Research Institute
INS	*Institut Nationale de la Statistique*
MSU	Michigan State University
ReSAKSS	Regional Strategic Analysis and Knowledge Support System
USAID	United States Agency for International Development
USGS	US Geological Service

1. INTRODUCTION

Over the next generation, growing trade in food staples appears poised to dwarf that in all other African agricultural markets. Currently, the market value of Africa's food staples amounts to $50 billion per year, or nearly three-fourths of the value of all agricultural production (Table 1). Given growing urbanization and the highest rates of poverty in the world, Africa's market demand for food staples will grow dramatically in coming decades. Recent projections suggest that these markets will grow to nearly $100 billion per year over the next decade (Diao and Hazell 2004). As a result, production of food staples – for growing urban markets and food-deficit rural areas – represents probably the largest growth opportunity available to African farmers. Facilitating expansion of these markets will, therefore, be critical for efforts at stimulating agricultural production growth, broad-based income expansion and poverty reduction.

Africa's many surplus producing areas supply these growing food markets in large cities and in deficit rural areas. But unlike many regions of the world, Africa's surplus food production zones frequently lie across national borders from the markets they serve. In part, the importance of cross-border trade in Africa arises from the prevalence of small, landlocked countries – 50 countries in an area two and a half times the size of the United States. Africa's political boundaries, drawn in Berlin in 1885, cut across natural market sheds, impeding the free flow of people and goods. They separate food surplus northern Mozambique from deficit markets in Malawi and eastern Zambia. They cut off surplus zones in eastern Uganda and northern Tanzania from deficit maize markets in Kenya. They separate surplus rice production in southern Mali from deficit markets in Burkina Faso and Mauritania. And they separate livestock producers in Somalia from deficit markets in Kenya. In Africa, political borders frequently separate surplus food production zones from the deficit markets they would normally serve.

Table 1. Size of Agricultural Markets in Sub-Saharan Africa, circa 2000

	Value ($US billions)	Percent
Exports out of Africa		
traditional	8.6	13%
nontraditional	6.1	9%
other	1.9	3%
Intra-Africa trade		
domestic food staples	49.7	73%
other	1.9	3%
Total	68.2	100%

Source: Diao and Hazell (2004).

These political borders translate into a welter of tariffs, export restrictions and other man-made impediments to cross-border trade in food staples. In turn, these impediments to trade raise costs and lower incentives for both farmers and traders while at the same time artificially raising consumer food prices in cross-border deficit zones. Without access to regional export markets, production surges in thinly traded national markets lead easily to price collapses, which in turn risk stalling production growth and private investment in agriculture. In order to maintain producer incentives in Africa's many surplus food production zones, farmers will need reliable access to regional food markets.

This paper aims to identify the geographic extent of major staple food market sheds in West Africa as well as the major trade corridors that link surplus producing areas with the deficit markets they serve. It serves as a companion piece to similar work in eastern and southern Africa (see World Bank 2008) and as a launching pad for future efforts elsewhere in Africa. We consider these efforts necessary for identifying sensible geographic units of intervention and for framing policies that will help to accelerate agricultural growth and improve food security in Africa.

2. CONCEPTS

2.1. Trade Corridors

Surplus production zones sell food staples to traders, who assemble, store or process the foodstuffs. Deficit markets, in turn, source their food supplies from trade networks originating in nearby surplus zones. Trade corridors define the geographic transit lanes that link the supplying and receiving zones.

2.2. Market Sheds

The term *market shed* describes the flow of food from the area where it is grown to the place where it is consumed. Like a watershed, which describes the geographic extent of the surface area capturing and channeling water to a final freshwater outlet to the ocean, a market shed describes the catchment area supplying a major market outlet. A market shed includes at least one deficit market plus the surplus producing areas and trade corridors linking the two. Some people refer to this catchment area as a *foodshed* (Harrison et al. 1974). Others refer to it as a *market basin* (FEWSNET 2009). Like a river with many tributaries and with market towns at junctions and along the way, a market shed typically contains multiple deficit markets. We, therefore, define a market shed as *a network of deficit markets linked by common supply lines*. This definition implies common price movements within the market shed.[1] It also suggests a formal definition from the trade literature as all supplying areas able to serve a given market within import and export parity price bands.

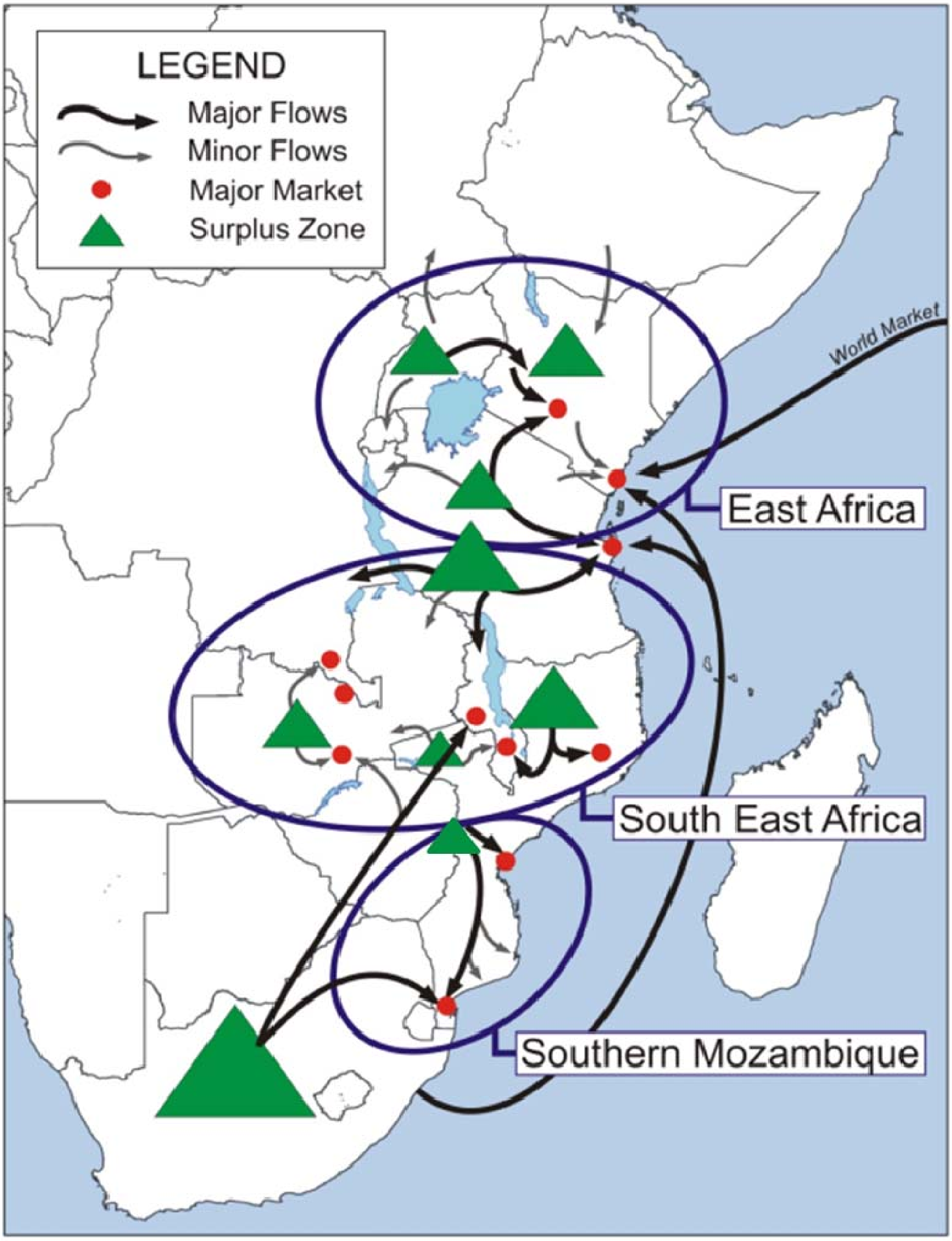
2.3. Mapping Conventions

By convention, this paper displays surplus producing areas as green triangles and major deficit markets as red dots (Figure 1). The green color of the surplus food production represents the abundant chlorophyll in fertile farming areas, while the triangles symbolize physical piles of surplus food. In the same way that water flows down from high mountains, surplus food flows down from the heavily surplus producing areas. Where quantitative spatial data permit, we map these surpluses using three-dimensional Geographic Information System (GIS) tools that depict the volumes of the foothills and mountains as proportional to the relative volumes of surplus food each location supplies (Figure 2). Where traders can offer only notional estimates of relative quantities marketed, we map big triangles and small triangles to represent major and minor surplus zones.

Major deficit markets drain surplus food supplies from surrounding surplus zones. Graphically, this paper depicts these major markets as red circles. Think of them as drains at the bottom of a sink sucking in surplus foodstuffs from the surrounding market basin. In a similar vein, management consultants refer to these major markets as *demand sinks*. The larger the red circle the larger the volume of food purchases in a given market.

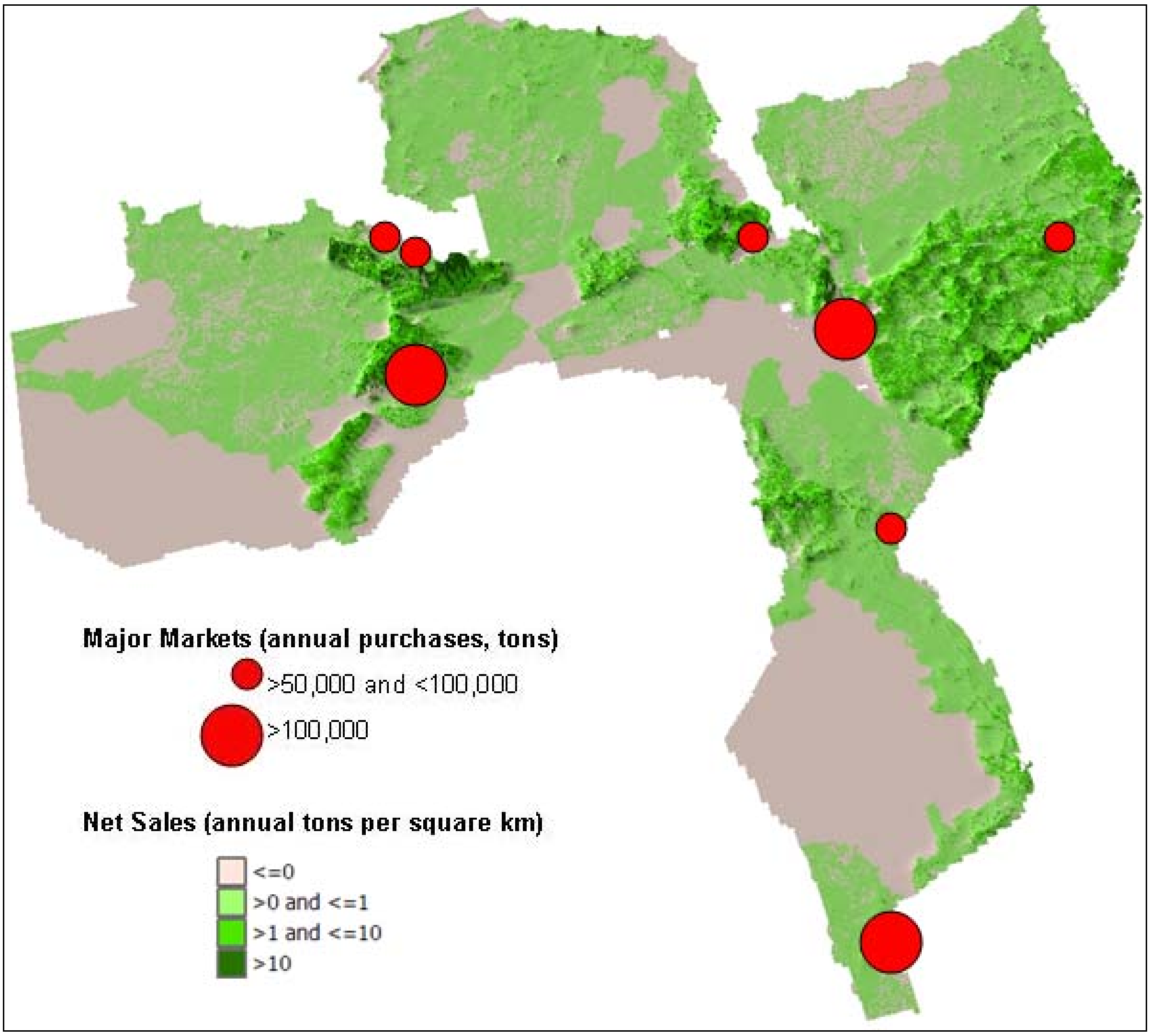
[1] Although prices normally move up and down together within the market shed, the absolute price level differs by location. Areas closest to the producing zones enjoy low food prices while the more distant markets incur higher transport and storage costs and therefore face higher food prices.

Figure 1. Maize Market Sheds in Eastern and Southern Africa



Source: Govereh et al. (2009).

Figure 2. Sales of Maize plus Cassava in South East Africa



Source: Haggblade, Longabaugh, and Tschirley (2009).

Traders move food staples from surplus areas to the deficit markets they serve. In the following market shed maps, black arrows delineate trade corridors and define the direction of the major trade flows (see Figure 1).

2.4. Normal Flows

Many markets experience seasonal changes in the volume of food traded. Indeed, the direction of trade flows may also change from one season to the next. Kenya, for example, typically services its large deficits by importing maize from Uganda and Tanzania, particularly between November and January. Yet despite Kenya's net deficit position, differences in seasonal price movements enable Kenyan traders to export small quantities of maize to Tanzania between July and October (Awuor 2007).

From one year to the next, production shocks in a particular location may change the topography of food surpluses available from exporting agricultural zones. Unlike watersheds, in which mountains remain stable over long periods of time, foodshed mountains may grow or shrink from one year to the next. The magnitude and even the direction of trade flows may change as a result. During drought years, Malawi consistently imports maize, while in exceptional harvest seasons they may export to surrounding countries. Likewise, as production surfaces change so do food prices. Sometimes prices increase by over 100% from one year to the next. As a result, consumers substitute one food for another and the size of the red circles may change. Exogenous income shocks – such as those stemming from declining world prices for a key export commodity or an outbreak of disease – also affect purchasing power and the size of market demand for specific food commodities.

For these reasons, a single map can rarely capture all of the possible sales, purchases, and trade flow permutations. In the case of a recurring deviation from normal – an annual seasonal change in flows or intermittent but recurring drought in a certain region – it is often useful to map market flows in normal and abnormal periods. These alternate maps may prove helpful in contingency planning for recurring food emergencies.

3. STAPLE FOODS

3.1. Consumption

Maize and cassava provide the number one and number two sources of calories in Sub-Saharan Africa (Table 2). However, consumption patterns differ quite dramatically by region, as well as by agro-ecological zones within a given region. In southern and eastern Africa, maize clearly dominates consumption baskets, while cassava and wheat serve as secondary staples. In central Africa, cassava provides the largest source of calories, with wheat and sorghum serving as supplementary staples. In coastal West Africa, rice provides the single largest source of calories, with cassava and maize close behind. In the Sahel, millet furnishes the largest volume of calories, with sorghum and rice playing secondary roles. Nigerians, with the continent's most varied consumption basket, consume a blend of sorghum, millet, rice, cassava, yams, maize, and wheat. In terms of food security, the importance of various food commodities clearly differs across locations.

3.2. Production

As a source of farm income, food products dominate African agriculture. Food commodities account for 18 of the top 20 sources of agricultural revenue in Sub-Saharan Africa. Collectively, they contribute $58 billion out of $62 billion in annual agricultural sales (Table 3).

Within food products, livestock and non-cereals predominate. Beef and cow milk together generate roughly $12 billion in annual sales, accounting for 20% of the value of the top 20 agricultural products. Poultry, eggs and sheep meat earn farm households an additional $5 billion in annual sales.

Non-cereal crops – such as cassava, yams, plantains, groundnuts, and vegetables – likewise generate significant sources of farm revenue. Although pricing valuations merit some scrutiny[2], these non-cereals form an important component of farm incomes, particularly along the west coast and in central parts of Africa. Livestock earnings, particularly beef and cow milk, loom largest in the highlands of eastern Africa.

3.3. Key Staples

The importance of individual food staples clearly differs by region. Rankings also differ depending on whether income or food security governs selection criteria. For purposes of the following discussion, this paper will explore the spatial distribution of consumption and production for the following food commodities: maize, cassava, sorghum and millet (considered together), beef, rice, yams, and wheat. Our interest in West Africa motivates the selection of yams. And rapid changes in urban consumption patterns motivate our interest in wheat.

[2] FAOSTAT prices appear to value fresh cassava at the same rate as maize and yams at double the price of maize.

Table 2. Caloric Consumption in Sub-Saharan Africa (SSA), by Staple Food and Sub-Region in 2003

	SSA	West Africa			Central	Eastern			Southern
		Sahel	Coastal	Nigeria		Horn	East	SouthEast	
Cereals	1,073	1,684	934	1,253	776	1,173	792	1,095	1,512
maize	*371*	*191*	*307*	*179*	*160*	*332*	*520*	*854*	*969*
sorghum	*177*	*374*	*64*	*362*	*221*	*183*	*50*	*53*	*29*
millet	*123*	*604*	*36*	*294*	*64*	*27*	*43*	*17*	*11*
rice	*192*	*372*	*441*	*284*	*66*	*7*	*88*	*69*	*166*
wheat	*173*	*122*	*116*	*127*	*223*	*318*	*98*	*113*	*327*
Starchy roots	402	29	676	511	501	157	453	395	87
cassava	*252*	*15*	*371*	*249*	*447*	*12*	*255*	*332*	*0*
yams	*64*	*4*	*231*	*204*	*19*	*124*	*1*	*0*	*19*
sweet potato	*34*	*7*	*11*	*37*	*16*	*9*	*126*	*5*	*2*
Sugar and sweeteners	121	108	89	108	106	48	107	168	318
Pulses	85	82	38	88	64	112	161	72	42
Oilcrops	63	75	98	90	70	9	63	46	24
groundnuts	*37*	*69*	*66*	*39*	*61*	*1*	*15*	*48*	*13*
Vegetable oils	191	182	257	335	176	46	111	134	295
Vegetables	25	25	30	44	22	9	21	10	31
Fruits	82	12	128	84	62	17	153	34	68
Stimulants	2	1	4	1	1	3	3	1	2
Spices	6	4	8	12	4	13	2	2	4
Alcoholic beverages	49	23	23	84	23	11	84	21	103
Meat	67	78	54	39	68	42	52	43	205
beef	*28*	*29*	*13*	*12*	*29*	*26*	*34*	*19*	*75*
poultry	*12*	*12*	*15*	*4*	*8*	*2*	*5*	*8*	*72*
goats and sheep	*10*	*22*	*5*	*7*	*14*	*6*	*7*	*2*	*18*
Animal fats	11	15	5	7	9	12	10	14	19
Dairy	61	71	21	24	80	40	83	20	117
Fish	13	17	32	14	14	1	11	6	14
Total	2,266	2,404	2,396	2,714	1,977	1,694	2,106	2,061	2,843

Source: FAOSTAT Food Balance Sheets.

Table 3. Value of Agricultural Production in Sub-Saharan Africa, 2007

Top 20 Agricultural Commodities	Sub-Saharan Africa: Value $ billions	Value % value	Quantity million tons	Price $/ton
Indigenous Cattle Meat	7.8	12%	3.8	2,068
Cassava	7.5	12%	105.0	71
Yams	7.2	12%	44.5	163
Plantains	4.9	8%	24.4	200
Groundnuts, with shell	4.1	7%	9.2	450
Cow milk, whole, fresh	3.9	6%	14.8	263
Maize	3.4	5%	47.7	72
Rice, paddy	2.9	5%	14.4	203
Vegetables fresh nes	2.6	4%	13.9	188
Millet	2.6	4%	17.5	146
Potatoes	2.3	4%	18.0	129
Indigenous Chicken Meat	2.2	4%	1.9	1,166
Cocoa beans	2.2	3%	2.8	770
Sorghum	2.1	3%	19.4	108
Cotton lint	1.7	3%	1.1	1,484
Indigenous Sheep Meat	1.3	2%	0.7	1,978
Hen eggs, in shell	1.2	2%	1.5	800
Tomatoes	0.9	1%	3.7	237
Grapes	0.9	1%	1.9	464
Wheat	0.7	1%	5.0	146
Sum	62.5	100%		

Source: FAOSTAT.

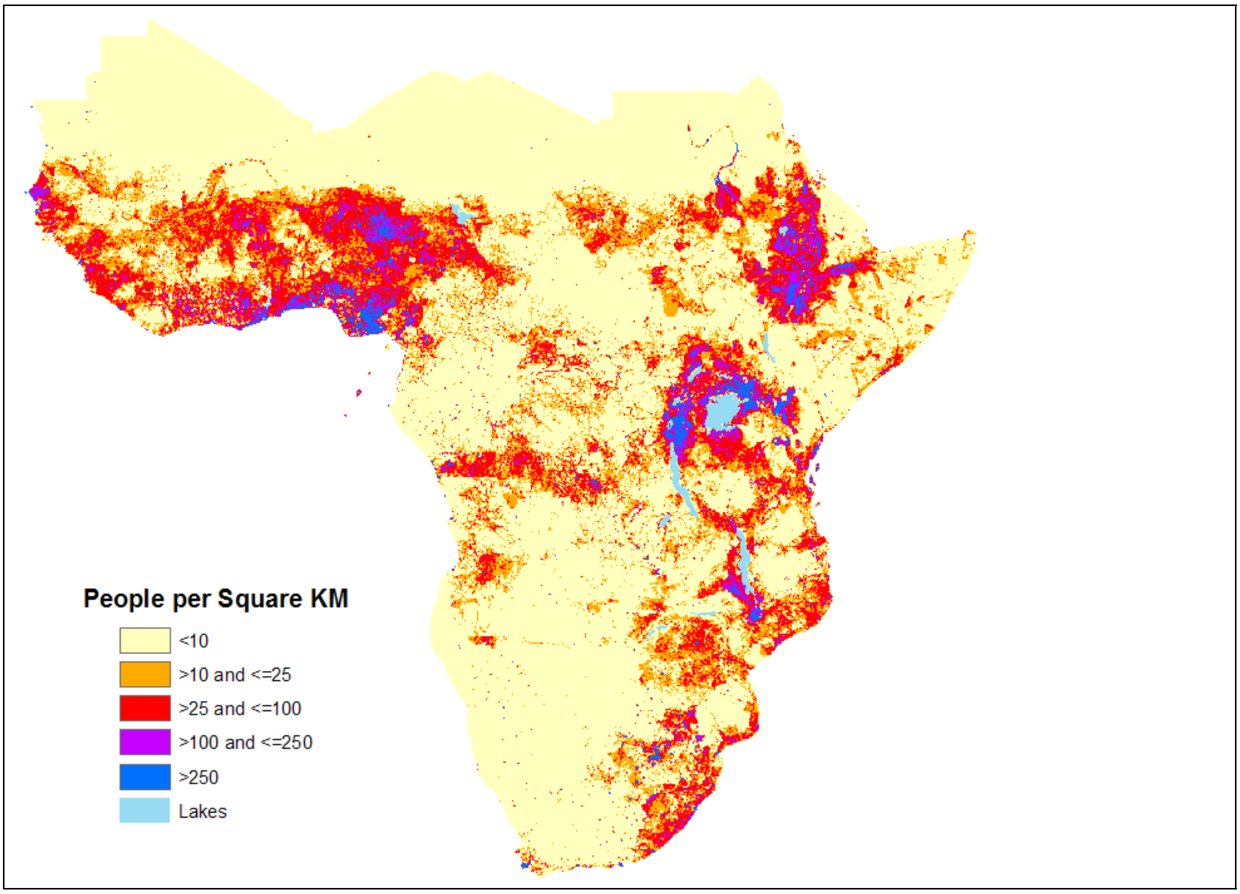
4. MARKETS

4.1. Population Clusters

The purchasing power in major deficit markets provides the central gravitational pull in African food market sheds. Therefore, the first step in mapping food marketing flows involves mapping the location and relative size of these net purchasing centers.

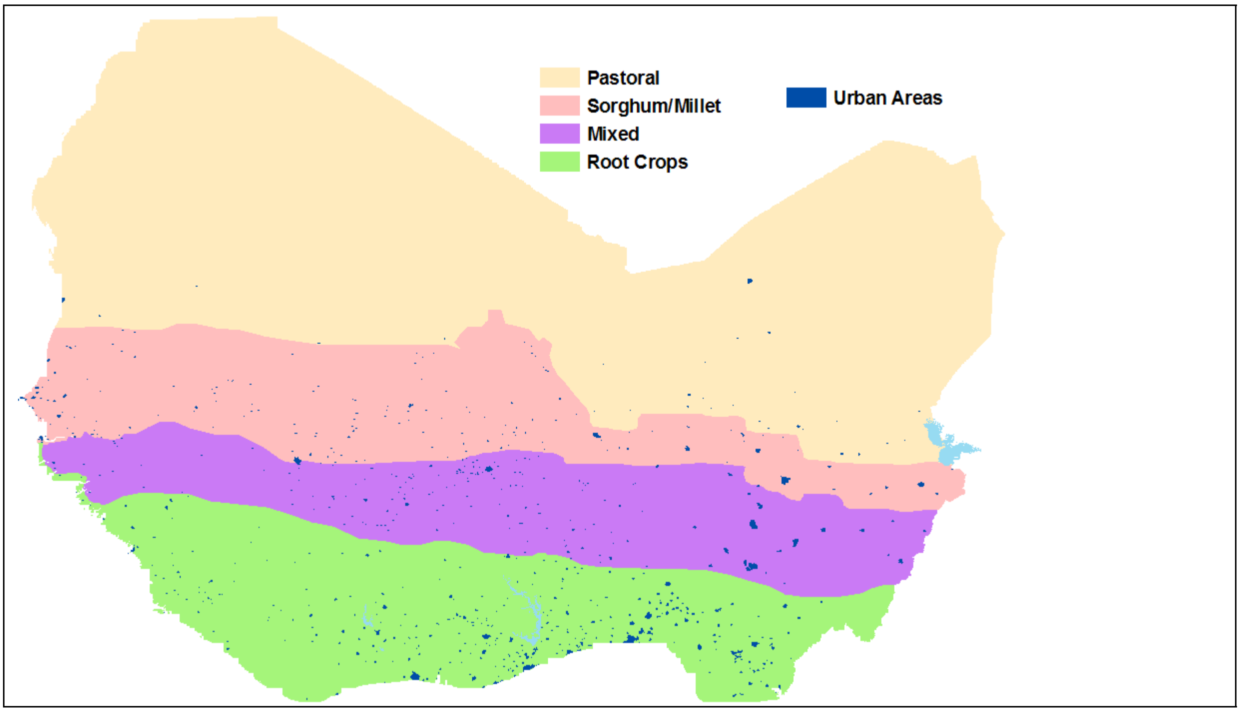
This effort begins by mapping the geographic distribution of rural and urban population. Spatially, such an exercise reveals three major population clusters in Sub-Saharan Africa. The first, centered in Nigeria, includes spillovers along the West African coast, emanating from Lagos, as well as a similar east-to-west corridor in the Sahel, centered in Kano. The second major concentration of population arises in the Ethiopian highlands. A third population center, also in the east African highlands, encircles the Great Lakes (Figure 3). Smaller clusters of high population density emerge in Malawi, in parts of South Africa and along the Congo River basin from Kinshasa and Brazaville upriver to Mguji-Mayi.

Figure 3. Population Distribution in Sub-Saharan Africa



Source: Landscan (2007).

Figure 4. Food Staple Zones in West Africa



Source: Dixon, Gulliver, and Gibbon (2001).

Because consumption patterns and income levels differ in urban and rural areas, it is necessary to distinguish spatially between rural and urban population. Figure 4 displays the location of all urban areas in West Africa with population in excess of 100,000 people.

4.2. Regional Differences in Food Consumption

Tastes, preferences, and relative food prices differ across regions. As a result, so does the composition of staple food baskets.

As a rough first approximation, it is possible to summarize FAOSTAT food consumption data by broad regional country groupings. When applied to West Africa, these figures offer a general sense of consumption differences across agro-ecological zones (see Appendix Table A.6). This rough zonal approximation is not fully satisfactory, however, because many countries cut across a range of agro-ecological zones. In West Africa, Nigeria, in particular, covers the full range of agro-ecological zones, from humid coastal areas where root crops dominate food consumption, through to pastoral zones where livestock, millet, and sorghum form the basis of food economy.

Rather than country-based zonal aggregations (as in Table 1), we prefer to define geographically based food staple zones. Using West Africa as a test case, Figure 4 demonstrates one way to go about defining different food staple consumption zones. This spatial breakdown begins by mapping the agro-ecologically based farming systems as defined by Dixon, Gulliver, and Gibbon (2001). We then piece together evidence from micro-level consumption surveys to estimate how the relative consumption of basic food staples differs across the region[3]. Cassava and yam consumption is highest along West Africa's coastal belt, while sorghum and millets dominate in the Sahelian zones. Both maize and cassava co-exist in the intermediate, mixed-staple zone. Consumption surveys offer estimates of the relative consumption share in each zone, while the aggregate food balance sheets and spatial distribution of rural and urban population across the various zones (Figures 3 and 4) enable us to estimate rural and urban consumption across food staple zones. Aggregate consumption figures, by country and for the region as a whole, are available from national food balance sheets (FAOSTAT). So it is possible to use the micro-level consumption survey data to project the relative share of each staple's consumption across zones, the spatial data to distribute population across space, and the aggregate food balances sheets to ensure consistency with the aggregate food balance sheet for the region. Table 4 summarizes the resulting per capita consumption estimates.

Table 4. Rural and Urban Staple Food Consumption in West Africa

		Food Consumption (kilograms/person/year)								
Food staple zone	Population (millions)	maize	sorghum + millet	cassava*	wheat	rice	yams*	beef	poultry	sheep + goat
Pastoral zone										
rural	8	15	163	0	2	1	0	7	1	6
urban	2	6	61	0	30	26	0	11	2	9
total	10	13	142	0	7	7	0	8	1	7
Sorghum/millet zone										
rural	41	21	223	2	5	10	1	4	1	3
urban	17	17	100	4	25	57	0	11	2	4
total	58	20	188	3	10	23	0	6	2	3
Mixed cereals and rootcrops										
rural	47	37	122	16	6	17	21	1	2	1
urban	10	57	43	25	34	48	13	3	4	2
total	57	41	109	17	11	22	20	1	3	1
Root crop zone										
rural	81	22	3	55	7	43	39	1	2	1
urban	60	21	1	40	44	50	14	3	5	3
total	141	22	2	49	23	46	29	2	3	2
West Africa total										
rural	177	26	93	30	6	27	24	2.0	1.8	1.8
urban	88	24	26	31	39	51	11	4.9	4.5	3.1
total	265	25	70	30	17	35	20	3.0	2.7	2.2

* Population figures differ among sources. These population data come from the Global Rural-Urban Mapping Project (GRUMP). Appendix 3, Table A.6 summarizes the differences across sources.
Source: FAOSTAT; GRUMP; Alderman (1990); Teklu (1996); Bricas, Thirion, and Zoungrana (2009); Benin (2010); Burkina Faso (2010); Lamine and Sylla (2010); Mali (2010); Tape et al. (2010); Ibrahima and Ekade (2011); and Togo (2010).

[3] See, for example, Alderman (1990), as well as reviews by Teklu (1996); Bricas,Thirion, and Zoungrana (2009); Benin (2010); Burkina Faso (2010); Lamine and Sylla (2010); Mali (2010); Tape et al. (2010); Ibrahima and Ekade (2011); and Togo (2010).

4.3. Major Urban Staple Food Markets

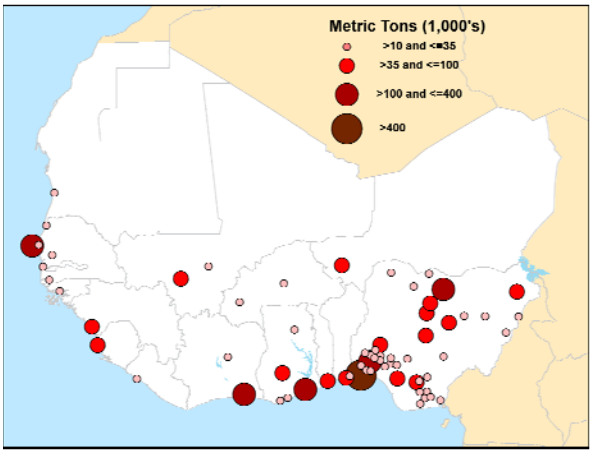
Because urban areas provide the most geographically concentrated deficit food markets in West Africa, our mapping of food market sheds begins by quantifying the level of staple food consumption in African cities. This effort starts with the geographic mapping of all cities with populations of over 100,000 (Figure 4). Multiplying the population figures for each city by the per capita consumption for that city's food staple zone (Table 4) allows us to estimate the approximate annual volume of staple food consumption in each of West Africa's major urban centers.

Figures 5 and 6 map the resulting distributions of urban demand for starchy staples (cereals, roots, and tubers) and meats, respectively. These maps provide the red circles that designate the major food markets in West Africa.

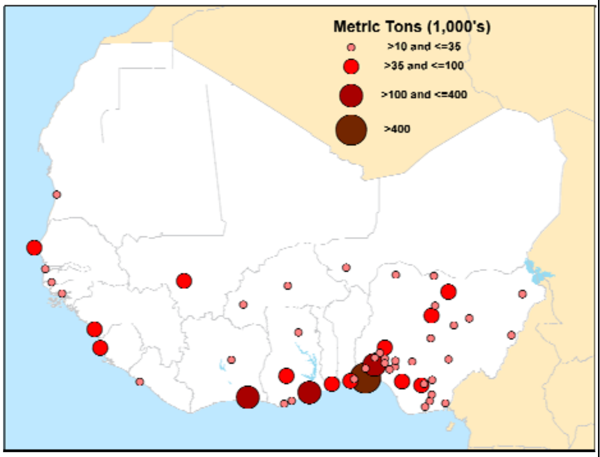
But where are the green triangles? Where are the centers surplus food production and sale serving these deficit markets?

Figure 5. Major Urban Staple Food Markets in West Africa

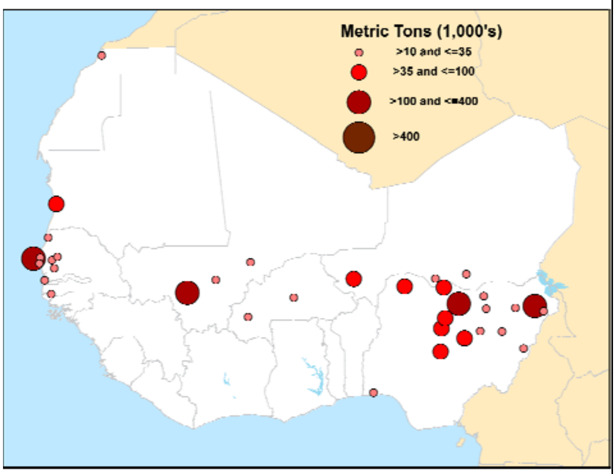
a. Rice



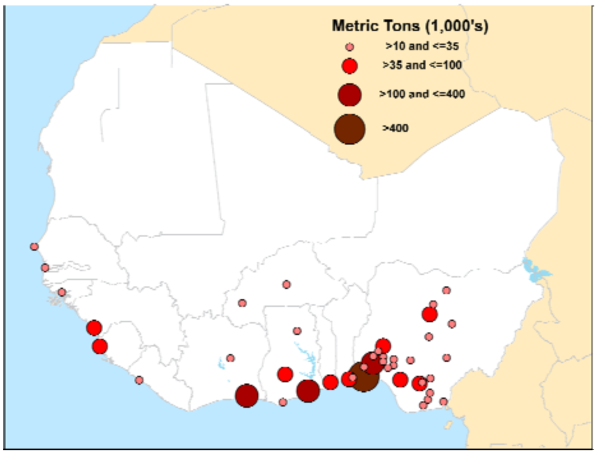
b. Wheat



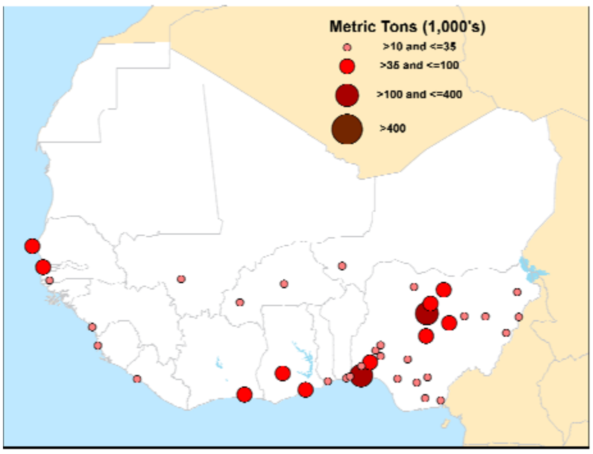
c. Sorghum plus Millet



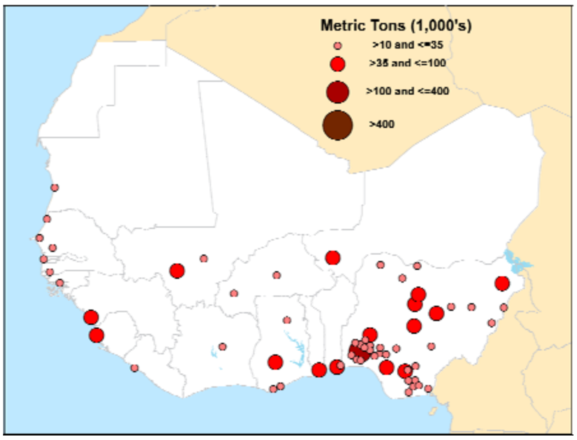
d. Cassava



e. Maize



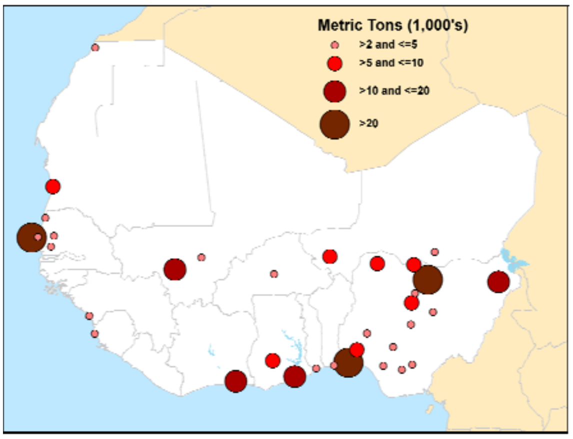
f. Yams



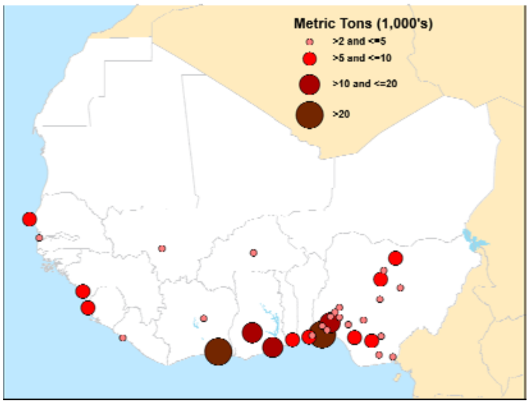
Source: Authors.

Figure 6. Major Urban Meat Markets in Sub-Saharan Africa

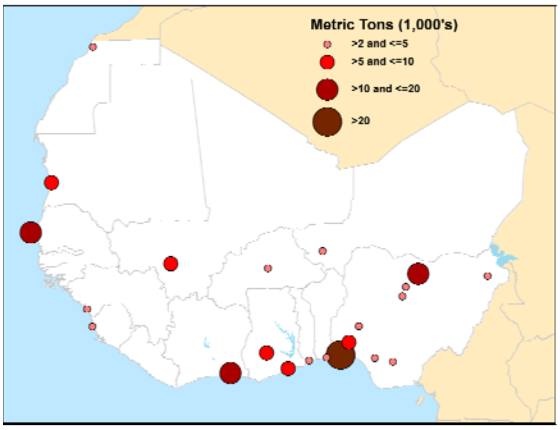
a. Beef



b. Chicken



c. Sheep plus Goat Meat



Source: Authors.

5. SURPLUS PRODUCTION ZONES

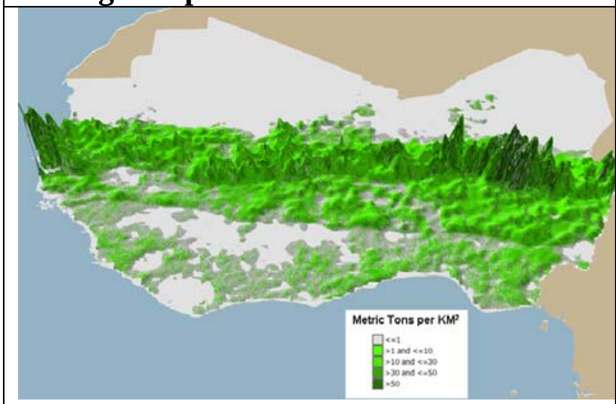
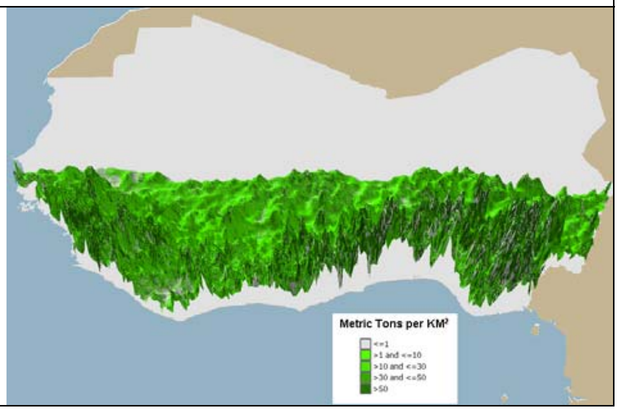
5.1. Alternate Methods for Mapping Surplus Zones

Food production is typically more geographically dispersed than consumption. Because farm households normally walk no more than one hour each way to their fields, the spatial distribution of rural population offers a good indication of where farm production takes place. The Landscan gridded population data base, produced using high-resolution satellite imagery, enables identification of the spatial distribution of rural population per square kilometer.[4]

As a coarse first approximation, it is possible to multiply average per capita production (or net sales) in a particular food staple zone by the rural population in each square kilometer grid cell. Figure 7 displays the resulting spatial distribution of sorghum plus millet and cassava production in West Africa under the assumption of uniform per capita production across each food staple zone.

But, in reality, per capita production and net sales are not uniformly distributed across space even within a single food staple zone. Net sales, in particular, often cluster geographically in high-potential and easily accessible agricultural zones. Therefore, the mapping of large centers of surplus food sales – the green triangles in our market shed maps – will require more than simply knowing the spatial distribution of farm population and average per capita production and sales levels in a given zone. To realistically depict the spatial distribution of market sales will require some way of identifying and measuring the rural areas producing large food surpluses for sale.

Figure 7. Staple Food Production in West Africa, Assuming Uniform per Capita Production across Rural Population in Each Food Staple Zone

a. Sorghum plus millet	b. Cassava
	

Source: Authors.

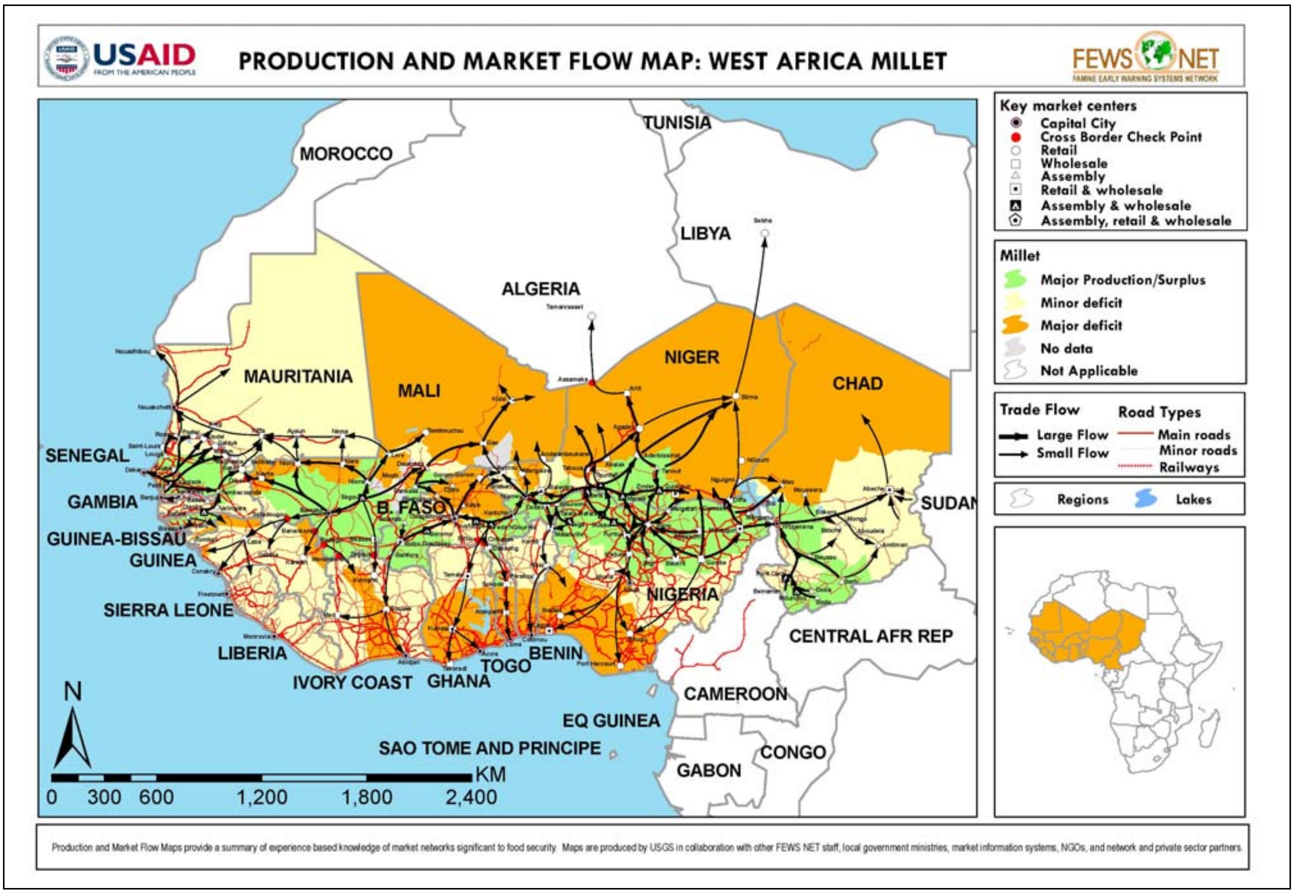
[4] See Haggblade, Longabaugh, and Tschirley (2009) for a discussion of alternative spatial population data bases. Field verifications conducted by FEWSNET staff suggest that the Landscan data base provides the best available estimate of the spatial distribution of rural population in Sub-Saharan Africa.

At least three different approaches are possible. The first method for spatially distributing production and sales across space involves the use of subnational production and sales data. A second possible allocation method involves spatial modeling which distributes national production (or sales) across space using gridded data on agro-ecological properties (rainfall, length of growing period, temperature, and slope) sometimes in combination with maps of irrigated areas and commercial farming blocks. The third method revolves around the use of expert local knowledge.

5.2. Data and Method Adopted

In the absence of subnational production and marketing data, this paper combines elements of methods two and three in order to spatially map surplus production zones for key West African food staples. This effort begins with the Famine Early Warning System Network (FEWSNET) maps summarizing expert local knowledge about food surplus and deficit zones in West Africa. Figure 8 displays the FEWSNET map of surplus millet-selling zones in West Africa. This map indicates surplus and deficit zones, though not the volumes produced or sold.

Figure 8. FEWSNET Map of Surplus Millet Selling Zones in West Africa

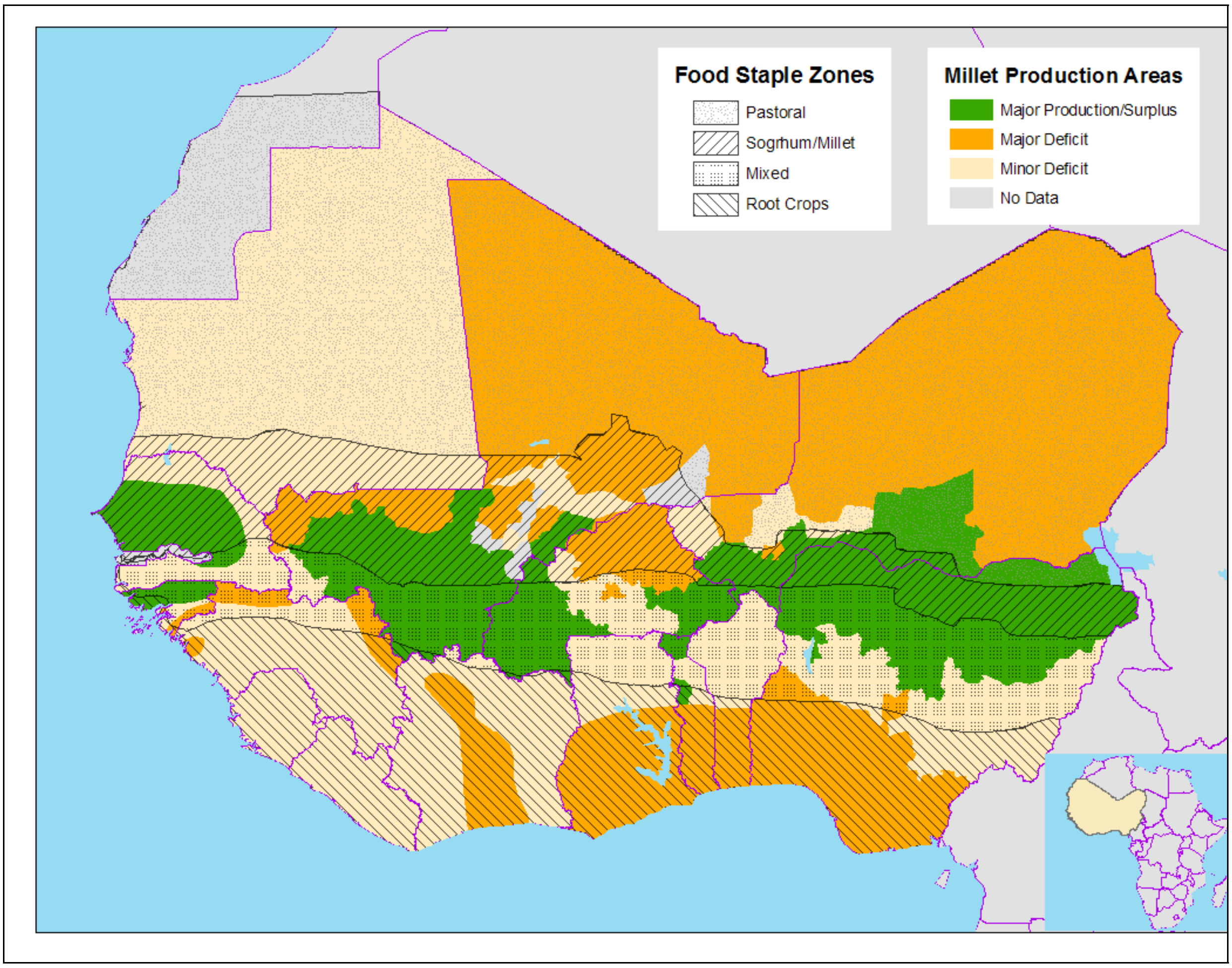


Source: FEWSNET.

To quantify the total marketed volumes of each staple food, we combine available data on production, consumption, and imports (Table 5). These data reveal that rice is the most widely marketed food staple in West Africa[5], with roughly 5.7 million tons purchased and sold. Wheat follows with 4.1 million tons marketed, sorghum and millet with 3.6 million tons, cassava with 3 million tons of dried equivalents[6] and maize with 2.4 million tons (Table 5).

In order to map these marketed volumes spatially across West Africa, we break down the region into polygons that reflect differences in marketing intensity. The partitions used overlay spatial maps of country boundaries, food staple zones (Figure 4) and FEWSNET-designated surplus and deficit zones (Figure 8). The resulting partitioning is displayed in Figure 9.

Figure 9. Millet Production Areas Overlaid on Food Staple Zones



Sources: Figures 4 and 8.

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[5] West Africa includes the countries mapped in Figure 9.

[6] Because fresh cassava is two-thirds water and because a majority of cassava trades in dried, processed form – as gari, a pre-cooked, toasted convenience food – these figures convert all cassava (and yams) to dried weight equivalents using cassava-to-maize cassava calorie equivalents of 0.31 kilograms of dried weight for each kilogram of fresh cassava.

Table 5. Indicators of Marketed Volumes of Staple Foods in West Africa

	Staple Foods ('000 tons)								
	maize	sorghum + millet	cassava*	wheat	rice	yams*	beef	poultry	sheep + goat
Consumption									
rural	4,182	15,114	4,854	958	4,375	3,860	327	301	287
urban	1,949	2,103	2,539	3,163	4,123	912	397	367	249
total	6,131	17,217	7,392	4,121	8,498	4,772	725	668	535
Availability (fresh weight)									
production (Q)	9,897	23,948	51,541	81	4,994	36,298	703	504	532
imports (M)	317	8	21	4,246	5,030	2	22	169	3
exports (X)	27	3	27	131	45	17	0	4	0
availability (Q+M-X)	10,187	23,952	51,536	4,195	9,978	36,283	724	668	535
Purchases									
Urban consumption	1,949	2,103	2,539	3,163	4,123	912	397	367	249
Rural purchases									
estimated share purchased**	10%	10%	10%	100%	35%	10%	0%	0%	0%
estimated rural purchases	418	1,511	485	958	1,531	386	-	-	-
Total purchases	2,367	3,614	3,024	4,121	5,654	1,298	397	367	249
Sales									
net imports	290	4	(6)	4,115	4,985	(15)	21	165	3
marketing from domestic production***	2,077	3,610	3,030	7	669	1,313	376	203	246
Total sales	2,367	3,614	3,024	4,121	5,654	1,298	397	367	249
Sources of marketed supply									
Imports	12%	0%	0%	100%	88%	-1%	5%	45%	1%
Sales from domestic production	88%	100%	100%	0%	12%	101%	95%	55%	99%
Total marketed	100%	100%	100%	100%	100%	100%	100%	100%	100%
Indicators of marketed share									
urban share of total consumption	32%	12%	34%	77%	49%	19%	55%	55%	46%
urban share of marketed volumes	82%	58%	84%	77%	73%	70%	100%	100%	100%
import share of total availability	3%	0%	0%	98%	50%	0%	3%	25%	1%
share of domestic production marketed	21%	15%	6%	8%	13%	4%	53%	40%	46%

* Root crops (cassava and yams) converted to dry weight as maize calorie equivalents = fresh weight x 0.31.
** Key informant estimates.
*** Computed as a residual as total purchases minus net imports.
Source: FAOSTAT, GRUMP, key informant interviews, and Table 4.

Next, we estimate per capita sales of each staple food for each surplus polygon in Figure 9. The example below uses West Africa's number one food staple (sorghum plus millet) as an example. Given negligible imports into the region, West African farmers produce virtually all of the 3.8 million tons of millet and sorghum marketed within the region (see Table 5). By overlaying Landscan population data onto Figure 9, and summing rural population in each polygon, we estimate that about 36 million rural people live in the surplus (green) sorghum and millet growing areas. On average, this results in sorghum plus millet sales of 100 kilograms per capita in the surplus zones.

This average marketing volume masks probably significant variation in marketing intensity across the region. Ideally, farm-level data on marketed volumes, by location, would be available to estimate differences in marketing intensity across the surplus zones. Given an absence of spatially disaggregated micro-level marketing data, we have instead adopted a set of decision rules described in Annex 2. Table 6 displays the resulting average per capita sales within each country, surplus area, and food staple zone.

Given these per capita sales figures, the Landscan population grid enables us to allocate total millet and sorghum sales across West Africa in 1 square kilometer grids by multiplying the population in each square kilometer by the corresponding per capita millet and sorghum sales figure from Table 6. Figure 10a displays the resulting three-dimensional map of the geographic distribution of sorghum and millet sales from across West Africa. For a more simplified schematic representation, we can depict the large aggregate selling zones as green triangles, as in Figure 10b.

The following market shed maps combine the schematic market surplus maps (using green triangles) with the major deficit urban markets (red circles), adding arrows to indicate the major supply links and direction of trade flows in normal years.

Table 6. Sales of Sorghum plus Millet in Surplus Areas, by Country and Food Staple Zone

a. Per capita Sales (Kilograms per Person per Year)

	Food Staple Zones				
	Pastoral	Sorghum/ millet	Mixed	Root Crop	Total
Senegambia					
Senegal	0	43	65	0	44
Gambia	0	0	0	0	0
Mauritania	0	0	0	0	0
Coastal West Africa					
Guinea	0	0	0	0	0
Guinea-Bissau	0	0	6	2	5
Sierra Leone	0	0	0	0	0
Liberia	0	0	0	0	0
Mali-Burkina Cotton Belt					
Mali	0	72	108	36	87
Burkina	0	60	90	30	87
Gold Coast					
Côte d'Ivoire	0	0	0	0	0
Ghana	0	0	0	0	0
Togo	0	0	106	35	90
Greater Nigeria Basin					
Nigeria	46	92	138	0	111
Niger	72	144	216	0	120
Benin	0	0	0	0	0
Total West Africa	61	88	122	20	100

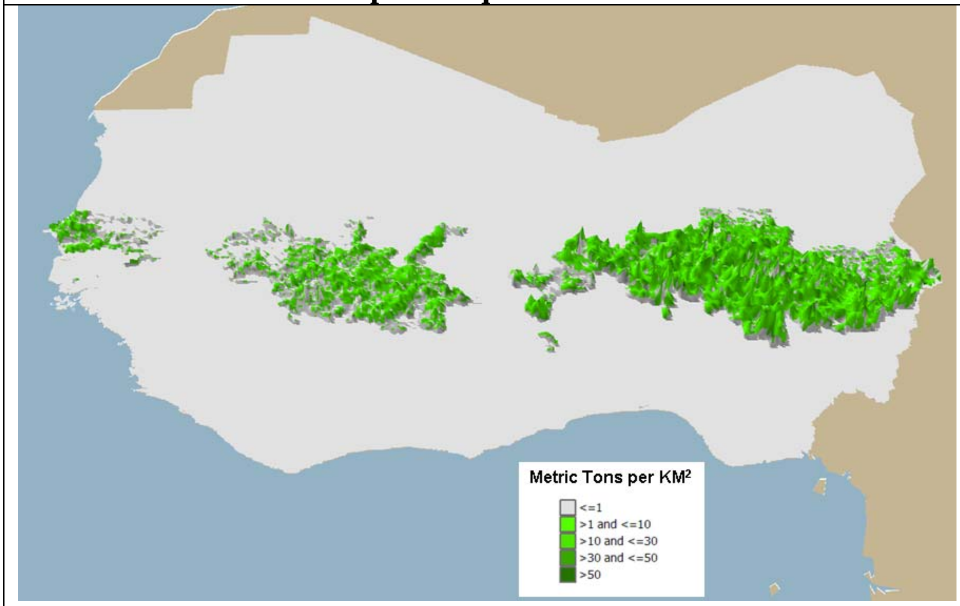
b. Total Sales ('000 Tons per Year)

	Food Staple Zones				
	Pastoral	Sorghum/ millet	Mixed	Root Crop	Total
Senegambia					
Senegal	0	123	6	0	129
Gambia	0	0	0	0	0
Mauritania	0	0	0	0	0
Coastal West Africa					
Guinea	0	0	0	0	0
Guinea-Bissau	0	0	2	0	3
Sierra Leone	0	0	0	0	0
Liberia	0	0	0	0	0
Mali-Burkina Cotton Belt					
Mali	0	191	215	1	407
Burkina	0	14	252	1	267
Gold Coast					
Côte d'Ivoire	0	0	0	0	0
Ghana	0	0	0	0	0
Togo	0	0	33	3	36
Greater Nigeria Basin					
Nigeria	59	861	1,343	0	2,263
Niger	119	343	47	0	509
Benin	0	0	0	0	0
Total West Africa	178	1,532	1,899	6	3,614

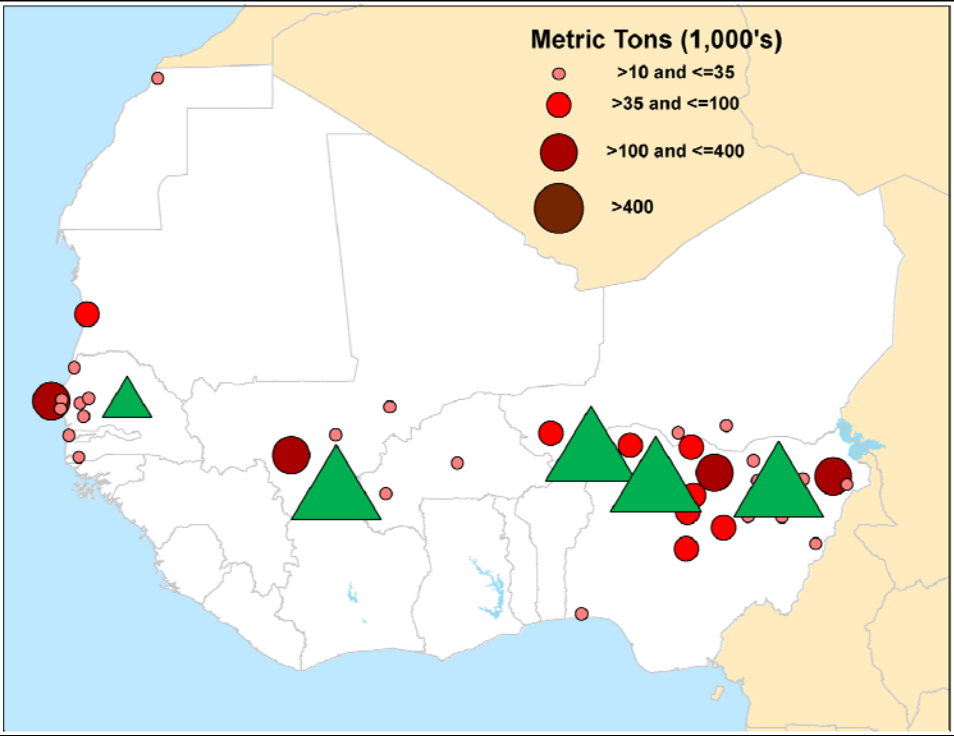
Source: Authors' calculations based on FAOSTAT, FEWSNET, Landscan.

Figure 10. Surplus Sorghum and Millet Selling Zones of West Africa

a. Three-dimensional Map at 1 Square Kilometer Grids



b. Schematic Representation of Major Surplus Zones and Urban Markets



Source: Authors.

6. ILLUSTRATIVE FOOD MARKET SHEDS IN WEST AFRICA

This section produces market shed maps for the two most important food staples in West Africa. Sorghum and millet, indigenous to West Africa, remain the largest source of staple calories in the region. Rice, the region's second largest source of calories, is also the region's biggest food import and, by volume, the most heavily marketed food commodity in the region (Table 5).

6.1. Sorghum and Millet

Production of sorghum and millet, the longstanding dietary staples across the Sahel, has roughly tripled over the past three decades, growing from roughly 10 million metric tons in 1980 to 30 million tons in recent years (FAOSTAT). Growth has remained concentrated in two major breadbasket zones, the first a dense cluster of farms across northern Nigeria and spilling into southern Niger, with a second, smaller cluster centered in Burkina Faso and Mali (Table 7). These two traditional surplus zones have grown steadily in the past decades, with production growth concentrated in northern Nigeria and Burkina Faso (Bricas, Thirion, and Zoungrana 2009). A third, much smaller production zone in Senegal has diminished over time in response to consumption competition from imported rice and to a lesser extent wheat (Soulé and Gansari 2010).

Growth in marketed volumes has increased more rapidly than production, driven by rapid urbanization and increased cross-border trade, particularly since the major droughts of the 1970s (Soulé and Gansari 2010). Traders and farmers in the major surplus zones serve the nearby cities across the Sahel, where trade centers in three distinct, though sometimes overlapping market basins (Figure 11)

The Eastern Market Shed dominates sorghum and millet production and traded volumes. Pairs of linked assembly markets line the Niger-Nigeria border. Dawanau market in Kano (northern Nigeria) serves as the largest wholesale cereal market in West Africa with traders there marketing 2 to 3 million tons of cereal per year, primarily sorghum and millet (Soulé and Gansari 2010).

In the Central Market Shed, surplus sorghum and millet zones of Burkina Faso and southern Mali serve the major nearby urban markets of Bamako, Ouagadougou, Bobo Dialaso and other nearby cities in northern Ivory Coast and northern Ghana.

In recent decades, sorghum and millet have diminished in importance in the Western Market Shed. Production of these coarse grains has fallen over time, largely at the expense of growing rice production and imports. Small, localized trade serves the major cities. Occasional surplus flows from Mali have been generally replaced with rice in recent years.

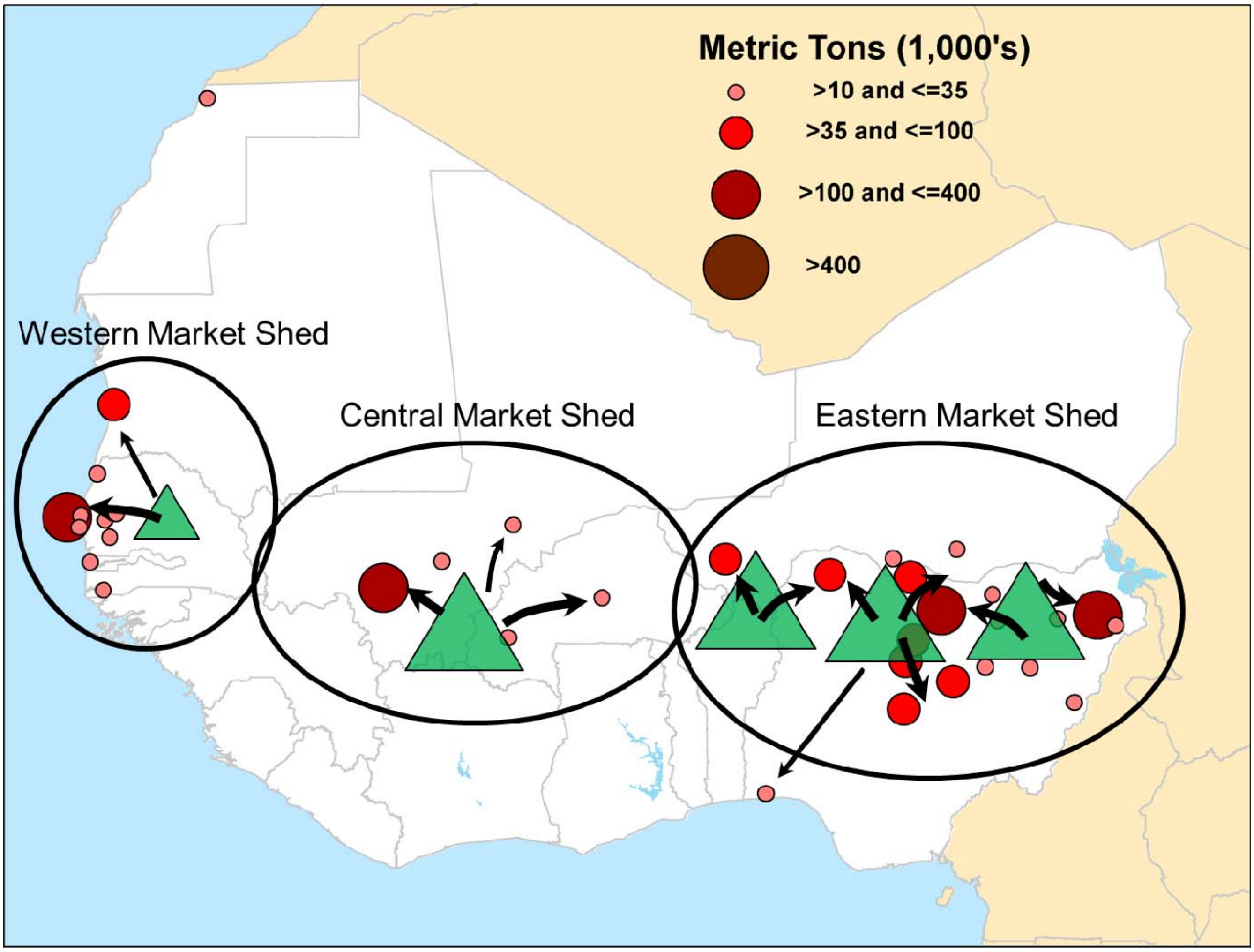
Table 7. Sorghum and Millet Commodity Balances in West Africa, 2003

	Commodity Balances ('000 tons)				Supply Shares		
	production	imports	exports	consumption	production	net imports	total
Western market shed							
Greater Senegambia							
Senegal	818	0	0	495	1.00	0.00	1.00
Gambia	125	1	-	95	0.99	0.01	1.00
Mauritania	68	1	-	59	0.99	0.01	1.00
Coastal West Africa							
Guinea	17	-	-	13	1.00	0.00	1.00
Sierra Leone	31	-	-	24	1.00	0.00	1.00
Liberia	-	-	-	26	0.00	1.00	1.00
subtotal	1,060	2	0	712	1.00	0.00	1.00
Central market shed							
Mali-Burkina Cotton Belt							
Mali	1,465	0	0	1,291	1.00	0.00	1.00
Burkina Faso	2,795	0	2	2,056	1.00	0.00	1.00
Gold Coast							
Ivory Coast	93	-	0	57	1.00	0.00	1.00
Ghana	513	5	0	333	0.99	0.01	1.00
Togo	227	0	0	144	1.00	0.00	1.00
subtotal	5,093	5	3	3,881	1.00	0.00	1.00
Eastern market shed							
Nigeria	14,310	0	1	10,110	1.00	0.00	1.00
Niger	3,220	0	-	2,339	1.00	0.00	1.00
Benin	228	-	-	175	1.00	0.00	1.00
subtotal	17,758	1	1	12,624	1.00	0.00	1.00
Total West Africa	23,948	8	3	17,217	1.00	0.00	1.00

Shading:
- large surplus supplier (dark grey)
- medium surplus zone (light grey)

Source: FAOSTAT.

Figure 11. Sorghum and Millet Market Sheds in West Africa during a Normal Year



Sources: Figure 5a, FEWSNET (2009), Africa Crossborder (2006), Soulé and Gansari (2010).

6.2. Rice

Rice is the most widely marketed food in West Africa, with about 5.7 million tons of milled rice marketed each year. At these levels, rice volumes marketed exceed wheat (4.1 million tons) and sorghum and millet (3.6 million tons) by about 40% to 60%, cassava (3 million tons) by 90% and other food staples by over 100% (Table 5). West African farmers produce roughly half of all rice consumed in the region, while traders import the remaining half, primarily from Asia. Imports, however, account for nearly 90% of marketed volumes (Table 8).

Table 8. Rice Commodity Balances in West Africa, 2003

	Commodity Balances ('000 tons)				Supply Shares		
	production	imports	exports	consumption	production	net imports	total
Western market shed							
Greater Senegambia							
Senegal	155	886	33	774	0.15	0.85	1.00
Gambia	14	77	0	55	0.15	0.85	1.00
Mauritania	51	39	-	86	0.57	0.43	1.00
Coastal West Africa							
Guinea	600	332	0	638	0.64	0.36	1.00
Sierra Leone	177	145	-	382	0.55	0.45	1.00
Liberia	67	101	2	160	0.40	0.60	1.00
subtotal	1,063	1,580	35	2,094	0.41	0.59	1.00
Central market shed							
Mali-Burkina Cotton Belt							
Mali	626	31	-	664	0.95	0.05	1.00
Burkina Faso	64	137	1	192	0.32	0.68	1.00
Gold Coast							
Côte d'Ivoire	634	818	3	1,010	0.44	0.56	1.00
Ghana	159	331	0	453	0.32	0.68	1.00
Togo	45	59	1	95	0.44	0.56	1.00
subtotal	1,528	1,375	6	2,414	0.53	0.47	1.00
Eastern market shed							
Nigeria	2,250	1,606	1	3,486	0.58	0.42	1.00
Niger	51	165	3	200	0.24	0.76	1.00
Benin	43	211	-	158	0.17	0.83	1.00
subtotal	2,344	1,981	4	3,845	0.54	0.46	1.00
Total West Africa	4,994	5,030	45	8,498	0.50	0.50	1.00

Shading:
large supplier (dark grey)
medium supplier (light grey)

Source: FAOSTAT.

Of the four major rice producers in West Africa, only Mali approaches self-sufficiency (Table 7). Nigeria, the largest rice producer in West Africa, is also the region's largest importer. Guinea, Mali, and Côte d'Ivoire all produce roughly 600,000 tons of rice, while Nigeria produces four times that amount. An array of studies of rice production in West Africa enables us to locate the large production zones on a map[7]. The urban consumption estimates in Figure 5a serve to locate the major urban rice markets in West Africa. With these estimates of major urban market size and location, the detailed recent field studies by FEWSNET (2009) and Soulé and Gansari (2010) enable us to track the major flows of rice between production zones and the end markets they serve.

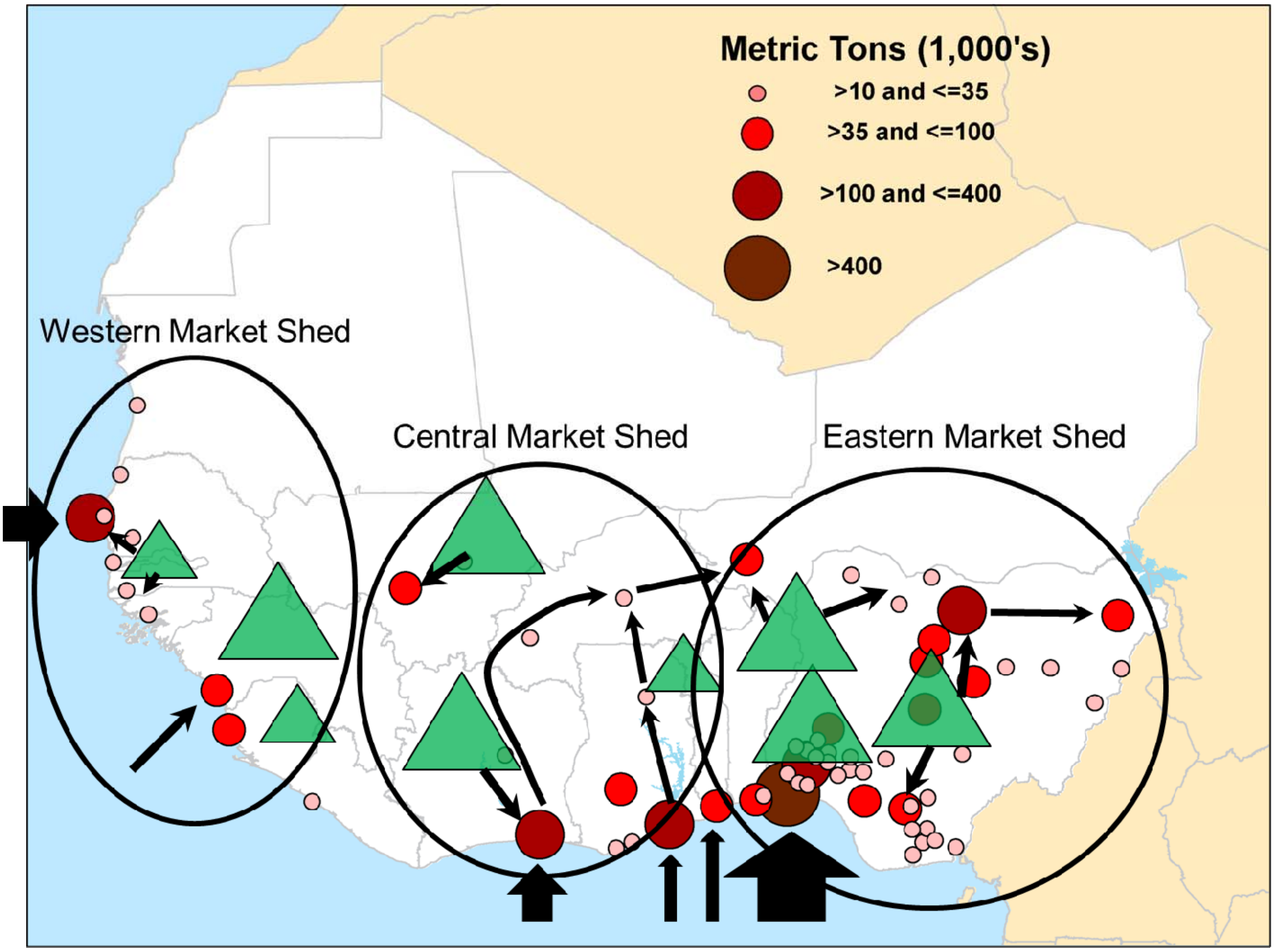
[7] See, for example, Kuper and Tonneau (2002); Africa Crossborder (2006); Erenstein et al. (2003); Bricas, Thirion, and Zoungrana (2009); FEWSNET (2009); Soulé and Gansari (2010); Campbell et al. (2009).

Three principal market sheds (or market basins) serve the large deficit urban rice markets of West Africa (Figure 12). The Western Market Shed depends on imported volumes for about 60% its total rice consumption. Domestic production, primarily from Guinea, supplements imports in supplying these coastal markets. Mountains, long distances, and poor roads largely isolate the western market basin from the center of West Africa.

The Central Market Shed encompasses the majority of Mali, Burkina Faso, Côte d'Ivoire, Ghana, and Togo. Although imported rice can reach Bamako via railroad from Dakar or by road from Côte d'Ivoire, traders generally source the bulk of domestic supplies from the irrigated perimeters of Mali's nearby Office du Niger. The two major rice producing countries in this basin, Mali and Ivory Coast, supply slightly over half of total rice consumption in the central basin. Although Mali produces 95% of the rice it consumes, other countries in the basin produce only 30% to 40% of their rice requirements. Traders import the balance, primarily via Abidjan but also from Accra for coastal consumption and trans-shipment inland.

The Eastern Market Shed encompasses most of Benin, Niger, and Nigeria. Nigeria's large rice producing areas serve internal markets in the north, around Kano and Kaduna, and send some surpluses south to the coastal cities. Because Benin and Niger produce less than a quarter of the rice they consume, imports account for slightly under half of total consumption in the market shed.

Figure 12. Rice Market Sheds in West Africa, Normal Year



Sources: Figure 5a; Kuper and Tonneau (2002); Erenstein et al. (2003); Africa Crossborder (2006); FEWSNET (2009); Bricas, Thirion, and Zoungrana (2009); Soulé and Gansari (2010); and Campbell et al. (2009).

7. CONCLUSIONS

This paper has explored means of spatially mapping staple food production and marketing flows in ways that summarize large volumes of information simply and clearly – in market shed maps. We believe maps of this type can prove useful as one component of analytical work that aims to anticipate future market pressure points and trends, in policy discussions aimed at identifying public investments and priority areas for policy reform, and in private sector dialogues aimed at identifying means of improving regional marketing efficiency.

Analysis in this paper has focused on a single-year, *normal* snapshot of production and marketing activity. Yet under rainfed agriculture, which dominates the production of coarse cereals, roots and tubers in West Africa, weather variations from one year to the next generate shifts in the geographic distribution of surplus food production, and hence in spatial price surfaces and in the volume and even direction of marketed flows. Future work, therefore, will benefit from examination of the spatial implications of various shocks to these marketing systems – drought years, pest attacks, political turmoil in key market locations.

Consumer substitution among food staples, likewise, merits investigation about the magnitude of interactions between various staple food marketing systems. As world rice and wheat prices spike, and rapidly subside, these increasingly volatile world price shocks induce consumer and trader responses across West Africa. Variations in domestic production, particularly of moisture-sensitive crops such as maize, lead to variable production from one year to the next. Drought-tolerant crops such as sorghum, millet and cassava, therefore, become important as part of private sector market system response to major food shocks. As beef and poultry consumption grows, interactions between food and feed stocks become an important part of equilibrating equations and indeed serve as potential shock absorbers in the regional food system. These interactions offer important practical implications for farmers, traders, and policy makers and therefore merit further study in coming years.

Finally, we note a dearth of spatially based field studies of staple food marketing systems. Given the growing importance of regional food markets, regionally focused market shed work will serve as a valuable complement to ongoing efforts to accelerate agricultural growth and ensure food security in West Africa in coming decades.

APPENDICES

APPENDIX 1. ALTERNATIVE METHODS FOR MAPPING SURPLUS ZONES

The first method for spatially distributing production and sales across space involves the use of subnational production and sales data. Where district- or provincial-level farm production and sales data are available, it is possible to quantify and map difference in the concentration of food sales across space. In a recent study of southeast Africa, Haggblade, Longabaugh, and Tschirley (2009) have applied this method, using district-level production data to evaluate differences in production and sales across districts. They then apply Landscan population rasters to map the dispersion of production and sales within districts. This empirical approach results in maps detailing differences across each 1 square kilometer grid in the study locations (see Figure 2). However, data demands are high. This method require subnational production data for all countries in a given market shed, a difficult feat in areas where civil unrest has restricted data collection for many years. Even where subnational production data are available, subnational marketing data often are not.

A second possible allocation method involves spatial modeling which distributes national production (or sales) across space using gridded data on agro-ecological properties (rainfall, length of growing period, temperature, and slope) sometimes in combination with maps of irrigated areas and commercial farming blocks. You and Woods (2007), for example, have used a maximum entropy model together with agro-ecological raster data to allocate national production of major food crops across 10-sqare-kilometer grids worldwide. This approach offers the advantage of requiring only readily available spatial data (rainfall, temperature, etc.) thus permitting broad application even in the absence of sub-national production or marketing data. However, when applied very broadly, this approach can lead to anomalies – the attribution of significant cassava production areas in Zimbabwe, for example, when in fact they plant only negligible amounts[8].As with any modeling method, local expert knowledge and ground truthing enable the modeler to improve the accuracy of modeling projections.

The third method revolves around the use of expert local knowledge. FEWSNET, in particular, has adopted this approach to determine which zones regularly market surpluses of specific food staples. FEWSNET has invested considerable resources interviewing and convening groups of local traders and market watchers to identify major surplus production and marketing zones. In West Africa, FEWSNET, with assistance from US Geological Service, has summarized this expert knowledge in a series of maps identifying surplus and deficit production zones for various food staples as well as the trade flows linking surplus and deficit markets (see Figure 8). [9]

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[8] See the Harvest Plus maps at http://mapspam.info/maps.

[9] See the FEWSNET web site at http://www.fews.net/pages/marketflowmap.aspx?gb=r1&loc=3&l=en.

APPENDIX 2. ESTIMATING RELATIVE MARKETING INTENSITY

Average marketing volume masks possibly significant variation in marketing intensity across the region. Ideally, farm-level data on marketed volumes, by location, would be available to estimate differences in marketing intensity across the surplus zones. Given an absence of spatially disaggregated micro-level marketing data, we have instead adopted the following decision rules. We have first estimated national marketed volumes by allocating the 3.8 million tons marketed regionally across countries in direct proportion to their total sorghum and millet production. Within each country, we then assign all sales to the surplus areas (the green zones in Figure 9). Since the surplus areas cut across food staple zones, we overlay Landscan population data onto these polygons to estimate the rural population in each of the surplus polygons (defined by country, surplus status, and food staple zone).

For purposes of this exercise, we have assumed higher levels of marketing in the mixed belt (the highest rainfall area of the large-scale sorghum and millet production) than in the more arid Sahelian belt and the lowest marketings in the coastal root crop zone and pastoral areas. Specifically, we have assumed that per capita marketing of sorghum and millet is three times higher in the mixed zone than in the pastoral and root crop zone and two times higher in the sorghum/ millet zone than in the root crop and pastoral zones. Using these relative per capita marketing ratios, together with rural population totals for each polygon, it is possible to allocate market sales spatially across each polygon. From each, it is then possible to compute average per capita sales within each country, surplus area, and food staple zone (Table 6).

APPENDIX 3. SUPPLEMENTARY TABLES

Appendix Table A.1. Staple Food Consumption, by Sub-Region (Kilograms per Person per Year)

	SSA	West Africa			Central	Eastern			Southern
		Sahel	Coastal	Nigeria		Horn	East	SouthEast	
Cereals	127	199	111	149	92	139	94	130	179
maize	*43*	*22*	*35*	*21*	*18*	*38*	*60*	*98*	*112*
sorghum	*22*	*46*	*8*	*45*	*27*	*22*	*6*	*6*	*4*
millet	*16*	*77*	*5*	*36*	*8*	*3*	*5*	*2*	*1*
rice	*19*	*38*	*45*	*28*	*7*	*1*	*9*	*7*	*17*
wheat	*23*	*17*	*16*	*18*	*30*	*43*	*13*	*15*	*44*
Starchy roots	151	11	254	213	188	59	170	148	33
cassava	*95*	*6*	*139*	*114*	*168*	*5*	*96*	*125*	*0*
yams	*23*	*1*	*84*	*74*	*7*	*45*	*0*	*0*	*7*
sweet potato	*13*	*3*	*4*	*14*	*6*	*3*	*48*	*2*	*1*
Sugar and sweeteners	14	11	11	11	16	5	13	17	33
Pulses	9	9	4	10	7	12	17	8	5
Oilcrops	5	6	8	8	6	1	5	4	2
groundnuts	*3*	*5*	*4*	*3*	*4*	*0*	*1*	*3*	*1*
Vegetable oils	8	8	11	14	7	2	5	6	12
Vegetables	33	33	40	61	30	11	28	13	41
Fruits	48	7	75	67	36	10	89	20	39
Stimulants	1	1	2	0	1	2	2	1	1
Spices	1	0	1	1	0	1	0	0	0
Alcoholic beverages	38	18	18	73	18	9	66	16	81
Meat	14	16	11	8	14	8	11	9	42
beef	*5*	*5*	*2*	*2*	*5*	*5*	*6*	*3*	*14*
poultry	*4*	*3*	*4*	*2*	*2*	*1*	*1*	*2*	*21*
goats and sheep	*2*	*5*	*1*	*2*	*3*	*1*	*1*	*1*	*4*
Animal fats	1	1	0	0	0	1	0	1	1
Dairy	33	39	11	12	44	22	46	9	61
Fish	7	9	17	7	7	0	5	3	7

Source: FAOSTAT.

Appendix Table A.2. Protein Intake by Staple Food and by Sub-Region (Grams per Person per Day)

	SSA	West Africa			Central	Eastern			Southern
		Sahel	Coastal	Nigeria		Horn	East	SouthEast	
Cereals	28	44	24	33	20	30	20	28	39
maize	*9*	*5*	*8*	*5*	*4*	*8*	*13*	*22*	*25*
sorghum	*5*	*11*	*2*	*11*	*7*	*5*	*1*	*2*	*1*
millet	*3*	*15*	*1*	*8*	*2*	*1*	*1*	*0*	*0*
rice	*4*	*7*	*9*	*6*	*1*	*0*	*2*	*1*	*3*
wheat	*5*	*4*	*3*	*4*	*7*	*9*	*3*	*3*	*10*
Starchy roots	4	0	7	5	5	2	5	4	1
cassava	*2*	*0*	*3*	*1*	*3*	*0*	*2*	*2*	*0*
yams	*1*	*0*	*4*	*3*	*0*	*2*	*0*	*0*	*0*
sweet potato	*0*	*0*	*0*	*1*	*0*	*0*	*2*	*0*	*0*
Sugar and sweeteners	0	-	0	-	0	-	0	0	0
Pulses	6	5	2	6	4	7	11	5	3
Oilcrops	3	3	5	5	3	0	3	2	1
groundnuts	*2*	*3*	*3*	*2*	*3*	*0*	*1*	*2*	*1*
Vegetable oils	0	0	0	-	0	0	0	0	0
Vegetables	1	1	2	2	1	0	1	1	2
Fruits	1	0	1	1	1	0	2	0	1
Stimulants	0	0	0	0	0	0	0	0	0
Spices	0	0	0	0	0	0	0	0	0
Alcoholic beverages	0	0	0	1	0	0	1	0	1
Meat	5	6	4	3	5	3	4	3	16
beef	*2*	*2*	*1*	*1*	*2*	*2*	*3*	*1*	*6*
poultry	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*1*	*7*
goats and sheep	*1*	*2*	*0*	*1*	*1*	*0*	*1*	*0*	*1*
Animal fats	0	0	0	0	0	0	0	0	0
Dairy	3	4	1	2	4	2	4	1	7
Fish	2	3	5	2	2	0	2	1	2
Total	55	67	52	61	47	47	53	46	73

Source: FAOSTAT.

Appendix Table A.3. Commodity Summaries, by Sub-Region

	SSA	West Africa			Central	Eastern			Southern
		Sahel	Coastal	Nigeria		Horn	East	SouthEast	
Population (millions)									
rural	518	43	52	83	100	69	91	42	40
urban	152	8	18	41	34	7	19	13	12
total	697	51	69	124	134	76	110	55	52
Maize									
production ('000 tons)	37,870	1,445	3,673	4,779	2,790	2,804	6,674	5,322	9,891
consumption ('000 tons)	29,750	1,122	2,454	2,555	2,456	2,885	6,582	5,370	5,762
net imports ('000 tons)	1,710	118	157	15	384	94	100	925	(185)
consumption (kg/person/year)	43	22	35	21	18	38	60	98	112
imports (kg/urban population/year)	11	14	9	0	11	14	5	71	(16)
production (kg/rural population/year)	73	34	71	58	28	41	73	128	247
Sorghum plus millet									
production ('000 tons)	37,410	8,366	1,272	14,310	7,803	2,040	2,504	571	423
consumption ('000 tons)	26,002	6,240	867	10,110	4,692	1,943	1,273	472	253
net imports ('000 tons)	173	(1)	6	(0)	9	52	2	11	76
consumption (kg/person/year)	37	122	12	82	35	26	12	9	5
imports (kg/urban population/year)	1	(0)	0	(0)	0	8	0	1	6
production (kg/rural population/year)	72	195	25	173	78	30	28	14	11
Cassava									
production ('000 tons)	101,604	308	18,320	32,913	24,575	411	14,332	9,025	0
consumption ('000 tons)	66,095	289	9,664	14,173	22,434	350	10,551	6,824	4
net imports ('000 tons)	76	20	(15)	(11)	(1)	(6)	(0)	0	81
consumption (kg/person/year)	95	6	139	114	168	5	96	125	0
imports (kg/urban population/year)	1	2	(1)	(0)	(0)	(1)	(0)	0	7
production (kg/rural population/year)	196	7	354	398	246	6	158	217	-
Wheat									
production ('000 tons)	4,289	10	-	71	349	1,403	488	351	1,607
consumption ('000 tons)	16,290	844	1,093	2,184	4,032	3,245	1,458	833	2,283
net imports ('000 tons)	12,389	805	1,083	2,227	3,637	2,109	1,014	502	741
consumption (kg/person/year)	23	17	16	18	30	43	13	15	44
imports (kg/urban population/year)	82	99	62	54	107	311	53	39	63
production (kg/rural population/year)	8	0	-	1	3	20	5	8	40

Appendix Table A.3. Commodity Summaries, by Sub-Region (continued)

	SSA	West Africa			Central	Eastern			Southern
		Sahel	Coastal	Nigeria		Horn	East	SouthEast	
Rice									
production ('000 tons)	8,072	946	1,798	2,250	387	10	597	201	2
consumption ('000 tons)	13,571	1,917	3,095	3,486	898	55	979	382	869
net imports ('000 tons)	7,336	1,220	2,160	1,604	443	49	436	203	827
consumption (kg/person/year)	19	38	45	28	7	1	9	7	17
imports (kg/urban population/year)	48	150	123	39	13	7	23	16	71
production (kg/rural population/year)	16	22	35	27	4	0	7	5	0
Yams									
production ('000 tons)	37,853	75	9,899	26,324	1,216	3,800	47	7	434
consumption ('000 tons)	16,331	72	5,852	9,211	918	3,419	44	7	361
net imports ('000 tons)	(15)	2	(15)	(2)	0	(1)	0	0	35
consumption (kg/person/year)	23	1	84	74	7	45	0	0	7
imports (kg/urban population/year)	(0)	0	(1)	(0)	0	(0)	0	0	3
production (kg/rural population/year)	73	2	191	318	12	55	1	0	11
Beef									
production ('000 tons)	3,561	273	151	280	669	361	690	192	761
consumption ('000 tons)	3,578	274	167	283	708	362	690	188	712
net imports ('000 tons)	23	2	16	3	38	1	0	(3)	(43)
consumption (kg/person/year)	5	5	2	2	5	5	6	3	14
imports (kg/urban population/year)	0	0	1	0	1	0	0	(0)	(4)
production (kg/rural population/year)	7	6	3	3	7	5	8	5	19
Poultry									
production ('000 tons)	1,943	159	143	201	96	51	146	125	920
consumption ('000 tons)	2,452	178	288	202	288	52	146	129	1,062
net imports ('000 tons)	504	19	145	1	192	1	0	4	136
consumption (kg/person/year)	4	3	4	2	2	1	1	2	21
imports (kg/urban population/year)	3	2	8	0	6	0	0	0	12
production (kg/rural population/year)	4	4	3	2	1	1	2	3	23
Sheep and goat meat									
production ('000 tons)	1,471	230	61	241	383	96	156	28	177
consumption ('000 tons)	1,478	230	64	241	375	92	156	28	186
net imports ('000 tons)	6	0	3	0	(7)	(4)	0	(0)	9
consumption (kg/person/year)	2	5	1	2	3	1	1	1	4
imports (kg/urban population/year)	0	0	0	0	(0)	(1)	0	(0)	1
production (kg/rural population/year)	3	5	1	3	4	1	2	1	4

Source: FAOSTAT.

Appendix Table A.4. Calorie Conversion into Wheat Equivalents

Commodity	Calories per kilogram	Wheat Equivalents
wheat	2,698	1.00
rice	3,609	1.34
maize	3,172	1.18
millet	2,871	1.06
sorghum	2,989	1.11
cassava	972	0.36
yams	1,000	0.37
groundnuts	5,450	2.02
beef	1,988	0.74
chicken	1,284	0.48
sheep and goat meat	1,775	0.66

Source: FAOSTAT.

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