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FOOD SECURITY ASSESSMENT

Of all the developing regions, Sub-Saharan Africa is projected to have the largest increase in food insecure people over the next decade.

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Food Security Assessment

Shahla Shapouri and Stacey Rosen, coordinators

Abstract

Just over 1 billion people in the 70 low-income countries studied in this report are estimated to have consumed less than the recommended nutritional requirements in 2004. This marks an increase from more than 830 million in 2003, due to weather-related factors. Over the coming decade, food security is projected to improve most significantly in Asia, followed by Latin America and the Caribbean. The situation is expected to deteriorate in Sub-Saharan Africa, where deep poverty, political unrest, and the effects of HIV/AIDS hinder prospects for improvement.

Keywords: Food security, food aid, production, imports, Sub-Saharan Africa, North Africa, Asia, Latin America, Commonwealth of Independent States.

Preface

This report continues the series of food assessments begun in the late 1970s. Global Food Assessments were done from 1990 to 1992, hence the GFA series. In 1993, the title was changed to Food Aid Needs Assessment to more accurately reflect the contents of the report, which focuses on selected developing countries with past or continuing food deficits. In 1997, we widened our analysis beyond the assessment of aggregate food availability to include more aspects of food security. We therefore changed the title to Food Security Assessment.

Acknowledgments

Appreciation is extended to Neil Conklin, Director of the Market and Trade Economics Division, and John Dunmore for their support of the food security work, and to Cheryl Christensen and Joy Harwood for valuable comments on the articles. We would also like to thank the reviewers, especially Carol Goodloe, USDA's Office of Chief Economist; Lorie Jacobs, Rita Carleton, Mary Chambliss, Bobby Richey, and Rebecca Fecitt Du Biel, USDA's Foreign Agricultural Service; David Stallings, USDA's World Agricultural Outlook Board. Special thanks are extended to Dale Simms, Wynnice Pointer-Napper, and Victor Phillips, Jr. for editorial and design assistance.

Cover Photos: World Food Program (left: Lori Waselchuk; center: Richard Lee; right: Nancy Palus).

Contents

In previous issues, data on the countries/regions reported on here were available in printed format. With this issue, please see *http://www.ers.usda.gov/publications/GFA16/* for data and charts in six Microsoft Excel spreadsheets.

Summary

As we approach 2015, the milestone set by the World Food Summit in 1996 to reduce global hunger by half, how close are we? According to ERS projections, the number of people consuming below the nutritional requirement in 2014 will be about 27 percent lower than the 2004 estimate. Performance by region varies significantly, with the sharpest decline projected for the Asian and Latin American/Caribbean regions, each at 46 percent. The Commonwealth of Independent States (CIS) region is projected to have an increase, but the number of people consuming below the requirement relative to total population will remain small. Sub-Saharan Africa is projected to suffer a 15-percent increase in the number of people with a consumption shortfall.

What Is the Issue?

The latest FAO report, *The State of Food Insecurity in the World, 2004*, states that, in aggregate, the number of undernourished people in developing countries has increased since the second half of the 1990s. According to this report, the number of chronically undernourished people worldwide was estimated at 852 million in 1999-2001. Of this estimate, about 95 percent were in developing countries. The report shows that the incidence of undernutrition declined in Asia and Latin America, but rose in the Middle East, North Africa, and Sub-Saharan Africa.

What Did the Project Find?

The food security indicators for the 70 lower income countries show a deteriorating situation in 2004 relative to 2003. The number of hungry people was estimated to have risen by roughly the same rate, reaching almost 1.1 billion for 2004. Food needs to maintain per capita consumption and nutritional requirements are estimated at 11 million tons and 14 million tons for 2004. (see box, "How Food Security Is Assessed: Methods and Definitions," p. 2.) When uneven income and food consumption within countries are taken into account, food needs increase to 31 million tons. Projections for 2014 show a decline in the number of hungry people in all regions except in Sub-Saharan Africa, which has no prospects for improvement. The region has the potential to expand food production and imports but requires "political will" to mobilize its resources.

Key forces that influence food availability of lower income countries are domestic production, commercial imports, and food aid. In many low-income countries, domestic production accounts for most of the food supply as foreign exchange constraints limit imports. In recent decades, about half of all gains in crop yields have been attributed to increased use of conventional inputs, especially fertilizer and irrigation water; the remainder was due to genetic improvements in seeds. In the most food-insecure countries, however, expansion of land continues to play a key role in food production growth. Nearly all of Sub-Saharan Africa's production growth was due to area expansion; yield growth was negligible. The region's grain yields per hectare are the lowest in the world, measuring about one-third of world averages.

In addition to inadequate production growth—on a per capita basis—short-term production shocks intensify the food security problems in many of these countries. Extreme weather events, though significant, were not the only cause of short-term production shocks. Political instability was also a contributing factor.

Domestic food production is less critical to food security if countries can import required foods. The problem is financial constraints and the fact that most food-insecure countries depend on imports not only for food, but for other essential commodities like fertilizers, fuels, medicine, and essential manufacturing inputs and products. These nonfood items can comprise a large share of the total import bill. In Sub-Saharan Africa, for example, fuel imports were about 16 percent of the total value of imports in 2002. Given the current hike in oil prices, these countries must make hard choices in importing commodities.

Food aid has been a major means by which the international community improves food access and reduces suffering in low-income countries. The global quantity of food aid has fluctuated during the last two decades, and its share has declined relative to both total exports of food aid suppliers and total food imports of low-income countries. By far the largest recipient of food aid in 2002 was North Korea, at 1.2 million tons, followed by Ethiopia, Afghanistan, and Pakistan, which each received about half a million tons. The major food aid donors are the United States, the European Union, Japan, Canada, and Australia.

How Was the Project Conducted?

All historical and projected data are updated relative to the 2003 Food Security Assessment (FSA) report. Food production estimates for 2004 are preliminary, based on USDA data as of October 2004, with supplemental data from the FAO and the World Food Program (WFP). Financial and macroeconomic data are based on the latest World Bank data. Projected macroeconomic variables are either extrapolated based on calculated growth rates for the 1990s or are World Bank projections/estimations. Projections/estimates of food availability include food aid, with the assumption that each country will receive the 2001-2003 average level of food aid throughout the next decade.

This year, we have changed the format of the report. We treat food security by region and country in one section, with two additional sections devoted to the twin pillars of food availability: production and imports. One special article, “Genetically Engineered Corn in South Africa: Implications for Food Security in the Region,” reviews the importance of corn in the diet of most Southern African countries and the promise of genetically engineered varieties in alleviating hunger.

Global Food Security: 2004 Assessment and Prospects

All ERS food security indicators show weather-related deterioration in food availability in 2004 relative to 2003. In the next decade, the number of hungry people is projected to decline in all regions except in Sub-Saharan Africa. [Shahla Shapouri and Stacey Rosen]

Some Improvement In Food Security Is Projected, But …

The food security indicators for the 70 lower income countries covered in this report show a deteriorating situation in 2004 relative to 2003 (see box, "How Food Security Is Assessed: Methods and Definitions").[1] The distribution gap, which takes into account unequal purchasing power within countries, was estimated at close to 31 million tons for 2004—up nearly 30 percent from 2003. The number of hungry people was estimated to have risen by roughly the same rate, reaching almost 1.1 billion for 2004.[2] Grain production for the countries, on average, is estimated to have fallen approximately 2 percent. (These estimates for 2004 do not include impacts of the recent tsunami in several Asian countries.)

Status quo (amount of grain equivalent needed to maintain per capita consumption at 2001-03 levels) and nutritional requirement food gaps are estimated at 11 million tons and 14 million for 2004, about 15-18 percent of estimated commercial grain imports (table 1-1). The distribution gap is about 41 percent of grain imports. These percentages are averages for all 70 countries; the situation varies widely by country. In general, those countries that are most vulnerable to food insecurity rely less on imports, and in most cases this is not by choice but because of limited foreign exchange. Closing the food gaps by increasing domestic food production is more feasible in most countries. Domestic production contributes 60 to 95 percent of food consumption in the study countries. Growth in food production would also increase farm income. Since most of the poor live in rural areas, a boost in agricultural income would improve income inequality and thus food security.

Consumption fell short of nutritional requirements for an estimated 1.1 billion people in 2004; this is projected to decline to under 800 million by 2014. The number of undernourished people in Asia was double that of Sub-Saharan Africa (SSA), 664 million versus 333 million, in 2004. Latin America and the Caribbean (LAC) were home to 82 million of such people, with another 2 million in the Commonwealth of Independent States (CIS). Happily, even the poorest in North Africa (the lowest 10 percent in income) had adequate food consumption on average. However, hunger is not absent in these countries, only less prevalent.

As we approach 2015, the milestone set by the World Food Summit in 1996 to reduce global hunger by half, how close are we? According to ERS projections, the number of people consuming below the nutritional requirement in 2014 will be about 27 percent lower than the 2004 estimate. Performance by region varies significantly, with the sharpest decline projected for

[1] The estimates of 2004 food security indicators are based on preliminary 2004 food production data and the projections of commercial imports and constant country food aid data at the 2001-03 level. Therefore, if commercial imports are higher than estimated, or countries decide to draw down stocks, or donors increase food aid commitments to countries in need, these estimates of gaps, as well as the number of hungry people, could fall.

[2] A person is considered food insecure, or hungry, if average food availability or access to food falls below Food and Agriculture Organization recommended average calorie intake levels of approximately 2,100 calories per day, depending on the region.

How Food Security Is Assessed: Methods and Definitions

Commodities covered in this report include grains, root crops, and a group called "other." The three commodity groups account for 100 percent of all calories consumed in the study countries and are expressed in grain equivalent. The conversion is based on calorie content. For example: grain has roughly 3.5 calories per gram and tubers have about 1 calorie per gram. One ton of tubers is therefore equivalent to 0.29 ton of grain (1 divided by 3.5), and one ton of vegetable oil (8 calories per gram) is equivalent to 2.29 tons of grain (8 divided by 3.5).

Food consumption and food access are projected in 70 lower income developing countries—37 in Sub-Saharan Africa, 4 in North Africa, 11 in Latin America and the Caribbean, 10 in Asia, and 8 in the Commonwealth of Independent States (see Appendix 1 for a detailed description of the methodology and definitions of terms and Appendix table 2a for a list of countries). The projections are based on 2001-2003 data. The periods covered are 2004 (current), 2009 (5-year forecast), and 2014 (10-year forecast). Projections of food gaps for the study countries through 2014 are based on differences between consumption targets and estimates of food availability, which is domestic supply (production plus commercial and food aid imports) minus nonfood use. The estimated gaps are used to evaluate food security of the study countries.

The food gaps are calculated using two consumption targets: 1) maintaining base per capita consumption or status quo (SQ), which is the amount of food needed to support 2001-2003 levels of per capita consumption; and 2) meeting nutritional requirements (NR), which is the gap between available food and food needed to support a minimum per capita nutritional standard (for definitions of terms used see Methodology in Appendix 1). Comparison of the two measures, either for countries, regions, or the aggregate, indicates the two different aspects of food security: consumption stability and meeting the nutritional standard.

The aggregate food availability projections do not take into account food insecurity problems due to food distribution difficulties within a country. Although lack of data is a major problem, an attempt was made in this report to project food consumption by different income groups based on income distribution data for each country. The concept of the income-consumption relationship was used to allocate the projected level of food availability among different income groups. The estimated "*distribution gap*" measures the food needed to raise food consumption of each income quintile to the minimum nutritional requirement. Finally, based on the projected population, the number of people who cannot meet their nutritional requirements is projected.

The common terms used in the reports are **domestic food** supply, which is the sum of domestic production and commercial and food aid imports; f**ood availability**, which is food supply minus non-food use such as feed and waste; **import dependency**, which is the ratio of food imports to food supply; and **food consumption** which is equal to food availability.

Table 1-1—Food availability and food gaps for 70 countries

Year	Grain production	Root production (grain equiv.)	Commercial imports (grain)	Food aid receipts (grain equiv.)	Aggregate availability of all food
			1,000 tons		
1995	410,087	61,111	55,121	8,562	668,294
1996	434,035	62,935	53,989	6,203	677,648
1997	423,897	64,870	59,112	6,458	681,917
1998	440,753	66,355	64,396	7,629	702,867
1999	455,565	71,410	65,019	8,586	726,695
2000	454,884	73,281	65,508	8,700	725,056
2001	471,994	75,469	64,329	9,601	757,112
2002	445,659	76,968	73,940	8,284	769,764
2003	484,756	77,255	74,773	8,494	797,969
Projections				**Food gap***	
				SQ / NR	
2004	475,436	79,496	75,168	***11,073 / 13,912***	776,431
2009	545,110	86,700	88,933	***7,872 / 11,471***	884,638
2014	607,199	94,458	100,876	***11,931 / 11,817***	975,831

*SQ stands for status quo and describes the amount of grain equivalent needed to support 2001-2003 levels of per capita consumption, and NR stands for nutritional requirements and describes the amount needed to support nutritional standards.

Source: FAOSTAT, USDA, ERS calculations.

the Asian and LAC regions at 46 percent. The CIS region is projected to have an increase, but the number of people consuming below the requirement relative to total population will remain small. Sub-Saharan Africa is projected to suffer a 15-percent increase in the number of people with a consumption shortfall.

The latest FAO report *The State of Food Insecurity in the World, 2004*, states that, in aggregate, the number of undernourished people in developing countries has increased since the second half of the 1990s. According to this report, the number of chronically undernourished people worldwide was estimated at 852 million in 1999-2001. Of this estimate, about 95 percent were in developing countries. The report shows that the incidence of undernutrition declined in Asia and Latin America, but rose in the Middle East, North Africa, and Sub-Saharan Africa.

Our estimates mirror FAO trend estimates, but are higher in absolute terms. In estimating hunger, we use an average daily requirement of 2,100 calories, versus FAO's 1,800 calories. Another difference is that our estimates are based on annual data, which include both chronic and transitory shortfalls in consumption. In contrast, FAO's estimates are based on 3-year averages. Including the variability is important since it reflects the profound impact of short-term food insecurity. Since 1992, variation from trend in the number of people consuming less than the nutritional requirement ranged from an annual increase of 150 million people to a decrease of 220 million people. In fact,

because of the frequency of transitory hunger, we could not identify a clear trend at the aggregate level in the number of food-insecure people in the study countries. This is not to say that there are no clear trends in specific regions or countries, but aggregate trends are harder to discern. Improvements in hunger in one country may be offset by deterioration in another.

The unambiguous trend, however, is the worsening of the situation in Sub-Saharan Africa, with no prospects for improvement. According to the FAO report, there is no shortage of resources to combat hunger, but "political will" is required to mobilize these resources. The fundamental forces that influence food security in Sub-Saharan Africa—domestic food production, available technology, and trade growth—can right themselves. Much greater food production is possible even in the most vulnerable countries. Sub-Saharan Africa has arable land that can be brought into production, although at some cost. In regions and countries with limited arable land, more intensive agricultural production under newly available technologies can improve yields. Trade can also enhance countries' food availability. The region's trade share in the global market was just 1.3 percent in 2002, a decline from about 3 percent in the early 1970s. There is significant potential for the region to expand its trade.

In Sub-Saharan Africa, however, the reality of the past dampens optimism. The region has been upended by years of political unrest and regional conflicts, and now is faced with the devastating effects of HIV/AIDS, which are difficult to quantify. According to the FAO report, 55 million Africans are projected to die from AIDS, over 2000 to 2020. A recent FAO report indicates that AIDS has reduced the economic growth of countries where the disease is widespread by 2-4 percent, deepening the problem of food insecurity. Despite the dampening effect of AIDS on population growth, it remains high in Sub-Saharan Africa, and is expected to remain so. The annual projected population growth during 2005-2015 is 2.4 percent, followed by 1.9 percent in North Africa, 1.7 percent in Asia and LAC, and 0.9 percent in CIS countries. Total population of the 70 countries is expected to grow from 2.8 billion in 2004 to 3.3 billion by 2014. Sub-Saharan Africa having to feed 157 million more people over the next 10 years is unlikely to break the cycle of hunger and poverty.

What Is in This Report?

All historical and projected data are updated relative to the 2003 Food Security Assessment (FSA) report. Food production estimates for 2004 are preliminary, based on USDA data as of October 2004, with supplemental data from the FAO and the World Food Program (WFP). Financial and macroeconomic data are based on the latest World Bank data. Projected macroeconomic variables are either extrapolated based on calculated growth rates for the 1990s or are World Bank projections/estimations. Seventy countries are covered in this report. Projections/estimates of food availability include food aid, with the assumption that each country will receive the 2001-2003 average level of food aid throughout the next decade.

This year, we have changed the format of the report. We treat food security by region and country in one section as opposed to separate regional

sections. Two additional sections focus on the twin pillars of food availability: production and imports. The analysis of food aid and its impact on food security is included in the import section.

This report includes one special article, "Genetically Engineered Corn in South Africa: Implications for Food Security in the Region." It reviews the importance of corn in the diet of most Southern African countries. Given the financial constraints that hinder import capacity, domestic corn production in South Africa is critical. However, exceedingly low yields and low levels of input use have reduced the region's food supplies. The adoption of higher yielding technologies holds some promise, especially the use of genetically engineered corn in South Africa.

Food Security: Regional and Country Perspectives

The most significant improvement over the next decade is expected in Asia, followed by Latin America and the Caribbean (LAC). In Sub-Saharan Africa (SSA), with the largest number of countries (37), there will be some improvement in per capita consumption and nutritional adequacy at the aggregate national level. However, the deep poverty that leads to hunger among the lower income population will remain unchanged.

North Africa

North Africa is and will continue to be a food-secure region, at the national level. Per capita calorie consumption in the region averages well above 3,000 calories per day, which is comparable to most developed countries. The region's per capita consumption is projected to remain stable over the next 10 years, with only a slight decline in Egypt. This compares with a 0.6-percent annual increase from 1980 to the present. This slowdown is a reflection of slower production growth—from 1.7 percent per year since 1990 to about 1.1 percent for the projection period. North Africa's trend mirrors trends in Egypt, the region's largest producer. Egypt's grain yields are by far the highest in the region—and among the highest in the world—but its growth is not expected to match that of the recent past.

As a result of the slowdown in production growth, Egypt is the only country in the region with aggregate-level food gaps. This means that during the next decade Egypt is not expected to maintain its per capita food consumption levels of 2001-03. By 2014, the status quo food gap for the region—based on Egypt's situation—is projected at 345,000 tons (table 1-2). The country will, however, be able to meet nutritional food needs in 2014. Algeria, Morocco, and Tunisia are projected to have sufficient food at the national level and when income inequality is taken into account for 2014.

The main food security issue for North African countries is the ability to finance imports. The region is dependent on imports for about half of its essential food items, and this share is expected to grow along with income as imports of higher value commodities rise. Food aid, which had been a

Table 1-2—Food availability and food gaps for North Africa

Year	Grain production	Root production (grain equiv.)	Commercial imports (grains)	Food aid receipts (grain equiv.)	Aggregate availability of all food
			1,000 tons		
1995	19,881	1,353	20,186	250	47,162
1996	33,267	1,465	16,578	193	44,082
1997	22,439	1,192	20,691	137	46,027
1998	26,699	1,261	20,084	74	43,955
1999	24,476	1,202	21,590	105	46,670
2000	21,312	1,224	24,530	356	46,373
2001	25,442	1,239	23,989	82	47,505
2002	24,702	1,381	27,456	72	52,413
2003	32,220	1,412	27,477	47	57,778
Projections				**Food gap**	
				SQ NR	
2004	32,883	1,406	26,849	***0*** ***0***	58,031
2009	29,109	1,535	32,590	***0*** ***0***	59,850
2014	30,826	1,671	37,219	***345*** ***0***	65,377

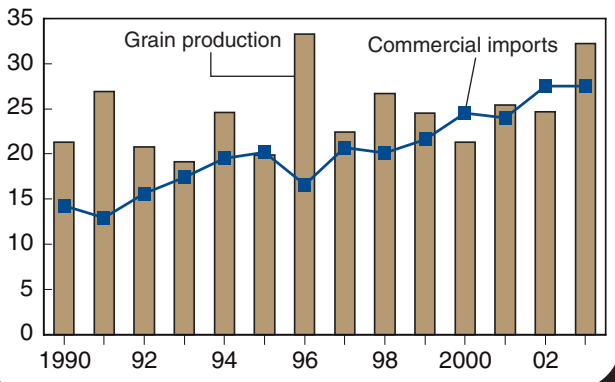
North Africa (147 million people in 2004)

Calorie consumption, on average, is well above the nutritional requirement of 2,100 calories per day.

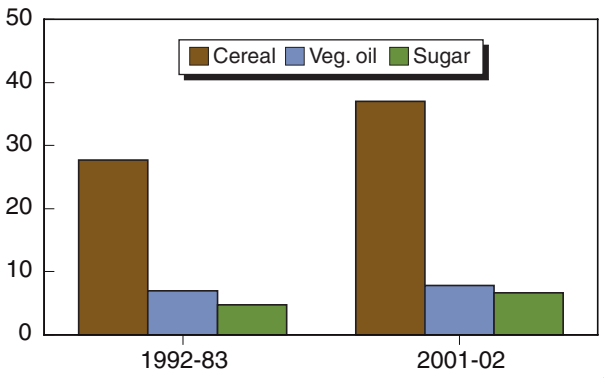
Although production growth is projected to slow relative to the historical period, food supplies will be adequate to meet nutritional requirements through the next decade.

Imports contribute about 45 percent of food supplies and the share is projected to increase. Therefore, the state of the economies of these countries and export potential play a key role in the food security outlook.

North Africa: Grain production and imports



North Africa: Commodity imports as share of domestic consumption



North Africa: Food import dependency

	Food imports		Food as % of tot. imports		Cereal imports as % of consumption	
	2001-02	Growth since 1992-93	1992-93	2001-02	1992-93	2001-02
	1,000 U.S. dollars		*Percent*			
North Africa	7,251,597					
Algeria	2,503,134	17.2	24.5	22.9	40.1	46.4
Egypt	2,740,579	49.6	22.2	17.7	22.9	23.4
Morocco	1,290,318	50.4	12.2	11.4	30.0	34.4
Tunisia	717,567	81.9	6.3	7.5	18.0	43.8

Source: FAOSTAT, ERS calculations.

major source of imports, for Egypt in particular, in the early 1980s, currently accounts for less than 1 percent of total food imports in the region. This makes financial capacity a critical element in projecting the region's food security. Recent growth in oil prices is good news both directly (as exporters) and indirectly because of the gains from worker remittances. Higher oil prices are expected to stimulate regional labor migration and increase remittances. Among the four countries in the region, Algeria is the only one where the value of exports has been higher (15 percent) than imports during 2000-02. External financing accounted for 25 percent of imports in Morocco, 16 percent in Egypt, and 7 percent in Tunisia. Historically, these countries have been successful in accessing credit to finance imports. Continuing political unrest and slowdown in tourism/investment could hurt the region's finances.

Sub-Saharan Africa

Sub-Saharan Africa's per capita food consumption is projected to follow the trend of the last two decades and remain stagnant through 2014. Annual production growth is projected at 2.5 percent for the next decade, fairly close to population growth (table 1-3). The number of hungry people (those who can not meet the nutritional target) in the region is projected to increase from an estimated 333 million in 2004 to 383 million in 2014 (fig. 1-1). This rate of increase, however, is less than the region's population growth rate, meaning that the share of hungry people in the region will decline from 52 percent in 2004 to 48 percent in 2014. Still, this is the only region where the number of undernourished people is projected to grow in absolute terms.

In Sub-Saharan Africa, the food security problem stems both from inadequate food availability and unequal access to what is available. In other regions, food availability may be adequate, but lack of purchasing power is the main impediment to food security. In SSA, inequality in food access deepens the severity of the situation. According to our estimates for 2004, average per capita food consumption (availability) fell short of the nutritional requirement in 15 of the 37 SSA countries. In 29 countries, per capita food consumption is estimated to be less than the average of 2001-03. The region has about 23 percent of the population of the 70 study countries, but is saddled with more than 80 percent of various food gaps.

This pattern is not new. While obesity becomes more prominent in most developed and some developing countries, per capita food consumption in many Sub-Saharan countries continues to decline. Based on FAO data, annual per capita calorie consumption has declined in 12 of these countries since 1990. Average daily consumption in the region was 2,208 calories in 2001-02, slightly higher than the 2,100-calorie average requirement and 20 percent less than the global average (2,804 calories per day in 2002). Average daily consumption for the most food-insecure countries in the region is 1,776 calories—about 15 percent less than the requirement and 37 percent less than the global average.

Seven of the SSA countries—Democratic Republic of Congo, Burundi, Eritrea, Ethiopia, Somalia, Chad, and Sierra Leone—have especially severe food insecurity, with consumption falling below the nutritional target across

Table 1-3—Food availability and food gaps for Sub-Saharan Africa (SSA)

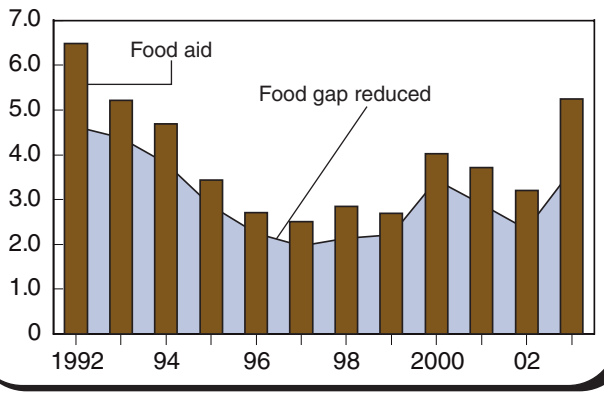
Year	Grain production	Root production (grain equiv.)	Commercial imports (grains)	Food aid receipts (grain equiv.)	Aggregate availability of all food
			1,000 tons		
1995	64,250	40,480	6,795	3,431	136,843
1996	68,799	41,412	7,670	2,707	140,167
1997	63,592	42,729	10,248	2,497	141,685
1998	71,237	45,678	12,050	2,837	152,901
1999	67,570	47,768	9,814	2,690	152,828
2000	68,552	49,120	10,784	4,027	157,677
2001	73,862	51,126	13,108	3,722	170,429
2002	68,281	51,677	14,075	3,225	170,204
2003	74,919	51,352	13,526	5,251	177,979
Projections				**Food gap**	
				SQ NR	
2004	71,567	53,352	14,378	***9,454 13,394***	168,947
2009	89,866	58,235	15,537	***7,079 10,792***	199,298
2014	103,519	63,499	16,781	***10,912 11,171***	223,410

Sub-Saharan Africa (645 million people in 2004)

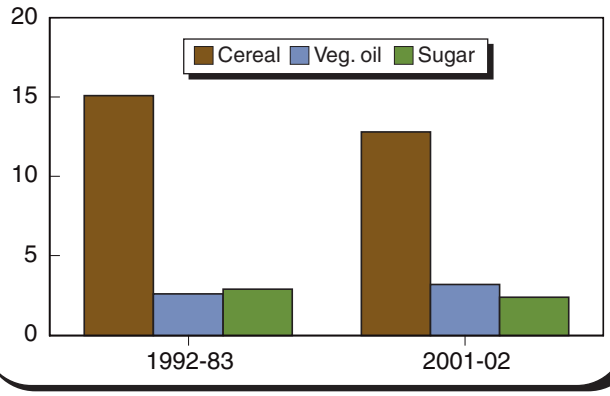
At the regional level, per capita consumption is projected to increase nominally through the next decade. However, at the national level, it will decline in 16 of the 37 countries.

The number of hungry people in the region is projected to rise from 333 million in 2004 to 383 million in 2014. This means that roughly half of the region's population will consume less than their nutritional requirements throughout the next decade.

Average food aid effectiveness in reducing food gaps was 79% in SSA



Sub-Saharan Africa: Commodity imports as share of domestic consumption



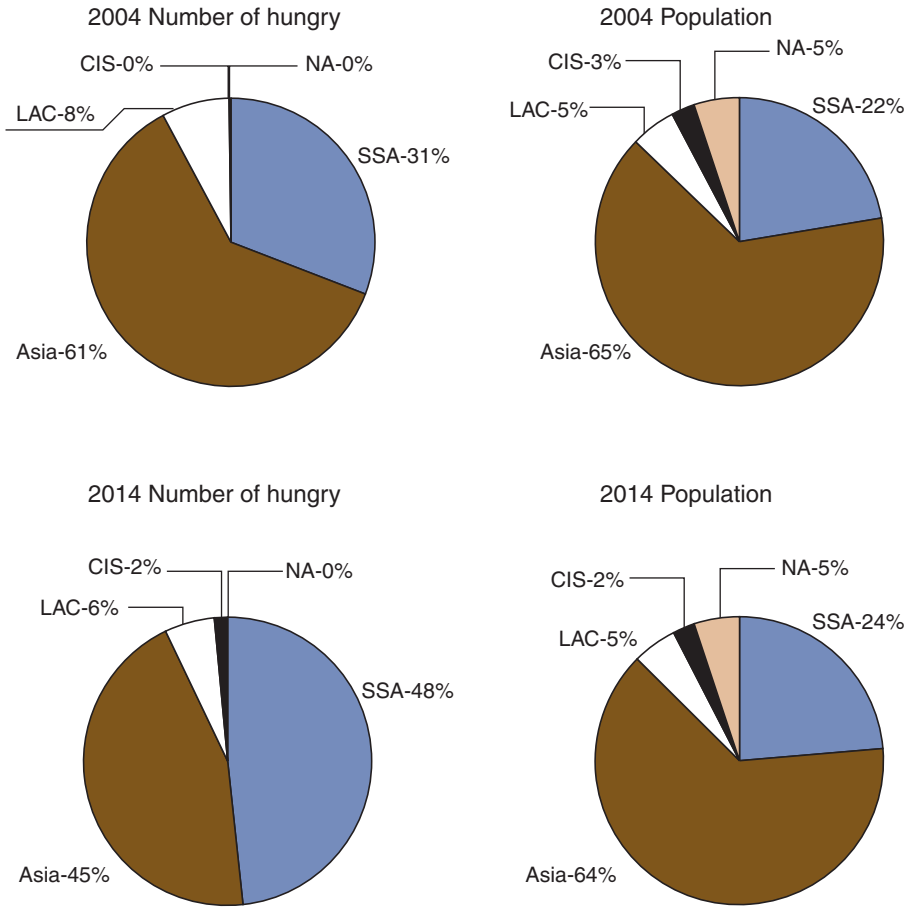
Sub Saharan Africa: Food import dependency of selected countries

	Food imports		Food as % of tot. imports		Cereal imports as % of consumption	
	2001-02	Growth since 1992-93	1992-93	2001-02	1992-93	2001-02
	Mil. U.S. dollars		*Percent*			
SSA	**6,768,253**					
Ethiopia	169,766	73.9	12.7	9.7	4.5	5.7
Senegal	436,621	50.2	24.2	28.8	22.2	32.3
Rwanda	42,665	-5.8	14.1	16.3	6.2	1.9
Kenya	271,680	48.3	10.1	7.5	7.5	11.0
Tanzania	195,077	136.0	5.6	11.5	2.6	5.5

Source: FAOSTAT, ERS calculations.

Figure 1-1

SSA will have the largest share of hungry people by 2014



Source: Economic Research Service, USDA.

all income quintiles in 2004. Most of these countries have been embroiled in some kind of internal conflict. In the Dem. Rep. of Congo, per capita food availability has been declining since 1992 and has fallen short of the nutritional target since 1995, measuring 77 percent in 2003. Even with optimistic assumptions for area and yield growth, production growth is not likely to exceed projected population growth of nearly 3 percent per year through the next decade. Per capita availability in Ethiopia has risen steadily since the war with Eritrea ended in 1991. However, it remains less than 90 percent of the nutritional target. In Somalia, grain production is about half that of pre-war levels of the late 1980s. As a result, the nutritional situation is desperate—availability in 2003 was 64 percent of the nutritional target.

The food security outlook for Sub-Saharan Africa is based on historical performance and some factors could alter the outcome. Growth in prices for oil and metal is welcome news for Nigeria, Angola, and Chad. If these increased earnings are managed carefully, they can have positive long-term economic benefits. Improvements in the political situation for some of the most food-insecure countries, such as Burundi and the Central African Republic, also hold promise for future recovery. For most SSA countries, however, higher oil prices are expected to dampen economic growth and

place additional pressure on import bills. Overall, the outlook is filled with risk. Political conflict continues to flare up in different countries. The region remains highly vulnerable to drought. Despite donors' increasing support for the fight against HIV/AIDS, health issues will put tremendous pressure on African countries indefinitely.

Lower Income Asian Countries

Growth in per capita food consumption in the Asian countries included in this report (10 countries) has been just 0.36 percent per year since 1990. This trend is projected to improve slightly during the next decade. This slow growth springs from the conservative import policies of countries like India, Bangladesh, and Nepal, which have resulted in some of the lowest import dependency rates of all the study countries. The value of total exports grew about 10-13 percent per year since 1990 in these countries, which would have allowed for higher food imports in the absence of such protectionist policies. The expected consequence of limited imports is an estimated decline in per capita food consumption in Bangladesh and Nepal and slight improvement in India. The estimated status quo food gap—the food needed to maintain per capita consumption—of 1.5 million tons in 2004 is projected to decline by more than half by 2014 (table 1-4).

During the next decade, the Asian region is projected to become more nutritionally food secure as population growth slows and production growth is maintained. Population growth, which averaged 2 percent per year during the 1980s and 1990s, is projected to fall to 1.5 percent per year. Production growth is projected to nearly match its historical rate of 2.2 percent per year. This means that by 2014, at the average national level, there would be adequate food to meet the nutritional needs of the countries.

The income disparity within countries, however, is expected to remain an obstacle to food security of the lower income groups in the region. Given the expected improvement in all relevant indicators, the impact of income disparity on food consumption will be much smaller in the next decade. The estimated regional distribution gap in 2004 was 8.6 million tons, but is projected to decline to 3 million tons by 2014. The improvements are reflected in fewer hungry people in the region. In 2004, it is estimated that 664 million people—or 35 percent of the population—were hungry. By 2014, this number is projected to fall to 354 million, or 16 percent. This success is principally driven by improvements in all countries except Afghanistan and North Korea. In Vietnam, per capita consumption is projected to continue rising by 1.2 percent per year through 2014 as a result of near 4-percent annual growth in production and low population growth. By 2014, even the poorest 10 percent of Vietnam's population, on average, could be consuming 13 percent above the nutritional target.

Afghanistan will remain the region's most nutritionally vulnerable country. After the recovery in agricultural output in 2003, grain production declined in 2004. The country remains dependent on imports and food aid for about 20 percent of its consumption. Commercial imports are primarily supported by external financial assistance since exports covered only 16 percent of the total value of imports in 2000-02. Traditional exports such as livestock

Table 1-4—Food availability and food gaps for Asia

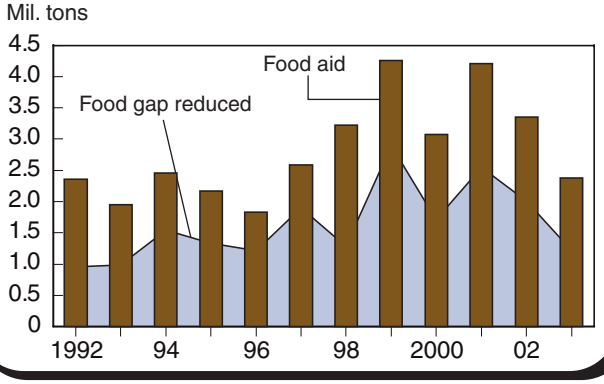
Year	Grain production	Root production (grain equiv.)	Commercial imports (grains)	Food aid receipts (grain equiv.)	Aggregate availability of all food
			1,000 tons		
1995	299,293	15,574	17,355	2,170	432,090
1996	303,164	16,277	16,568	1,834	440,090
1997	307,074	17,183	15,279	2,591	440,658
1998	317,031	15,644	18,657	3,223	450,938
1999	328,635	18,206	20,859	4,259	468,280
2000	333,190	18,571	16,572	3,070	465,754
2001	335,386	18,604	13,600	4,209	480,811
2002	312,002	19,307	18,620	3,345	485,160
2003	337,400	19,781	19,037	2,381	498,953
Projections				**Food gap**	
				SQ NR	
2004	332,905	19,912	18,616	***1,487 52***	484,713
2009	383,597	21,662	21,509	***786 75***	551,072
2014	427,414	23,545	22,766	***643 0***	600,841

Asia (1,788 million people in 2004)

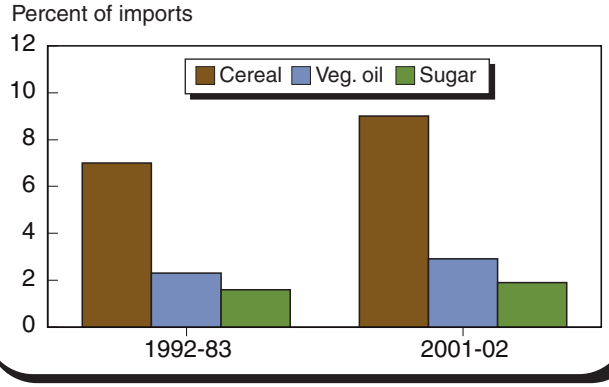
The number of hungry people in Asia is projected to decline from 664 million people in 2004 to 354 million people in 2014. In terms of population share, this marks a decline from 37 percent to 17 percent. India is projected to account for nearly all of this decline as the country's continued slowdown in population growth and steady production growth will result in rising per capita consumption.

The most vulnerable country in the region is Afghanistan, where roughly 60 percent of the country's population is projected to be hungry in 2014.

Average food aid effectiveness in reducing food gaps was 57% in Asia



Asia: Commodity imports as share of domestic consumption



Asia: Food import dependency of selected countries

	Food imports		Food as % of tot. imports		Cereal imports as % of consumption	
	2001-02	Growth since 1992-93	1992-93	2001-02	1992-93	2001-02
	Mil. U.S. dollars		*Percent*			
Asia	**9,258,641**					
Afghanistan	145,405	na	25.6	na	na	na
Bangladesh	745,134	-60.6	10.5	8.5	4.9	8.3
India	1,302,039	6.5	2.9	2.4	0.3	0.0
Indonesia	2,622,142	5.7	4.4	8.4	4.3	7.8
Korea, Dem.R.	294,413	835.2	18.6	22.6	11.7	26.8
Pakistan	617,218	-90.3	8.4	5.8	7.6	0.5

Source: FAOSTAT, ERS calculations.

products and fruits/vegetables remain limited. Political stability has followed the recent successful election, but security remains precarious. In addition, the outlook for economic growth, which is highly dependent on the flow of external assistance, remains uncertain. Income disparity within the country also remains a problem and that could intensify food insecurity of the country over time. Assuming the continuation of current weak production growth and an increase in external assistance to support food imports, the distribution gap is projected to increase from 305,000 tons in 2004 to 776,000 tons by 2014. This deterioration would intensify food insecurity for an increasing share of the population—from 40 percent in 2004 to about 60 percent by 2014.

North Korea is the region's second most vulnerable country. Grains contribute about two-thirds of total food consumption and imports account for 40 percent of grain consumption. More than half of the grain imports, annually more than 1 million tons (2000-3003), are food aid. Grain production declined gradually through the 1990s, followed by a sharp drop in 2000. Since then, output has begun to recover, albeit slowly. North Korea depends on external assistance for 25 percent of its imports and, because of its political situation, continued support is uncertain. Therefore, per capita food consumption is projected to decline in the next decade. Consumption was estimated to fall short of the nutritional target in 2004 for only the bottom income group; by 2014, this may be true for the bottom two groups. As such, between 20 and 40 percent of the population will be hungry. These results are highly dependent upon continued shipments of food aid. In our analysis, we assume food aid to be constant through the projection period at the base (2001-2003) level. If food aid reverts to levels of the mid-1990s (less than half of recent levels), food security in North Korea would deteriorate significantly.

Lower Income Latin American and Caribbean Countries

Per capita food availability in the region as a whole is steadily increasing. All 11 countries are projected to improve their food availability during the next decade (table 1-5). This increase in food supplies comes from rapidly growing food imports. The average annual growth rate for the region's food imports was above 5 percent per year between 1980 and 2003, with 7-percent growth since 1990. Growth in food production is slightly less than projected population growth of about 2 percent. Only Haiti, Honduras, and Nicaragua are expected to have nutritional food gaps in 2004; in Haiti and Nicaragua, this gap is expected to grow during the next decade.

A lack of nutritional gaps at the national level does not preclude food-insecure people. The distribution gap, which accounts for skewed income distributions by measuring the food needed to raise consumption of each income quintile to the nutritional requirement, reveals that food insecurity exists in all LAC countries, with the exception of Jamaica. In fact, Latin American countries have the most skewed income distribution in the world. The share of income held by the highest income quintile ranged from 49 percent in Jamaica to 64 percent in Guatemala. In contrast, the share held by the lowest income quintile ranged from less than 1 percent in Peru to 2.7 percent in Jamaica. The sharp income

Table 1-5—Food availability and food gaps for Latin America and the Caribbean

Year	Grain production	Root production (grain equiv.)	Commercial imports (grains)	Food aid receipts (grain equiv.)	Aggregate availability of all food
			1,000 tons		
1995	10,282	2,992	8,158	876	31,860
1996	10,110	3,047	9,035	722	32,555
1997	9,831	3,005	9,773	658	32,507
1998	10,138	2,989	10,474	1,013	33,977
1999	11,267	3,296	9,716	1,178	34,432
2000	11,430	3,424	10,209	887	35,363
2001	11,497	3,368	11,095	1,067	36,461
2002	11,787	3,409	11,854	1,127	38,088
2003	12,198	3,433	12,562	539	38,632
Projections				**Food gap**	
				SQ NR	
2004	11,892	3,540	13,090	***131*** ***465***	38,680
2009	13,542	3,865	16,885	***7*** ***527***	47,419
2014	14,663	4,214	21,574	***32*** ***539***	56,982

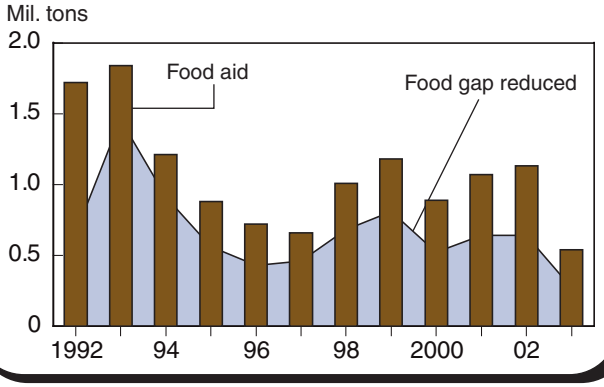
Latin America and the **Caribbean** (147 million people in 2004)

Food security in the region is projected to improve over the next 10 years, with the number of hungry people projected to decline from 82 million in 2004 to 47 million in 2014.

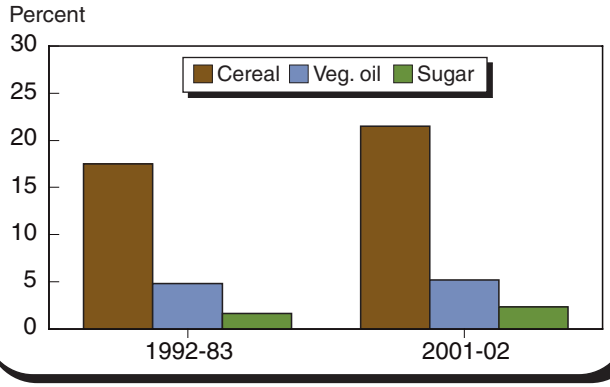
Commercial food imports will increasingly replace domestic production as the main food source.

Haiti, Honduras, and Nicaragua, the chronically food-insecure countries in the region, are likely to continue to require food aid.

Average food aid effectiveness in reducing food gaps was 62% in LAC



LAC: Commodity imports as share of domestic consumption



Latin America and the Caribbean: Food import dependency of selected countries

	Food imports		Food as % of tot. imports		Cereal imports as % of consumption	
	2001-02	Growth since 1992-93	1992-93	2001-02	1992-93	2001-02
	Mil. U.S. dollars		*Percent*			
LAC	**5,476,384**					
Guatemala	667,591	175	9.1	11.4	12.6	27.7
Haiti	279,461	286	55.9	25.9	23.9	28.6
Honduras	409,137	153	9.3	13.7	9.8	21.4
Nicaragua	211,765	141	18.0	11.9	10.0	12.1
Peru	776,796	-72	16.6	10.7	28.8	19.1

Source: FAOSTAT, ERS calculations.

disparity limits purchasing power and leads to food insecurity for a large share of population in these countries. In 2004, between 40 and 60 percent of the population are estimated to have been unable to achieve nutritional requirements in Bolivia, Colombia, the Dominican Republic, El Salvador, Ecuador, and Peru. The most severely affected countries are Guatemala, Haiti, Honduras, and Nicaragua, with more than 80 percent of their population deemed food insecure.

Projections for 2014 indicate that—except for Haiti, Honduras, and Nicaragua, where food insecurity will remain unchanged or grow worse—food security in the region is expected to improve, reducing the number of hungry people from 82 million in 2004 to 44 million by 2014. In Haiti, the potential for political uncertainty is problematic, but donors are aware of the tremendous need for food assistance in the country. In Nicaragua and Honduras, agricultural production and economic growth are just keeping pace with population growth of about 2.5 percent, holding per capita food consumption constant over the coming decade. Much faster growth in yields and income will be necessary to raise average consumption to the level of nutritional requirements.

The growing food import dependency of LAC countries, particularly for staple foods such as grains, dramatizes the issue of import financing. During 2000-02, countries such as Guatemala, Nicaragua, and Haiti used external support to finance 40 to 60 percent of their import bills (merchandise and services). In Bolivia, Honduras, the Dominican Republic, and El Salvador, external support covered 20 to 27 percent of their import bill. Jamaica was dependent on external support for 5 percent of its imports, while Peru and Columbia had a net trade surplus. Most countries are expected to be able to secure adequate external financing for imports, but countries like Haiti and Nicaragua that rely on such assistance for more than half of their import bill could be exposed to more vulnerability.

Commonwealth of Independent States (CIS)

There were no food gaps in 2004 for the eight CIS countries monitored in this report in terms of meeting average consumption or nutritional targets (table 1-6). For most countries, grain harvests will be near trend levels over the next decade. Because of stagnant crop production in the region, imports continue to rise. Low population growth of less than 1 percent per year eases food security pressure. Only Kazakhstan continues to be a significant grain exporter. Over the next decade, only Tajikistan will have a nutrition-based food gap, about 107,000 tons by 2014.

About 2 million people, or the 20 percent of the population in the lowest income quintile, in Georgia and Tajikistan were estimated to consume less than the nutritional requirement in 2004. In other countries, food insecurity is limited to less than 10 percent of the population. Projections for 2014 indicate a deterioration of the food situation in Tajikistan, and that could mean expanding food insecurity to 80 percent of the population (6 million people). The continuation of the decline in commercial imports is projected to worsen food security in Uzbekistan such that by 2014, consumption in the lowest income quintile—20 percent of the population—will fall just short of

Table 1-6—Food availability and food gaps for Commonwealth of Independent States (CIS)

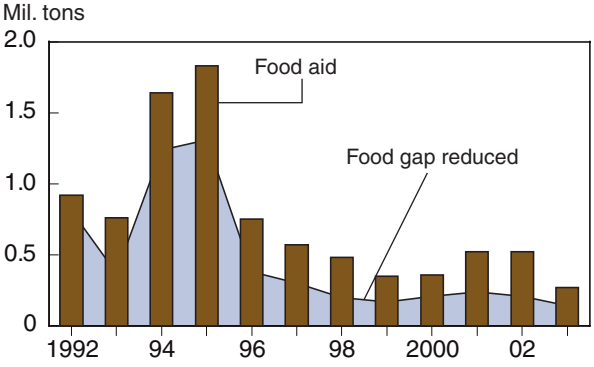
Year	Grain production	Root production (grain equiv.)	Commercial imports (grains)	Food aid receipts (grain equiv.)	Aggregate availability of all food
			1,000 tons		
1995	16,381	712	2,627	1,834	20,339
1996	18,695	735	4,138	747	20,754
1997	20,961	761	3,120	575	21,039
1998	15,648	782	3,132	481	21,096
1999	23,617	937	3,039	353	24,485
2000	20,400	943	3,413	360	19,889
2001	25,807	1,131	2,536	521	21,906
2002	28,887	1,194	1,935	516	23,898
2003	28,019	1,277	2,171	275	24,627
Projections				**Food gap**	
				SQ NR	
2004	26,189	1,286	2,236	***0*** ***0***	26,061
2009	28,995	1,403	2,413	***0*** ***77***	26,999
2014	30,776	1,529	2,536	***0*** ***107***	29,222

CIS (75 million people in 2004)

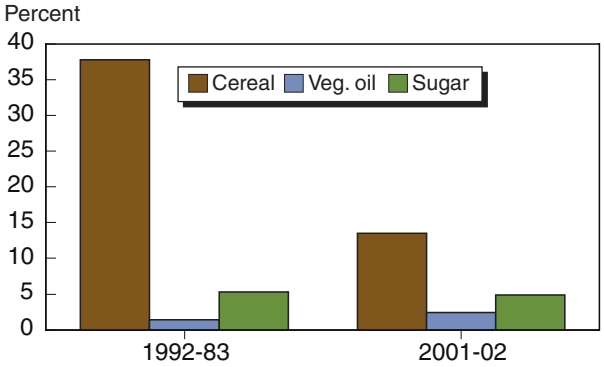
Only Tajikistan is projected to have longrun nutritional food gaps in this region, but food access might become a problem for the lowest income quintile in Uzbekistan during the next 10 years. The number of hungry people is projected to rise from 2 million in 2004 to 12 million in 2014.

Grain consumption declined sharply between 1992 and 1998, but has since rebounded. Food aid historically served as an important buffer to shocks in food availability. Only a few CIS countries today still rely on food aid to a significant degree.

Average food aid effectiveness in reducing food gaps was 56% in CIS



CIS: Commodity imports as share of domestic consumption



Commonwealth of Independent States: Food import dependency of selected countries

	Food imports		Food as % of tot. imports		Cereal imports as % of consumption	
	2001-02	Growth since 1992-93	1992-93	2001-02	1992-93	2001-02
	Mil. U.S. dollars		*Percent*			
CIS	**1,299,104**					
Armenia	147,376	5	70.0	16	42.9	31.4
Azerbaijan	194,787	-14	58.3	13	33.9	19.2
Georgia	172,537	-15	81.1	24.7	58.9	20.9
Kazakhastan	399,566	5	37.9	6.2	1.5	0.2
Tajikistan	96,625	150	44.6	13.7	63.1	25.5

Source: FAOSTAT, ERS calculations.

the nutritional target. Food security in Georgia is projected to improve as import capacity and grain production will grow as population declines.

Grain consumption in many CIS countries has increased since the late 1990s. In fact, per capita grain consumption, after declining 3 percent annually during 1988-98, increased sharply and in 2003 was nearly equal to the 1988 level. This gain is mainly due to production recovery. Grain imports as a share of total grain supply ranged from 20 to 25 percent in the early 1990s, but declined to about 7 percent by 2002-03. The recovery was not limited to the grain sector. Annual export growth of 7 percent overall surpassed the 4-percent import growth during 1992-02. Most countries in the region export oil, natural gas, and minerals. The recent oil and commodity price hikes have improved the financial situation of the countries, though this improvement is not uniform. The CIS countries with robust macroeconomic growth since the mid-1990s are Azerbaijan, Armenia, and Kazakhstan. The recovery has been slower and uneven in Georgia, Kyrgyzstan, Turkmenistan, Tajikistan, and Uzbekistan.

Future growth in the region depends on political stability since there are many unresolved disputes over national boundaries. Diversifying export destinations is also critical to maintaining growth. Currently, Russia is the main trading partner. According to the IMF World Economic Report (2004), the investment climate in these countries remains uncertain, with particularly weak regulatory institutions. Much policy reform is needed to develop market structure and institutions for market-based economies.

Forces Shaping Food Security: Factors Affecting Production

In recent decades, about half of all gains in crop yields have been attributed to increased use of conventional inputs, especially fertilizer and irrigation water; the remainder was due to genetic improvements in seeds. In the most food-insecure countries, however, expansion of land continues to play a key role in food production growth. (Stacey Rosen and Margriet Caswell)

Aggregate Trend In Per Capita Grain Production Was Negative During 1990-2003

Grains comprise the largest share of the diet in the developing world. In East and Southeast Asia, grains account for around 60 percent of calories consumed, on average. In Sub-Saharan Africa, this share is nearly 50 percent. In many of these countries, domestic production accounts for most of the grain supply as foreign exchange constraints limit imports. In this section, we examine trends in grain production, its contribution to consumption, and factors affecting its growth.

Growth in crop production stems from three sources: expansion of arable land, increase in cropping intensity (i.e., multiple cropping), and growth in yields. According to FAO, 80 percent of future production growth in developing countries will come from higher yields. Expansion of arable land will continue to play an important role in Sub-Saharan Africa and Latin America, albeit a much smaller role than in the past. However, most of the land with crop production potential not already used is in a few countries: Brazil, DR Congo, Sudan, Angola, Argentina, Colombia, and Bolivia. Moreover, some of this land is low quality or relatively inaccessible due to a lack of infrastructure. Therefore, productivity of the land would be poor or would require tremendous investment to make it more productive. There is almost no land available for expansion of agricultural activities in South Asia or North Africa.

Between 1990 and 2003, annual growth in grain production was highest in Sub-Saharan Africa at 2.4 percent, followed by Asia (1.8 percent), North Africa (just under 1.7 percent), and Latin America (1.4 percent). In the Commonwealth of Independent States (CIS), dramatic changes in the political landscape resulted in a sharp drop in output through 1998. Since then, production has rebounded and is approaching the levels achieved prior to the breakup of the Soviet Union. The production growth in Sub-Saharan Africa is surprising in that the region is characterized by food security issues. For that reason, these data need to be examined in more depth.

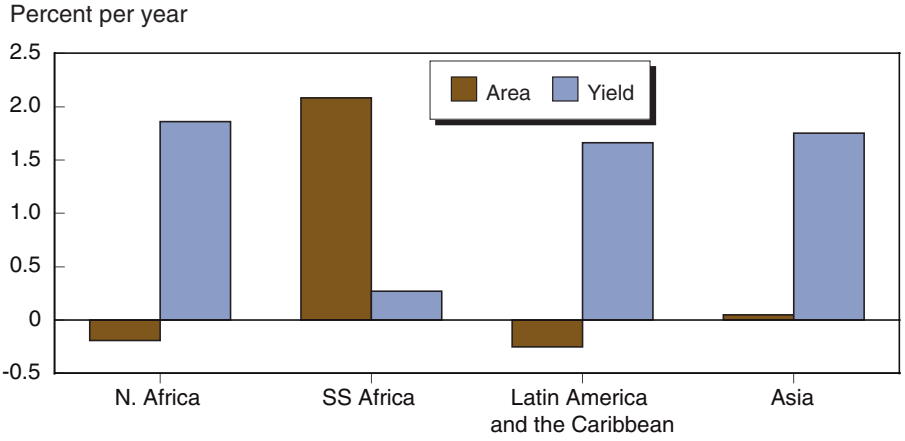
Population growth, which varies widely across these regions, must be factored into these growth trends. Since Sub-Saharan Africa has the highest population growth of all the regions (2.6 percent per year), its **per capita** grain production actually dipped between 1990 and 2003. In fact, negative per capita grain production characterized all the regions, some more than others.

In Sub-Saharan Africa, nearly 90 percent of the growth in grain production was achieved through area expansion (fig. 2-1). In the other regions, yields were the driving force. In Asia, for example, area expansion drove only 3 percent of production growth. In the other regions, the area used for grain production actually declined between 1990 and 2003, meaning that all growth was derived from yield gains. In addition to having the highest absolute level of yields, North Africa has had the highest gains in yields—growing nearly 2 percent per year since 1990. The high regional yields are principally due to production in Egypt, where most of the area is irrigated and grain yields are among the highest in the world.

Asia's yield growth is not far below that of North Africa—1.75 percent annually since 1990. In addition, the region's yields are approaching those in North Africa (fig. 2-2). This success has been driven largely by Vietnam and Bangladesh. In Vietnam, fertilizer use jumped more than threefold between 1990 and 2002. As a result, yields of rice—the staple crop in the

Figure 2-1

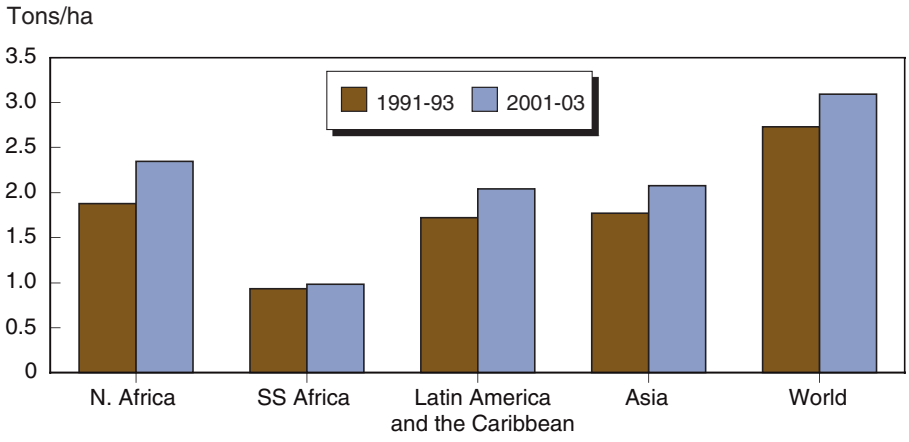
Yield growth is principal source of grain production growth except for SSA



Source: Economic Research Service, USDA.

Figure 2-2

SSA grain yields lag other world regions



Source: Economic Research Service, USDA.

country—average 4.6 kg per hectare, compared with the world average of less than 4 kg. In Bangladesh, irrigated area and fertilizer use both increased 50 percent between 1990 and 2002. Consequently, the country's rice yields, which were 70 percent of the world average as recently as the mid-1990s, now nearly match those levels.

Yield growth in Latin American and the Caribbean averaged 1.6 percent per year since 1990, an increase over the 1980s. This growth was spurred by the adoption of higher yielding corn varieties in Bolivia and Peru. Despite this improvement, the region's grain yields remain at about two-thirds of world levels.

Nearly all of Sub-Saharan Africa's production growth was due to area expansion, as yield growth was negligible. The region's grain yields per hectare are the lowest in the world, measuring about one-third of world averages. Yields of corn—a staple crop for many countries in the region—have basically stagnated since the mid-1970s and currently equal about one-fourth of world levels.

Sub-Saharan Africa's reliance on area expansion for growth in output is unsustainable. Much of the land being brought into production at this point is of poor quality. Therefore, increases in production will need to come from higher yields.

In addition to inadequate production growth—on a per capita basis—short-term production shocks intensify the food security problems in many of these countries. Extreme weather events, though significant, were not the only cause of short-term production shocks. Political instability was also a contributing factor. Projected improvements in yields from technological advances may not be enough to counter repeated short-term shocks. Shocks to agricultural production are compounded by the lack of effective food safety net programs in Sub-Saharan Africa to ward off famine.

Annual grain production in 14 of the 70 countries studied here fell by more than half in 1 year at least once during the last two decades. In that time, 53 of the 70 countries suffered production shortfalls of at least 20 percent at least once during the last 20 years, while 17 experienced such shortfalls more than five times (fig. 2-3). Successive years of drought caused grain production in Southern Africa to drop 20 percent in 2001 and 14 percent in 2002.

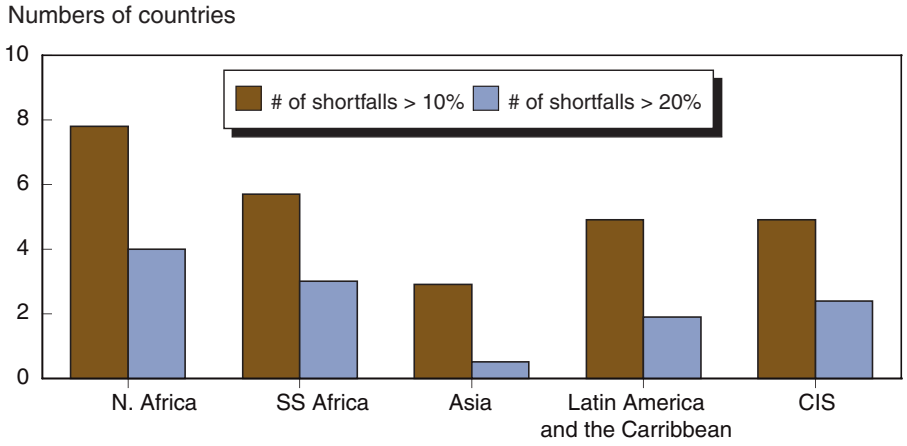
Factors Affecting Yields

Growth in agricultural production can result from extending the agricultural land base and/or intensifying production per unit of land. Given economic and environmental constraints on cropland expansion, however, the bulk of increased crop production will need to come from increased yields on existing cropland. Yields depend on the availability and quality of resources. In low-income, food-deficit countries, the dominant resources are land and labor. Inputs that require capital, such as fertilizer, machinery, and irrigation technology, are not widely used in these regions.

Purchased inputs and the use of new technologies can increase production efficiencies and resulting yields. The development and dissemination of

Figure 2-3

Production shortfalls from trend (1980-2000) are more frequent in Africa



Source: Economic Research Service, USDA.

technologies and practices that maximize yield potential for a particular area will depend on a country's ability to make needed investments and farmers' willingness and ability to adopt the provided technologies.

Farmers choose between technologies based on land characteristics such as soil quality and access to water, as well as personal characteristics like land tenure, income/wealth, and access to credit and information. The farmer's choice of practices, such as fertilizer application and residue management, depends on the time horizon. For example, practices generating high net returns today may not do so indefinitely if they cause land degradation. But practices that reduce land degradation and offer higher net returns in the long run may require initial investments that inhibit adoption.

In recent decades, about half of all gains in crop yields have been attributed to increased use of conventional inputs, especially fertilizer and irrigation water; the remainder was due to genetic improvements in seeds.

Fertilizer Use

FAO data and analysis indicate that increased fertilizer consumption accounted for one-third of the growth in world cereal production in the 1970s and 1980s. Growth in fertilizer consumption per hectare of cropland has been slowing, however, from a global average annual increase of 9 percent in the 1960s to an average annual decline of 0.1 percent in the 1990s. Growth in fertilizer use in developing countries is expected to exceed that of developed countries in the coming years. Developed countries are considered a mature fertilizer market. Also hindering growth in fertilizer use is the increasing awareness of potential environmental harm.

Developing countries' fertilizer consumption has increased rapidly during the last two decades. In 1980, these countries accounted for a third of global consumption. This share doubled to two-thirds by 2002. Among developing regions, per-hectare fertilizer consumption increased most rapidly in land-

scarce Asia and most slowly in Africa. Fertilizer consumption in Sub-Saharan Africa virtually stagnated during the 1990s. The region accounts for only 1 percent of global consumption. In many low-income countries, particularly in Sub-Saharan Africa and Latin America, almost all fertilizer is imported, and insufficient foreign exchange constrains availability. Fertilizer use is most productive on irrigated area or areas with sufficient moisture. Therefore, in regions suffering from or vulnerable to dry periods (Latin America or Sub-Saharan Africa), fertilizer use would not have the results that would be experienced in areas without similar adversities. Consequently, increased fertilizer use in those regions might be limited to irrigated areas or regions where rainfall is more predictable.

Changes in fertilizer use will depend partly on its potential to mitigate onsite land degradation (depletion of soil fertility) versus increased offsite degradation (impacts on water quality, for example).

Irrigation

FAO reports that grain yields in developing countries are more than twice as high in irrigated areas as in rainfed areas. Agriculture accounts for 70 percent of freshwater use worldwide and over 90 percent of withdrawals in low-income developing countries. Globally, irrigated area increased nearly 1.4 percent per year between 1980 and 2002, although the growth rate has declined over time. Growth in developing countries exceeded this rate, and currently more than a quarter of arable land area in developing countries is irrigated. It is estimated that about half of the grain production in developing countries is grown on irrigated land.

The highest growth in irrigated area in the developing world has occurred in Asia, particularly Bangladesh, Nepal, and Vietnam. In East and Southeast Asia, more than 28 percent of arable land is irrigated. In the Latin American and Caribbean countries, nearly 13 percent of arable land is irrigated. Irrigation is severely limited in the most nutritionally vulnerable region, Sub-Saharan Africa. The region accounts for less than 2 percent of the world's irrigated area. Less than 4 percent of its arable land is irrigated. In addition, expansion of irrigated land in the region is negligible—0.5 percent per year since 1990. This rate marks a significant slowdown from growth in the prior decade. Irrigation requires access to water as well as investment in equipment and maintenance—all factors that are elusive in most of Sub-Saharan Africa.

Population growth and the increasing cost of developing new sources of water will place increasing pressure on world water supplies in the coming decades. Even as demand for irrigation water increases, farmers face growing competition for water from urban and industrial users, as well as pressure to protect water's ecological functions. In addition, waterlogging and salinization of irrigated land threaten future crop yields in some areas.

The World Bank and others are reducing their investments in major irrigation projects, and concentrating more on improving water management at the local level in low-income countries. Improved water management not

only has a direct effect on crop growth, but can also increase the efficiency of other inputs. As mentioned, the principal factor limiting yield response to fertilizer use is the inadequate supply of water during the growing season.

Improved Seed Varieties

Genetic improvements to seeds that enhance input responsiveness, resistance to pests and diseases, and tolerance to other stresses have driven much of the gains in yields of late. By the 1990s, 90 percent of land in wheat in developing countries was in scientifically bred varieties, as was 74 percent of land in rice and 62 percent of land in corn. In developed countries, 100 percent of land in wheat, corn, and rice was in scientifically bred varieties by the 1990s (and probably even earlier). Gains from genetic improvements will continue, but likely at slower rates and increasing costs, particularly because gains in input responsiveness have been almost fully exploited. Moreover, while the use of hybrid seeds has raised yields considerably in some countries, their proliferation may not be possible in many developing countries where conditions are not amenable.

Despite these potential limitations, we examined the potential impact of higher yielding varieties on food security in a few Sub-Saharan African countries. This region is the most vulnerable to food shortages, but use of higher yielding varieties is limited largely due to financial constraints facing farmers. Using the Food Security Assessment model (see Appendix 1), we attempted to measure the impact of adopting these varieties by raising yields from their actual levels in 2004. We then examined the implications on food security by reviewing the resulting changes in the distribution gaps—the amount of food needed to raise consumption in each income group to the nutritional target. We chose Ethiopia, Tanzania, Madagascar, and Mali as the test cases because these four countries accounted for an estimated 40 percent of the Sub-Saharan distribution gap in 2004. In "Genetically Engineered Corn in South Africa: Implications for Food Security in the Region" (p. 35), the authors refer to a study performed in South Africa where farmers used GE corn and realized yield increases of roughly 10 percent. We assume a similar result for grains in the study countries, and the distribution gap subsequently declines 24 percent. We then went further and assumed yields to rise to the average of all developing countries. In this scenario, the gap is virtually eliminated—Madagascar is the only remaining country with a gap, and it is negligible. So, despite significant constraints to adopting these technologies, the benefits of doing so could be dramatic.

Prospects for Production Growth

Many developed and some developing countries are close to their maximum scientific and technical potential for growing crops. Therefore, maintaining current growth rates will be unlikely in these areas with today's technologies and practices. However, in many countries—particularly in Sub-Saharan Africa and Latin America—agricultural productivity can exceed that of historical levels. To do so, these countries must promote investment in agricultural research, technology education, and rural infrastructure.

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Forces Shaping Food Security: Factors Affecting Imports

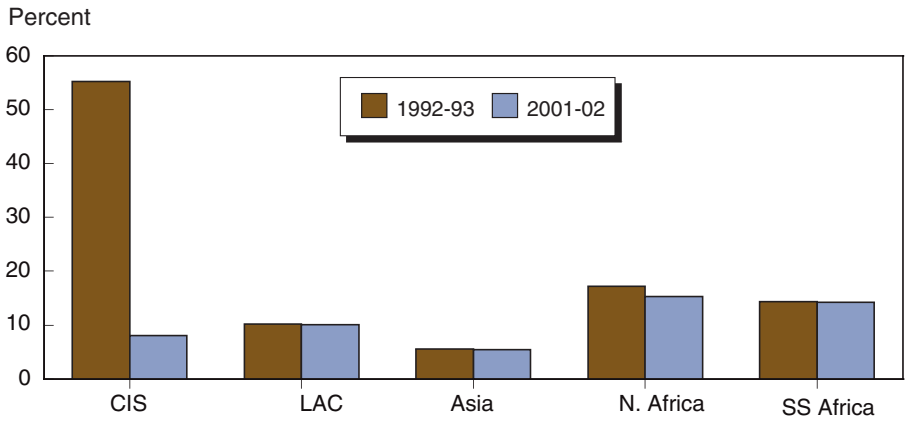
For low-income food-insecure countries, financial constraints severely limit their ability to achieve food security through imports. Food aid can effectively reduce food gaps, but less than 60 percent of food aid is targeted at the low-income food-insecure countries.
(Shahla Shapouri and Birgit Meade)

Food Import Dependency is Low in the Most Food-Insecure Countries

Domestic food production is less critical to food security if countries can import required foods. For low-income food-insecure countries, however, financial constraints severely limit their ability to do this. These countries depend on imports not only for food, but for other essential commodities like fertilizers, fuels, medicine, and essential manufacturing inputs and products. These nonfood items can comprise a large share of the total import bill. In Sub-Saharan Africa, for example, fuel imports were about 16 percent of the total value of imports in 2002. Given the current hike in oil prices, these countries must make hard choices in importing commodities. In this section, we review the level of food import dependency of 70 lower income countries, examine their food import composition, evaluate whether food imports and food aid can fill existing food gaps, and review forces that can influence future imports.

Of the regions studied here, North African countries have the highest level of average calorie consumption, and spend the largest share of their import budgets on food, 15 percent in 2001-02 (fig. 3-1). This marks a slight decline from 17 percent a decade prior (1992-93). The Sub-Saharan African (SSA) countries devoted 14 percent of import budgets to food, but remain the most food-insecure region. Latin American and Caribbean (LAC) coun-

Figure 3-1
Food as a share of total merchandise imports remained stable in all regions except CIS



Source: Economic Research Service, USDA.

tries spent 10 percent of their import budgets on food in 2001-02, and this pattern has not changed much through time. In the Commonwealth of Independent States (CIS) countries, the share of food in import budgets dropped from 55 percent in 1992-93 to 8 percent in 2001-02. The reason for this significant decline is both a rebound in domestic production and a more than two-fold expansion of import budgets during this period. In Asian countries, food captured just 5 percent of the total import budget for much of 1992-2002.

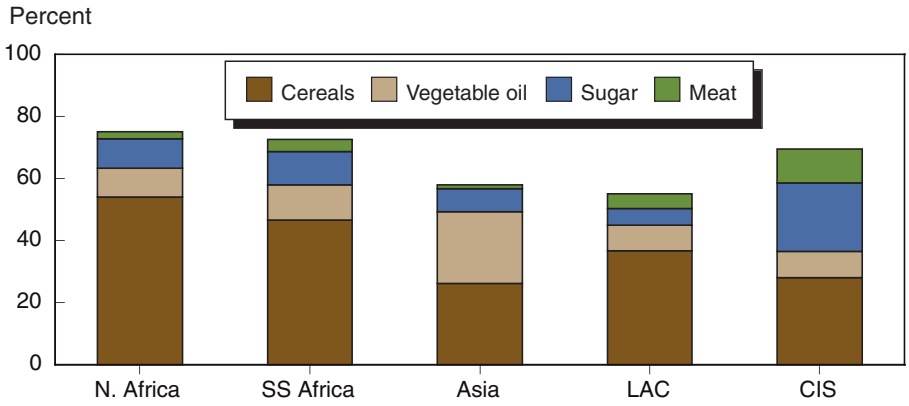
So except for CIS countries where food markets have undergone a major transition, the food share of total imports has remained stable. This pattern holds despite the differences in import budget growth among regions. For example, the total value of imports (all commodities) in LAC almost doubled from 1992-93 to 2001-02, while the food share of those imports held steady. On average, there is almost a one-to-one relationship between growth in food imports and total import budgets in the regions studied. This means that foreign exchange earnings will largely determine whether imports can support food security in these countries. Food import prices, of course, are critical. Given the constant share of food import value in total imports, any increase in food prices would mean a reduction in the quantity of food imports and, in turn, a reduction in food available for consumption.

Cereals Continue To Dominate Food Import Bills

Cereal imports, the key component of the diets of these countries, continue to dominate the food import list in all regions, followed by vegetable oils and sugar (fig. 3-2). Meat and pulses are important dietary components in several countries, but their import shares remain (except for CIS) below 5 percent. All regions but North Africa saw a decline in the cereal share of food imports between 1992-93 and 2001-02. Vegetable oil imports have grown in Asia and the CIS, while their share has declined in North Africa and LAC. Sugar imports have become very important in the CIS, reaching 22 percent of food imports in 2001-02, versus 10 percent in North Africa and SSA. Meat imports, at 10 percent of food imports, are fairly important in CIS countries.

Figure 3-2

Food imports consisted mostly of cereals, vegetable oil, and sugar in 2001-02



Source: Economic Research Service, USDA.

Pulse imports are of relative importance to low-income Asian countries only, where they comprise about 7 percent of total food imports.

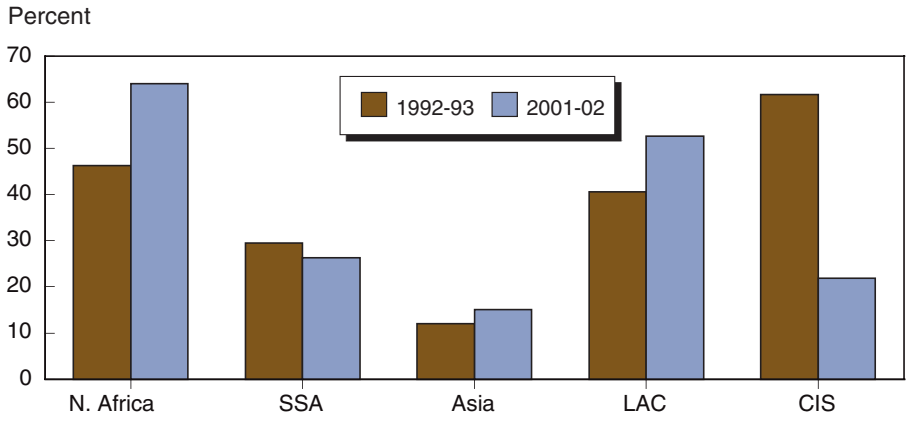
In terms of volume, the average share of cereal imports in total domestic cereal supplies decreased slightly from 36 percent in 1992-93 to 34 percent in 2001-02 for all the study countries. The trends differed widely among regions, with CIS countries dropping from 62 percent in 1992-93 to 22 percent in 2002 (fig. 3-3). In these countries, political instability and changing policies during the post-independence years of the early 1990s led to a decline in economic activity and an increase in imports. Since then, agricultural production has recovered and growth in demand has remained weak, thereby reducing import dependencies.

Of the remaining regions, the low-income Asian countries, despite their doubling of import volumes since 1990, remain the region least dependent on cereal imports, with the share of imports equaling about 15 percent in 2001-02. In contrast, cereal import dependencies in the low-income Latin American countries have grown from 40 percent in 1992-93 to 53 percent in 2001-02, nearing the most import-dependent region of North Africa at 64 percent. There are different reasons for the high import dependencies of the two regions. Latin American countries have purposely invested in export crops such as fruits and vegetables rather than staple crops such as corn. Agricultural exports contribute more than 50 percent of total exports in countries such as the Dominican Republic, Nicaragua, and Guatemala. In contrast, North Africa's import dependency stems from limited agricultural resources, and the agricultural share of total export earnings in this region was less than 10 percent in 2002. In Algeria, the agricultural export share was less than 1 percent of total earnings. North African countries also have longstanding policies that favor consumers. These policies are reflected in their high per capita calorie consumption, 3,162 calories per day in 2002. This compares favorably with higher per capita income countries, such as Sweden and Finland.

Sub-Saharan African cereal import dependencies have grown, but remain low given the general food insecurity. Financial constraints severely limit imports in most SSA countries. Political problems continue to plague

Figure 3-3

Cereals comprise more than half of domestic supply in North Africa and LAC



Source: Economic Research Service, USDA.

economic activity. Countries such as the Democratic Republic of Congo, Somalia, and Sierra Leone have the required resources to expand trade, but years of internal conflict have been prohibitive. Data for these countries are poor or nonexistent, and an assessment of the food situation is therefore weak. Based on available estimates (FAO), the size of cereal imports relative to domestic production ranges from 40 to 90 percent. However, the bulk of those imports consist of food aid.

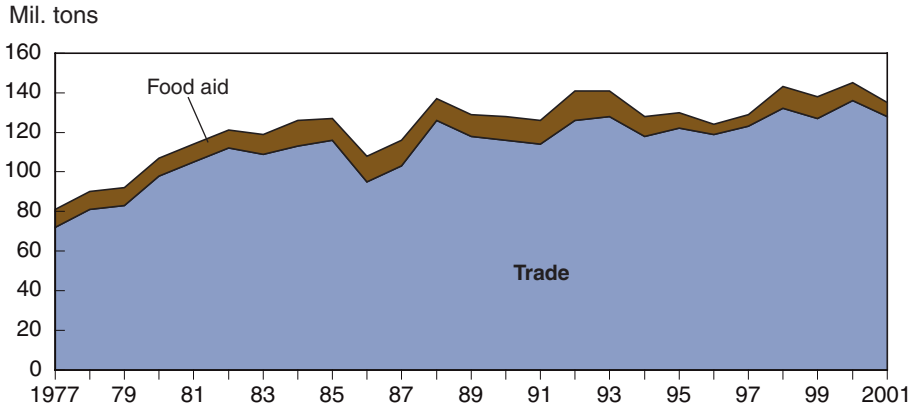
Not All Food Imports Are Commercial

Food aid has been a major means by which the international community improves food access and reduces suffering in low-income countries. The global quantity of food aid has fluctuated during the last two decades, and its share has declined relative to both total exports of food aid suppliers and total food imports of low-income countries. The number of food aid recipients also increased, particularly after the breakup of the Soviet Union and the emergence of new Central Asian countries. The share of food aid in total cereal imports was around 18 to 20 percent in the early 1990s, but has since declined to about 7 percent in 2002 (fig. 3-4).

Sub-Saharan African and Asian countries have been by far the largest recipients of food aid, receiving more than 60 percent of the volume during the last 15 years (fig. 3-5). Severe droughts in the early 1990s resulted in higher food aid shipments to SSA, while political change, financial collapse, and natural disasters in the late 1990s shifted donations to Asia. On a per capita basis, however, SSA's receipts are much higher than Asia's because of the difference in population: SSA countries have less than half the population of lower income Asian countries. North African countries, among the top food aid recipients two decades ago, now receive less than 2 percent of total food aid.

Most food aid is in the form of cereals, but noncereal food aid rose from about 15 percent in 1990 to 20 percent in 2002-03. This trend may be problematic for food security because cereals are the least expensive source of calories, and more expensive noncereal commodities will likely not reach the poorest segments of the population. The distribution of noncereal food aid is not uniform among recipients. In Georgia, for example, noncereals

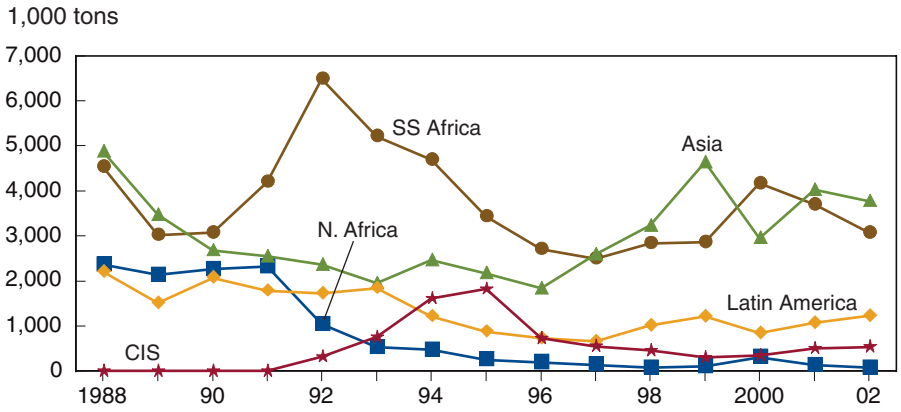
Figure 3-4
Food aid role in world cereal trade is small



Source: Economic Research Service, USDA.

Figure 3-5

Asia and SSA now compete for the first place in receiving food aid



Source: Economic Research Service, USDA.

accounted for two-thirds of the food aid package (67,739 tons in grain equivalent) in 2000. Commodities in this package included vegetable oil, pasta, dried potatoes, dried fish, pulses, sugar, and fresh vegetables. Regionally, Latin American and CIS countries were by far the largest recipients of noncereal food aid, receiving more than 60 percent of the total (converted to grain equivalent) in 2001-02.

By far, the largest recipient of food aid in 2002 was North Korea, at 1.2 million tons, followed by Ethiopia, Afghanistan, and Pakistan, which all received about half a million tons. Countries receiving the largest per capita amounts were Cape Verde, where 52,000 tons of food aid amounted to 115 kg per capita in 2002; North Korea, at 47 kg; and Afghanistan, 22 kg.

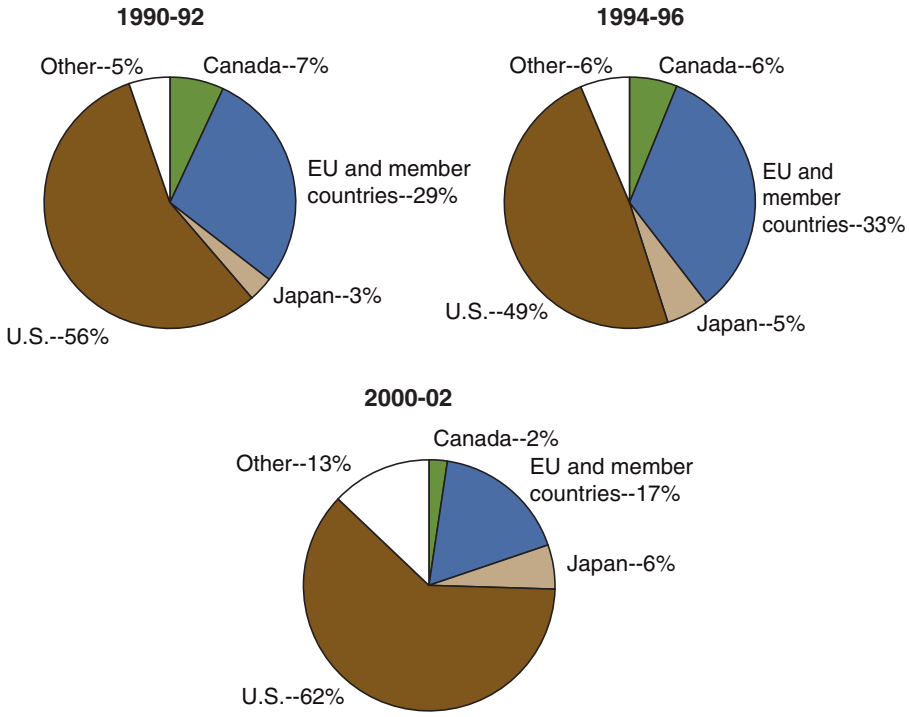
The major food aid donors are the United States, the European Union (EU), Japan, and Canada (fig. 3-6). In the early 1990s, the U.S. provided roughly 7 million tons of food aid per year, or 56 percent of global food aid. The EU share at that time was about 29 percent. U.S. donations fell considerably through the mid-1990s. This decline was partially offset by the EU, whose share rose to a third, and Japan, whose share doubled to 5 percent. U.S. donations rebounded considerably and in 2000-2002, the U.S. share of the world total matched the levels of the early 1990s. Conversely, EU donations have slipped, and its share of the total has averaged 17 percent in recent years. In 2003, U.S. food aid was again less than 50 percent of the total.

Can an Increase in Imports Fill the Food Gaps?

To increase food availability, countries can either increase food production or increase imports. Increases in production are often slow because of the lack of agricultural resources. Imports are often viewed as a quick remedy to fill the consumption gap. So why don't countries increase food imports sufficiently to eliminate or reduce food gaps? In this section, we focus on distribution gaps in relation to imports; this measure captures both the food availability and the food access dimension of food security.

Figure 3-6

U.S. share of global food aid rose after dipping during last decade



Source: Economic Research Service, USDA.

Based on our 2004 estimates, the size of the food gaps (distribution gaps) relative to commercial imports was highest in SSA, about 1.4 times commercial food imports. This is followed by Asian countries, whose food gaps were about half the size of imports. In Latin American countries, the food gap was about 30 percent of imports and in CIS countries it was only 5 percent. These regional averages, however, mask the different situation of each country. For example, in Colombia, the Dominican Republic, and El Salvador, estimated food gaps were less than 20 percent of commercial food imports in 2004. In Bolivia, Ecuador, Guatemala, and Haiti, they were 60 percent or less. In Honduras and Nicaragua, food gaps relative to commercial imports were 90 and 140 percent. Clearly, for many countries in Latin America, a large increase in imports to fill food gaps is unlikely, since they are already highly dependent on food imports. In Asia, countries are less dependent on food imports. In countries such as Indonesia, the Philippines, Sri Lanka, and Vietnam, an increase of less than 5 percent in commercial imports would cover their food gaps. India, with the largest food gap of about 4 million tons, can easily cut back on its exports of about 9 million tons of cereals to cover its food needs.

In Sub-Saharan Africa, the average distribution gap is estimated at 1.4 times commercial imports, with much larger variation by country than in other regions. In 18 of the 37 countries, imports need to grow more than two-fold and in 8 countries more than five-fold to cover food gaps. The countries with estimated gaps of more than 10 times their commercial imports are the Democratic Republic of Congo, Burundi, Ethiopia, and Somalia. Clearly, in

most SSA countries, food gaps cannot be closed by increasing commercial food imports, at least in the short term.

How Effective Is Food Aid in Reducing Food Gaps?

With continued hunger and inadequate safety nets in the low-income countries, food aid remains vital. For this reason, its effectiveness is critical, and this effectiveness hinges on both donors' and recipients' policies. Although the overall level of food aid is decided by donors, country allocations and distributions within countries are often decided jointly by donors, recipients, and multinational organizations such as the World Food Program (WFP) of the United Nations.

Not all food aid donated goes to the lowest income, food-deficit countries, and this concerns many. For example, in 2003, about 8.2 million tons, or 70 percent of total food aid, was given to the countries analyzed in this report (table 3-1). One reason for giving food aid to countries not as visibly needy as others is the "stickiness" of food aid. Institutional requirements for its distribution tend to support its flow even when the need is not as pressing. Poor donor coordination and the lack of uniform, need-related, and timely information that is acceptable to all donors are other reasons. Therefore, in many instances food aid is given to countries that are not critically food-deficient despite donors' intentions otherwise. However, such food aid may still support food security.

To examine the effectiveness of food aid at reducing hunger in the study countries, we used the food security model and actual data from 2003 to calculate the food gaps for 2003 with and without food aid (actual level of food aid received by the countries and actual production and import data in

Table 3-1—Total food aid in grain equivalent, 1988 and 2003

Year	70 recipient countries	All recipients	Food aid share of study countries
	1,000 tons		*Percent*
1988	13,982	15,529	90.04
1989	10,048	12,196	82.39
1990	10,163	13,755	73.88
1991	10,893	13,156	82.80
1992	12,017	15,972	75.24
1993	10,379	17,969	57.76
1994	10,546	12,991	81.18
1995	8,666	10,209	84.88
1996	6,318	7,400	85.39
1997	6,556	7,475	87.70
1998	7,683	8,660	88.73
1999	8,586	14,569	58.93
2000	8,700	11,193	77.73
2001	9,601	10,931	87.84
2002	8,284	9,823	84.34
2003	8,219	12,080	68.04

Source: World Food Program, ERS calculations.

2003). In 2003, the countries received 8.2 million tons of food aid. Surprisingly, by including 8.2 million tons in the estimated level of availability, the estimated gaps—status quo gap, nutritional gap, and distribution gap—were reduced by only 3-5 million tons. In 2003, food aid was more effective in reducing the status quo gap (or maintaining average per capita food consumption of countries) than providing support for inadequate food access within the countries, i.e., reducing the distribution gap (table 3-2). These results indicate that a considerable share of food aid was given to those countries that, according to ERS's definitions and estimations, either had no food gaps or received quantities of aid exceeding their needs. In other words, about half of the food aid was given to countries such as Algeria, Egypt, Armenia, and Azerbaijan, which did not need food aid according to our various indicators.

We also examined how the effectiveness of food aid in 2004 would change if food aid received by countries was held constant at the 2003 level. We used preliminary 2004 food production data and estimated 2004 commercial food imports. Without any change in the flow, food aid would be more effective in reducing the distribution gaps in 2004 than in 2003 (table 3-3). This result is due to the fact that several countries without distribution gaps and receiving food aid in 2003 we estimated to suffer production shortfalls in 2004. Therefore, the same allocation of food aid is effective in that it does reduce an estimated distribution gap. However, the reduction in the gap is only about 57 percent of the level of food aid. This exercise illustrates the critical role of these assessments and the need for flexibility in matching distribution of food aid to countries' needs.[1]

[1] We did not include the disincentive impacts of food aid, which have long been the subject of debate among analysts. The argument is that food aid increases domestic supply and reduces producer prices in recipient countries, which may reduce production incentives in those countries.

Prospects for Foreign Exchange Availability To Finance Imports

Estimated commercial imports of countries are based on an assessment of the countries' financial condition. The estimation of future food imports in the study countries is highly dependent on projections of foreign exchange availability, defined here as the sum of real export earnings and net real external financial flows. The response of food imports to foreign exchange availability is positive and close to one in most food-insecure countries (the

Table 3-2—Changes in food gaps due to food aid received by countries in 2003[1]

	Change in food gaps due to food aid			Food aid in 2003
Region	Status quo gap	Average nutrition gap	Nutritional distribution gap	
		1,000 tons		
Asia	1,360	617	250	2,381
Latin America & Caribbean	84	341	241	539
North Africa	0	0	0	47
CIS	0	63	270	275
SSA	3,225	3,503	2,360	5,251
Total	4,669	4,524	3,121	8,219

[1]These estimates are based on actual food consumption data.

Source: ERS calculations.

Table 3-3—Changes in nutritional distribution gaps in 2004 if food aid is provided at 2003 level

Region	Food gap with food aid	Food gap without food aid	Difference in gaps	Food aid in 2003
		1,000 tons		
Asia	8,648	10,141	1,493	2,381
Latin America & Caribbean	3,396	3,940	544	539
North Africa	0	0	0	47
CIS	230	309	79	275
SSA	18,900	21,480	2,580	5,251
Total	31,175	35,871	4,696	8,219

Source: ERS calculations.

food import response tends to be higher when its share is small relative to the total import bill). Food import prices and import/government trade policies also play an important role in import levels. Despite the range of food import responsiveness, countries' food imports will increase with an increase in foreign exchange availability. To project food imports, we assume that countries' export earnings mostly follow their historical path (since 1990), while the real net external financial flow (credit and external assistance) is assumed to remain constant at 2001-03 levels. This assumption implies that the performance of exports will be the key determinant of food import capacity.

During 1992-2002, the total value of export earnings (goods and services) expanded in all regions, despite variations by country. Asian export values increased fastest, nearly 8 percent per year, and North African countries slowest at 4 percent. In CIS countries, exports grew 7 percent per year, followed by about 5 percent in Sub-Saharan Africa and Latin America. In Asian and CIS countries, the growth in export earnings led to a decline in their trade deficit. In CIS countries, the trade deficit was about 42 percent of export earnings in 1992, declining to 14 percent in 2002. In Asian countries, the 1-percent trade deficit in 1992 was turned into a 6-percent trade surplus by 2002. North African countries saw improvements in the trade deficit, while in Sub-Saharan Africa and Latin America trade deficits deteriorated over 1992-02. Sub-Saharan Africa had the highest trade deficit-to-exports ratio in 2002, about 20 percent.

The future performance of commodity markets could have a major impact on the projected export earnings of the study countries. Most low-income countries, many in Sub-Saharan Africa, continue to depend on the exports of a few primary commodities—such as coffee, tea, sugar, and tobacco—for most of their export earnings. Prices for these commodities are not expected to grow much in the long term. According to the World Bank, in real terms, nonenergy and agricultural commodity prices are projected to decline, on average, nearly 2 percent per year in 2004-14, metals by 1.8 percent, and beverages by 3.5 percent. Internal market conditions (demand, supply) of these countries generally have no significant influence on world market prices. Without a major effort to diversify exports, growth in export earnings could slow considerably.

The projection of import capacity of these countries during the next decade is based on historical performance and disregards other sources of import financing options. Average net flows of import support to North Africa, Sub-Saharan Africa (excluding Nigeria), Latin America, and CIS countries declined during the last decade, while flows to the Asian countries in this study were positive. Again, there is wide variation among countries. For countries such as Mozambique, Rwanda, and Somalia, as much as 45 percent of imports were supported by external assistance in the last 5 years. In contrast, higher income countries with political problems, such as Algeria and Angola, are faced with a net loss due to capital flight. For a number of countries, the debt burden continues to dampen growth prospects and the risks of setbacks are considerable; therefore, financial conditions remain difficult. According to the World Bank, the ratio of debt to gross national income (GNI) was close to 100 percent in the low- and middle-income countries of Sub-Saharan Africa, Latin America, and South Asia in 2002.

The future financial stability of the low-income countries considered here remains uncertain. Many countries have taken economic and/or political steps that should help secure a more financially stable future. The International Monetary Fund (IMF), the World Bank, and donors have proposed and supported various policy reforms emphasizing demand management, currency devaluation, privatization, and reduction in market distortions. The benefits of such policy reforms have, so far, been remarkable in the developing countries of Asia. But fundamental changes in economic policies have also occurred or are underway in African and Latin American countries. Other significant progress has been made with respect to political liberalization. Since 1990, many countries have held presidential and/or parliamentary elections, some for the first time.

With success come new challenges and risks. In many countries, domestic investment remains very low. Countries with high investment and better management of capital inflow are generally less vulnerable to changes in world financial markets. Improvements in economic policies are recent in most countries and can be derailed by external forces. In the low-income African countries, policy progress is uneven and there are risks and uncertainties linked to political instability. For a number of highly indebted countries such as Nigeria and Côte d'Ivoire, a substantial debt burden continues to dampen growth prospects, and risks of setbacks are considerable while financial conditions remain difficult.

Prospects for Food Imports

Food imports are projected to play a growing role in the food supply and food security of the study countries. Commercial imports of all countries are projected to grow about 3.5 percent per year during the next decade under the strict assumption of constant financial flows (average 2000-02). This assumption may underestimate the import capacity of some countries, particularly some Asian and CIS countries that have enjoyed strong export growth since 1998 (8 percent per year), but it may overestimate the financial capacity of countries in other regions.

Food imports are expected to grow in North African and Latin American countries to more than half of food consumption, so foreign exchange earnings will be critical. These two regions have reduced their trade deficits during the last decade, which could attract external capital.

The projected commercial import growth for Sub-Saharan Africa is about 2 percent, despite the 5-percent average export growth projected in the region. Again, uneven performance characterizes the region. For example, export growth in countries such as Kenya, Tanzania, and Uganda is projected to be well above the regional average. As food production grows in these countries, food imports slow. Another reason for the expected slowdown in food import growth is the growing trade deficits in the region and the growing dependency on external assistance to finance imports. Continued political instability in Angola, Côte d'Ivoire, Liberia, the Democratic Republic of Congo, the Central African Republic, Sudan, Somalia, Rwanda, Burundi, and Zimbabwe dampens the region's prospects for attracting external financial support. Political instability in countries such as Angola and Zimbabwe has also led to capital flight, which leaves less foreign exchange for food imports.

In sum, food imports are expected to grow, but clearly remain at levels below those required to fully meet projected food gaps. Food import dependency in many food-insecure countries, Asian countries in particular, remains very low. Countries such as India continue to export food even when many inhabitants are struggling with hunger and poverty. For these countries, the potential for improving food security is much greater than we have projected. For other countries, particularly SSA countries, vulnerability to food insecurity remains high, and increases in commercial food imports are unlikely to change that. For these countries, external assistance, both direct and indirect, and expanded trade opportunities are essential.

Food aid can play a major role in this area. Allocations of food aid are based on a mix of objectives. In addition to hunger, factors such as political instability and financial difficulties influence donors' decisions. However, because of slow progress in improving global food security and the critical role of food aid, it is vital that donors better target their limited aid to maximize its benefits in terms of alleviating hunger.

Special Article

Genetically Engineered Corn in South Africa

Implications for Food Security in the Region

David Schimmelpfennig, Stacey Rosen, and Carl Pray*

*Schimmelpfennig and Rosen are economists with ERS and Pray is a Professor of Agricultural, Food and Resource Economics at Rutgers, the State University of New Jersey. This work was supported by grants from the Rockefeller Foundation and the views expressed in this article are not necessarily those of the U.S. Department of Agriculture.

Corn is the staple food in most Southern African countries, accounting for more than a third of calorie consumption in recent years. Its importance in the diet ranges from 17 percent in Angola to 60 percent in Lesotho. Given the region's financial constraints and limited import capacity, domestic production is critical to the supply of corn.

Corn production has declined since 1990 in 3 countries (7 of the 70 study countries were included in the analysis for this article) in the region—Swaziland, Zambia, and Zimbabwe. In Angola, Lesotho, Malawi, and Mozambique, growth in corn output has been heavily dependent upon increases in area. In Angola, for example, area growth has accounted for more than 80 percent of the growth in corn production since 1995. In Mozambique, more than half of the growth stemmed from area growth. In Lesotho and Malawi, corn output rose based on area growth alone as yields have declined since 1995. This dependence on area growth is not sustainable. Farmers in the region are already planting on marginal land, resulting in low yielding crops.

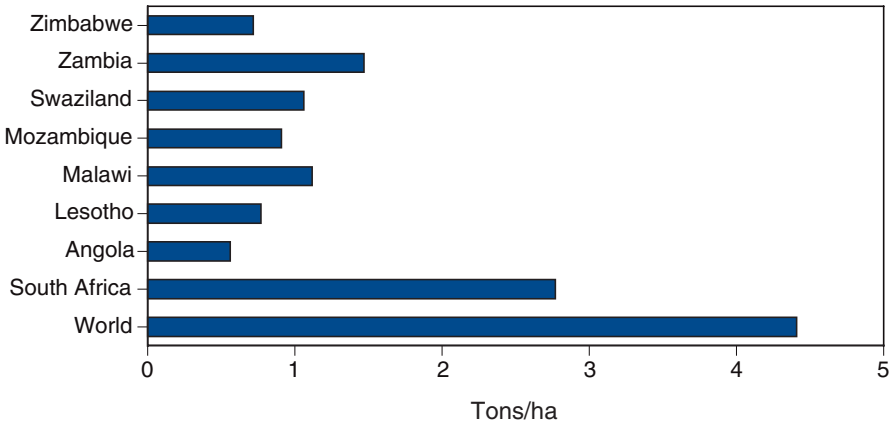
For production growth to keep pace with demand in these countries, yields need to improve. At this point, yields are among the lowest in the world. Even in South Africa, which has the highest yields in the region and where yield growth rather than area growth has accounted for the gains in production, yields pale in comparison to other regions of the world. Corn yields in the country were equal to 63 percent of the world average in 2001-03 (fig. A-1). They were just below those in Latin America and the Caribbean, and about even with those in East and Southeast Asia. Corn yields in the neighboring countries were even lower than those in South Africa, ranging from Zambia (53 percent of yields in South Africa) to Angola (20 percent).

Low levels of fertilizer use and limited technology adoption both contribute to these low yields. Sub-Saharan Africa as a whole, with more than 10 percent of the world's arable land, accounts for less than 1 percent of the world's fertilizer use, and use is growing slowly. Since 1980, fertilizer use in the region has grown only 1.3 percent per year, less than half the rate of population growth. In addition, this growth has slowed over time, and use has remained fairly flat since the early 1990s.

Given low yields, low levels of input use, and financial constraints on imports, securing sufficient food for the region seems contingent on higher yielding technologies. Here we review the use of genetically engineered corn in South Africa, and examine the potential implications of its use in other countries in the region.

Figure A-1

Corn yields (2001-03) in Southern Africa are far below world levels



Source: Economic Research Service, USDA.

Introduction

Many contend that biotechnology companies have not produced genetically engineered (GE) crops that will boost production of basic foods in developing countries or increase the income of small farmers. GE corn in South Africa is an exception, and could be an important proving ground for GE food crops in Africa and the rest of the developing world. South Africa was the first developing country to grow GE cultivars of corn. The staple food of South Africans is white-grained corn. Yellow-grained corn is also grown in large quantities, but primarily for animal feed and as an input in processed foods. In 1998, corn hybrids with a *Bacillus thuringiensis* (Bt) gene[1] to make them resistant to the corn stalk borer were approved for commercial use by the South African Government. (The stalk borer is a pest that damages the corn stalk, stunting or killing the crop). The first Bt corn hybrids were yellow-grained. In 2001, seed companies started selling white-grained Bt corn hybrids in South Africa. In 2003, Honduras, the Philippines, and Uruguay planted Bt corn for the first time. Argentina also plants Bt corn.

If GE corn proves beneficial to small farmers and poor consumers in South Africa, then the rest of Africa may be more inclined to adopt GE food crops. Bt white corn has the potential to greatly increase yields, boost income for farm families, reduce pesticide use, and improve the health of the rural poor by reducing their exposure to mycotoxins in corn.

Development and Spread of Bt Corn

Research on medical and agricultural biotechnology in South Africa started in the late 1970s. The first experimental plantings of GE plants were in 1990 with U.S. Bt genes in U.S. cotton varieties. In 1997, Bt cotton was approved by the South African Government for commercial planting, and 1997/98 was the first growing season for this crop. One year later, Bt corn, which is resistant to stalk borer, became the second GE crop approved for commercial use and was planted in the 1998/99 cropping season.

[1] *Bacillus thuringiensis* refers to a group of rod-shaped soil bacteria found all over the earth, which produce "cry" proteins that are indigestible by—yet still "bind" to—specific insects' gut (i.e., stomach) lining receptors. Those "cry" proteins are toxic to certain classes of insects (corn borers, corn rootworms, mosquitoes, black flies, some types of beetles, etc.), but are harmless to mammals. Genes that code for the production of these "cry" proteins have been inserted by scientists since 1989 into vectors (i.e., viruses, other bacteria, and other microorganisms) in order to confer insect resistance to certain agricultural plants.

In South Africa and other Southern African countries, yield losses from the African corn stalk borer are estimated to be between 5 and 75 percent. In South Africa, the yield loss averages 10 percent, equating to an average annual loss of nearly a million tons of corn worth about $130 million.

The initial spread of Bt corn in South Africa was quite slow. In 2000/2001, after 2 years of experience with Bt corn, farmers planted 75,000 ha of Bt corn, or less than 3 percent of the total corn area (table A-1). When surveyed by representatives of the University of Pretoria's Department of Agricultural Economics, Extension and Rural Development, both seed companies and farmers suggested three main reasons for the slow spread of Bt corn. First, the Bt hybrids on the market were not well adapted to the South African consumer market or to local agricultural conditions. White corn usually comprises 50-60 percent of total corn area in South Africa, but Bt white corn hybrids were not sold to farmers until 2001.

A second reason for slow adoption was that stalk borer is not a significant pest problem every year, so many farmers did not see a big productivity advantage from the Bt gene. Many farmers find that if they plant at the recommended time, they will miss the first moth flight and have limited damage whether they plant Bt varieties or not. Rainfall is the main factor controlling planting date. In years when planting windows are reduced by inadequate rain or pest pressures are higher, farmers might value Bt varieties more highly. For the few years that Bt corn has been available so far, many large farmers felt that the increased yield from Bt corn varieties was not enough to pay for the company's technology fee. Thus, at first Bt will probably only be adopted in those places where stalk borer is a particularly difficult problem.

The third reason for the slow spread of Bt corn was farmers' concerns that they would be unable to sell their crop at the local elevator because of consumer concerns about GE food. Several African countries have said that they will not import animal feed with GE ingredients, and Zambia rejected U.S. food aid because it contained GE corn.

In 2000, firms started selling Bt yellow corn hybrids that were specifically developed for South Africa's dry windy conditions. In 2001, the first Bt white corn hybrids were released. The second constraint on Bt use—farmers' perception of low profitability—changed in the 2001/02 season. That season there was a particularly severe attack of stalk borers, and commercial farmers suffered extensive damage and yield losses. As a result, many more commercial farmers opted to use Bt corn.

Table A-1—Estimated area planted to transgenic crops has risen considerably

Crop	1999/2000	2000/2001	2001/2002	2002/2003
Bt yellow corn (ha)	50,000	75,000	160,000	197,000
% of yellow	3	5	14	20
Bt white corn (ha)	0	0	6,000	55,000
% of white	0	0	0.4	2.8
Total Bt corn (ha)	50,000	75,000	166,000	252,000
% of total	1.3	2.3	4.7	7.1

Source: SANSOR and Monsanto.

Farmers' concern about demand and consumer acceptance has not proved to be a major factor in Bt adoption so far. There is currently no premium for non-GE corn in South Africa, and farmers are easily selling their GE crops. South African consumers scrutinize corn products carefully, but appear to value whiteness and other physical properties over lack of GE traits. In addition, the countries that are refusing GE corn imports or food aid are too small to have much impact on Bt corn prices.

GE corn area grew again in the 2002/03 planting season. Seed firms estimate that the area could double (to half a million hectares or more) in the next few years. The main constraint appears to be the supply of seed, particularly Bt white corn seed, which has not kept up with demand.

Small-scale farmers were able to obtain Bt white corn seed for the first time in 2001/02. Small-scale farmers in Mpumalanga, KwaZulu Natal, Eastern Cape, and Limpopo were given small packets of white Bt corn and the isoline (the same hybrid that does not include Bt). In 2002/03, many small-scale farmers were unable to buy Bt corn seed due to a limited seed supply and the increased demand by large-scale farmers.

Impact of Bt Corn on Large-Scale Farmers

Did the adoption of Bt corn have a measurable impact on farmers' yields and pesticide use? The main target of Bt corn in South Africa is the African corn stalk borer (*Busseola fusca*) and the Chilo borer (*Chilo partellus*); they are estimated to be responsible for a 10-percent loss in yield each year, even though chemicals are used to control them. In the United States, where Bt was designed to control similar pests, farmers failed to achieve the expected gain in benefits: surveys of U.S. farmers show a small increase in yields, but little reduction in insecticide use. Since the infestation level of European corn borers is low in most areas in most years, and pesticides are not very effective, few farmers used pesticides even on their conventional corn hybrids. Therefore, the adoption of Bt corn did not result in a discernable reduction in pesticide.[2]

Data on the impacts of GE corn in South Africa are from a sample of 33 large-scale corn producers, who were surveyed by representatives of the University of Pretoria about the 1999/2000 and 2000/2001 production seasons. All but one of the farmers grew both Bt and conventional yellow corn. The irrigated farms in the sample were from the Northern Cape and Mpumalanga, and the dryland farms from Mpumalanga and the northwest Provinces.

Yields increased 11 percent on irrigated land and 10.6 percent on dry land for large-scale farmers who planted Bt corn. The differences in means of Bt and conventional were statistically significant (at the 5-percent level) only in the total irrigation and the total dryland calculations. Thus, large-scale yellow corn farmers were seemingly able to increase their yields with Bt corn. Farmers did not report a high level of stalk borer infestation in either season or survey region. Yield benefits would likely increase in seasons with higher stalk borer pressure.

In addition to the yield gains from Bt yellow corn, large-scale farmers were also able to save on their plant protection operations. Seventy percent of the

[2] Jorge Fernandez-Cornejo and William McBride, *Adoption of Bioengineered Crops*, Agricultural Economic Report No. 810, May 2002, pp. 22-24. This analysis was done prior to the 2003/04 release of a new variety of Bt corn with corn rootworm resistance, which has stimulated increases in adoption. See "Data: Adoption of Genetically Engineered Crops in the U.S.", *http://www.ers.usda.gov/Data/BiotechCrops/adoption.htm*.

large-scale yellow corn farmers in our survey indicated stalk borers to be the dominant insect problem in corn production and, unlike in the U.S., South African farmers sprayed substantial amounts of pesticide to control them—particularly in the irrigated areas. The reduction in pesticide cost is only part of the farmers' actual reduction in pest management costs. Other savings include lower costs for labor and fuel in the application of pesticides and less time spent scouting fields for pest buildup. As expected, reductions in costs were highest in irrigated regions, where moist conditions are more favorable to insect growth and reproduction.

Large-scale farmers who planted Bt yellow corn enjoyed more income from Bt than from conventional corn fields, despite paying a technology fee along with the seed price. They received the same price for Bt and conventional corn, so the difference in revenue is directly due to yields. The price difference between conventional yellow corn seed and Bt corn seed (plus technology fee) varied among the different seed companies. The difference in 2000/2001 ranged between R130 ($21) for a bag of 80,000 seeds to R220 ($36) for a bag of 60,000 seeds. As a result, the increase in net income ranged from R170 ($28) per hectare in dryland areas to over R1,000 ($162) per hectare in the Northern Cape irrigated regions.

Can Small-Scale Farmers Also Benefit?

South Africa's commercial farmers are adopting Bt corn and benefiting from it. However, of greater interest to those working on the economic and social development of Africa is whether small-scale farmers can benefit when Bt is incorporated into a subsistence crop such as white corn.

We analyzed farm-level data from the 2001/02 planting season in six areas where Monsanto distributed white Bt and non-Bt corn seed free of charge. Monsanto worked with local extension agents and provided a 2-day training program to farmers selected by the extension system. The company provided small packets of Bt hybrid seed and the isoline and asked farmers to plant these seeds next to their usual corn seed in their usual corn fields so that agronomic practices and the impact of weather would be comparable.

Results suggest that Bt corn has a large yield advantage over conventional hybrids even for small-scale farmers. In Northern Highveld (Mpumalanga), Hlabisa (KwaZulu Natal), and Venda (Limpopo Province), the Bt seed *Yieldgard* showed yields of nearly 50 percent over the isoline (table A-2).

Small-scale farmers were able to reduce pesticide costs in most areas except in Venda, where very little pesticide was used in that particular season. About half of the farmers surveyed used insecticides (in granular form) intermittently. They reported that the main pest was indeed the stalk borer, followed by cutworm. In contrast, only 5 percent of small-scale farmers who planted *Yieldgard* corn reported using pesticides. It proved difficult to obtain precise estimates of amounts of pesticides used on any of the three different cultivars, and therefore, it is not possible to calculate the potential change in farmers' net income due to the adoption of Bt corn.

The survey also found that small-scale farmers liked the **quality** of the corn produced by *Yieldgard*. At harvest, farmers were shown their own grain and

Table A-2—Average corn yields for Bt higher than isoline hybrids, 2001/02

Area	Yield with isoline corn	Yield with Bt corn	Yield advantage
	Kg/kg seed		*Percent*
Northern Highveld	95.4	148.4	56
Southern Highveld	190.3	204.3	7
Hlabisa	121.2	177.7	47
Venda	114.1	178.3	56
Mqanduli	64.7	79.7	23
Flagstaff	112.2	129.3	15

Source: Authors' survey.

the *Yieldgard* grain and asked to judge the grain according to quality. Most farmers rated the *Yieldgard* grain to be of excellent quality and CRN/local grain as good quality. The Bt corn had less pest damage on the grain than the others. When asked what they liked best about the Bt hybrid corn, farmers at three sites chose better quality, while higher yield was the most cited at the other three sites. The farmers did not place much importance on the benefits from pesticide reduction (probably because only half of them used pesticides prior to the availability of Bt seeds).

Scenarios for Adoption in Other Countries

Yield increase is perhaps the most important benefit of Bt with respect to improving food security in the region. To illustrate the potential impact of introducing genetically engineered corn in other countries in Southern Africa, we ran two scenarios of yield implications using the USDA-ERS Food Security Assessment model. The results reported above indicate wide variability in yield response—from 7 percent to 56 percent—among small farmers to the improved seeds. Since large farmers were able to more consistently obtain 11-percent yield gains—and since small farmers under most conditions can get higher yields than large farmers—we chose 11 percent as a conservative across-the-board yield gain for the surrounding countries of Angola, Lesotho, Malawi, Mozambique, Swaziland, Zambia, and Zimbabwe. We also ran a scenario reflecting a 5-percent yield increase. We then examined the implications of these yield increases on consumption and food security relative to the baseline scenario—the original model results.

The greatest change to consumption was in Lesotho, with a 14.6-percent increase in consumption given a 5-percent increase in corn yields and a near 16-percent increase under the 11-percent increase in yields scenario. In this case, base production is so low that any boost to production will stimulate a spike in consumption. The smallest response—less than 1 percent under both scenarios—was in Swaziland, where domestic production plays a minor role in consumption relative to imports. As a result, the jump in production had little impact on overall consumption. Malawi and Zambia each had similar results—with roughly 3-percent increases in consumption under the 5-percent yield scenario and greater than 6-percent increases in consumption under the higher yield scenario. While these responses are much smaller than those in Lesotho, the increases are much higher than the rate of population growth—which is under 2 percent in each country—meaning positive per capita growth in consumption. In a similar vein,

Zimbabwe's consumption response—although smaller than in Malawi and Zambia—far exceeds its population growth.

To measure the implications of these yield increases on food security, we review changes to the distribution gap, or the amount of food needed to raise consumption in each income group to meet nutritional requirements. This measure aspires to meeting nutritional standards, versus simply maintaining consumption levels (status quo) that may fall short in some countries. This measure also addresses uneven purchasing power or food distribution problems within a country.

The yield increases had reasonably significant results in all but one country, Swaziland (table A-3), where domestic production contributes very little to consumption. Results for Angola were the most pronounced, with a 28- and 32-percent drop in the distribution gap due to the 5- and 11-percent increases in corn yields. In this case, the gap is almost negligible relative to the size of estimated consumption, so the increase in production has a major impact on the size of the gap. The opposite is true for Lesotho where the gap is large relative to estimated consumption levels, so the increase in production has a much smaller impact—the gap falls roughly 9 percent when corn yields increase 5 percent.

The impact in Malawi is of a similar scope to that in Angola, but for a different reason. Here, domestic production accounts for a large share of consumption, so the jump in production results in a significant drop in the distribution gap. This situation is nearly replicated in Mozambique and Zambia, where reliance on domestic production is high and the resulting decline in the food gap is nearly as large as in Malawi. Zimbabwe has by far the largest gap of all the countries studied here. However, the country has become increasingly reliant on imports to boost consumption as the role of production has declined. Consequently, the boost to production, while important, did not play as significant a role in reducing the food gap as in most of the neighboring countries.

Encouraging Small Farmers To Adopt Bt Corn

Small farmers who will purchase hybrid Bt corn are likely those already convinced of its value. At present, officials at Pannar Seed Company estimate that about 10 percent of small-scale South African farmers plant their land with non-Bt hybrids, primarily Pannar hybrids, while 90 percent of the

Table A-3—Distribution gap falls as yields rise

		Yield change scenarios	
	Base	5%	11%
		1,000 tons	
Angola	67	48	46
Lesotho	271	246	243
Malawi	192	161	123
Mozambique	132	110	96
Swaziland	15	15	15
Zambia	487	440	383
Zimbabwe	830	777	713

Source: ERS calculations.

small farmers' land is planted with open-pollinated varieties (OPVs) and saved seeds of hybrids and OPVs. Thus, it is likely that initial adoption of Bt hybrids would be limited to areas already growing hybrids and that adoption would be much slower in less developed areas like the Eastern Cape.

The area under Bt corn could be expanded if companies are willing to segment the Bt corn seed market and charge a lower price to small farmers than to large. The South African Government is pressuring agribusiness to assist small holders, and this is one option. Pannar has a program similar to this with conventional hybrid corn seed. For small farmers, Pannar offers double-cross hybrids or OPVs that are inexpensive to produce, and sells them to small farmers at low prices (R 350/bag ($57) for double-cross hybrids and R170/bag ($28) for OPVs). At the same time, it produces triple-cross hybrids and charges premium prices (R 700/bag ($113)) to large commercial farmers.

However, this type of pricing may not be possible if the regulatory process is structured so that it is more expensive to provide technology to small-scale than to large-scale producers. Under the current system in South Africa, every farmer who plants Bt crops must sign a contract with the companies that are selling GE seeds, identifying the area where the seed will be planted and agreeing to abide by the refuge requirements.[3] This is relatively easy for large companies who are selling directly through their marketing agents to large producers. However, if companies are dealing with thousands of small farmers, this expense could very well preclude the sale of GE seeds to the smaller farmers.

[3] Farmers are required to plant 20 percent of their Bt area with conventional hybrids if they spray the refuge with pesticides or 5 percent if they do not spray.

Another way to encourage small farmers to adopt Bt corn would be for private firms or government research institutes to put Bt into corn OPVs. Then small farmers could save their seed and still get the benefit of the Bt. However, it would be almost impossible for the government to enforce any type of Bt corn refuge without keeping track of the farmer-to-farmer sale of Bt corn. This lack of oversight might increase the speed at which Bt-resistant stalk borers would develop. Until more is known about the development of resistance, this option is probably not realistic.

Another way to improve the acceptance of Bt corn would be for the government to subsidize the purchase of seed, technology fees, or credit for the poorer farmer. The experience of Bt cotton in Makhathini suggests that credit, which has been subsidized by various government banks to purchase Bt seeds and complementary inputs, can influence the adoption of Bt crops by small-scale farmers. Seeds, pesticides, and other inputs were provided in-kind by a co-op, which then purchased the crop and kept enough money from the sale of the cotton to pay for the value of the inputs. This allowed small-scale farmers to adopt Bt cotton very rapidly. However, in recent years, when farmers did not have access to credit, the area under Bt cotton dropped dramatically. Although researchers on the Makhatini Flats in Kwa-Zulu Natal indicate that the farmers who planted self-financed cotton all planted Bt, the lack of credit has caused a substantial reduction in the planting of cotton altogether.

In sum, Bt white corn can benefit Africa because it can substantially increase crop yields and reduce pesticide use. This could increase small

farmers' incomes if seed cost is not too high. If Bt corn does turn out to be profitable for small farmers in South Africa, farmers who already use hybrids are likely to adopt it quickly elsewhere in Africa. In Zimbabwe, 91 percent of the corn area was planted with hybrids in 1997-99; in Kenya, 85 percent; and in Zambia, 65 percent. As the scenario results suggest, increased yields from the use of improved seeds can improve food security by boosting consumption. Proliferation of adoption will depend on whether policymakers can establish credible biosafety regulatory systems and base their decisions about GE crops on scientific evidence of the risks, costs, and benefits of these technologies.

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Appendix 1—Food Security Model: Definition and Methodology

The Food Security Assessment model used in this report was developed by USDA's Economic Research Service for use in projecting food consumption and access and food gaps (previously called food needs) in low-income countries through 2014. The reference to food is divided into three groups: grains, root crops, and a category called "other," which includes all other commodities consumed, thus covering 100 percent of food consumption. All of these commodities are expressed in grain equivalent.

Food security of a country is evaluated based on the gap between projected domestic food consumption (produced domestically plus imported minus nonfood use) and a consumption requirement. Like last year, we are using total food aid data (cereal and non-cereal food commodities). These data are provided by the World Food Program (WFP). All food aid commodities were converted into grain equivalent based on calorie content to allow aggregation. For example: grain has roughly 3.5 calories per gram and tubers have about 1 calorie per gram. One ton of tubers is therefore equivalent to 0.29 ton of grain (1 divided by 3.5), one ton of vegetable oil (8 calories per gram) is equivalent to 2.29 tons of grain (8 divided by 3.5).

It should be noted that while projection results will provide a baseline for the food security situation of the countries, results depend on assumptions and specifications of the model. Since the model is based on historical data, it implicitly assumes that the historical trend in key variables will continue in the future.

Food gaps are projected using two consumption criteria:

1) *Status quo target*, where the objective is to maintain average per capita consumption of the recent past. The most recent 3-year average (2001-2003) is used for the per capita consumption target to eliminate short-term fluctuations.

2) *Nutrition-based target*, where the objective is to maintain the minimum daily caloric intake standards of about 2,100 calories per capita per day—depending on the region—recommended by the U.N.'s Food and Agriculture Organization (FAO). The caloric requirements (based on total share of grains, root crops, and "other") used in this assessment are those necessary to sustain life with minimum food-gathering activities. They are comparable to the activity level for a refugee—they do not allow for play or work.

The status quo measure embodies a "safety-net" criterion by providing food consumption stability at recently achieved levels. The nutrition-based target assists in comparisons of relative well-being. Comparing the two consumption measures either for countries or regions provides an indicator of the need, depending on whether the objectives are to achieve consumption stability and/or to meet a nutritional standard. Large nutrition-based needs relative to status quo needs, for example, mean addi-

tional food must be provided if improved nutrition levels are the main objective. In cases where nutrition-based requirements are below status quo consumption needs, food availability could decline without risking nutritional adequacy, on average. Both methods, however, fail to address inequalities of food distribution within a country.

Structural Framework for Projecting Food Consumption in the Aggregate and by Income Group

Projection of food availability—The simulation framework used for projecting aggregate food availability is based on partial equilibrium recursive models of 70 lower income countries.[1] The country models are synthetic, meaning that the parameters that are used are either cross-country estimates or are estimated by other studies. Each country model includes three commodity groups: grains, root crops and "other." The production side of the grain and root crops are divided into yield and area response. Crop area is a function of 1-year lagged return (real price times yield), while yield responds to input use. Commercial imports are assumed to be a function of domestic price, world commodity price, and foreign exchange availability. Food aid received by countries is assumed constant at the base level during the projection period. Foreign exchange availability is a key determinant of commercial food imports and is the sum of the value of export earnings and net flow of credit. Foreign exchange availability is assumed to be equal to foreign exchange use, meaning that foreign exchange reserve is assumed constant during the projection period. Countries are assumed to be price takers in the international market, meaning that world prices are exogenous in the model. However, producer prices are linked to the international market. The projection of consumption for the "other" commodities is simply based on a trend that follows the projected growth in supply of the food crops (grains plus root crops). Although this is a very simplistic approach, it represents an improvement from the previous assessments where the contribution by commodities to the diet, such as meat and dairy products, was not considered. The plan is to enhance this aspect of the model in the future.

[1] These countries are low- and lower middle income countries as classified by the World Bank.

For the commodity group grains and root crops (c), food consumption (*FC*) is defined as domestic supply (*DS*) minus nonfood use (*NF*). n is country index and t is time index.

$$FC_{cnt} = DS^{cnt} - NF_{cnt} \quad (1)$$

Nonfood use is the sum of seed use (*SD*), feed use (*FD*), exports (*EX*), and other uses (*OU*).

$$NF_{cnt} = SD_{cnt} + FD_{cnt} + EX_{cnt} + OU_{cnt} \quad (2)$$

Domestic supply of a commodity group is the sum of domestic production (*PR*) plus commercial imports (*CI*), changes in stocks (*CSTK*), and food aid (*FA*).

$$DS_{cnt} = PR_{cnt} + CI_{cnt} + CSTK_{cnt} + FA_{cnt} \quad (3)$$

Production is generally determined by the area and yield response functions:

$$PR_{cnt} = AR_{cnt} * YL_{cnt} \quad (4)$$

$$YLcnt = f(\ LB_{cnt}, FR_{cnt}\ \ K_{cnt}, T_{cnt}\ ) \quad (5)$$

$$RPY_{cnt} = YL_{cnt} * DP_{cnt} \quad (6)$$

$$RNPY_{cnt} = NYL_{cnt} * NDP_{cnt} \quad (7)$$

$$AR_{cnt} = f(AR_{cnt-1}, RPY_{cnt-1}, RNPY_{cnt-1}, Z_{cnt}\ ) \quad (8)$$

where *AR* is area, *YL* is yield, *LB* is rural labor, *FR* is fertilizer use, *K* is an indicator of capital use, *T* is the indicator of technology change, *DP* is real domestic price, *RPY* is yield times real price, *NDP* is real domestic substitute price, *NYL* is yield of substitute commodity, *RNPY* is yield of substitute commodity times substitute price, and *Z* is exogenous policies.

The commercial import demand function is defined as:

$$CI_{cnt} = f(WPR_{ct}, NWPR_{ct}, FEX_{nt}, PR_{cnt}, M_{nt}\ ) \quad (9)$$

where *WPR* is real world food price, *NWPR* is real world substitute price, *FEX* is real foreign exchange availability, and *M* is import restriction policies.

The real domestic price is defined as:

$$DP_{cnt} = f(DP_{cnt-1}, DS_{cnt}, NDS_{cnt}, GD_{nt}, EXR_{nt}\ ) \quad (10)$$

where *NDS* is supply of substitute commodity, *GD* is real income, and *EXR* is real exchange rate.

Projections of food consumption by income group—Inadequate economic access is the most important cause of chronic undernutrition among developing countries and is related to the income level. Estimates of food gaps at the aggregate or national level fail to take into account the distribution of food consumption among different income groups. Lack of consumption distribution data for the study countries is the key factor preventing estimation of food consumption by income group. An attempt was made to fill this information gap by using an indirect method of projecting calorie consumption by different income groups based on income distribution data.[2] It should be noted that this approach ignores the consumption substitution of different food groups by income class. The procedure uses the concept of the income/consumption relationship and allocates the total projected amount of available food among different income groups in each country (income distributions are assumed constant during the projection period).

[2] The method is similar to that used by Shlomo Reutlinger and Marcelo Selowsky in "Malnutrition and Poverty," World Bank, 1978.

Assuming a declining consumption and income relationship (semi log functional form):

$$C = a + b \ln Y \quad (11)$$

$$C = C_o / P \quad (12)$$

$$P = P_1 + \ldots\ldots + P_i \quad (13)$$

$$Y = Y_o / P \quad (14)$$

$$i = 1 \text{ to } 5$$

where C and Y are known average per capita food consumption (all commodities in grain equivalent) and per capita income (all quintiles), C_o is total food consumption, P is the total population, i is income quintile, a is the intercept, b is the consumption income propensity, and b/C is consumption income elasticity (point estimate elasticity is calculated for individual countries). To estimate per capita consumption by income group, the parameter of b was estimated based on cross-country (70 low-income countries) data for per capita calorie consumption and income. The parameter a is estimated for each country based on the known data for average per capita calorie consumption and per capita income.

Historical Data

Historical supply and use data for 1980-2003 for most variables are from a USDA database. Data for grain production in 2004 for most countries are based on a USDA database as of October 2004. Food aid data are from the U.N.'s Food and Agriculture Organization (FAO), and financial data are from the International Monetary Fund and World Bank. Historical nonfood-use data, including seed, waste, processing use, and other uses, are estimated from the FAO Food Balance series. The base year data used for projections are the average for 2001-2003, except for export earnings, which are 2000-2002.

Endogenous variables:

Production, area, yield, commercial import, domestic producer price, and food consumption.

Exogenous variables:

Population—data are medium U.N. population projections as of 2000.

World price—data are USDA/baseline projections.

Stocks—USDA data, assumed constant during the projection period.

Seed use—USDA data, projections are based on area projections using constant base seed/area ratio.

Food exports—USDA data, projections are either based on the population growth rate or extrapolation of historical trends.

Inputs—fertilizer and capital projections are, in general, an extrapolation of historical growth data from FAO.

Agricultural labor—projections are based on UN population projections, accounting for urbanization growth.

Food aid—1988-2003 data from World Food Program (WFP).

Gross Domestic Product—World Bank data.

Merchandise and service imports and exports—World Bank data.

Net foreign credit—is assumed constant during the projection period.

Value of exports—projections are based on World Bank (*Global Economic Prospects and the Developing Countries*, various issues), IMF (*World Economic Outlook*, various issues), or an extrapolation of historical growth.

Export deflator or terms of trade—World Bank (*Commodity Markets—Projection of Inflation Indices for Developed Countries*).

Income—projected based on World Bank report (*Global Economic Prospects and the Developing Countries*, various issues) or extrapolation of historical growth.

Income distribution—World Bank data. Income distributions are assumed constant during the projection period.

(***Shahla Shapouri***)

Appendix table-2a—List of countries and their food gaps in 2004

	2004 food gaps				2004 food gaps		
	Status quo	Nutrition	Distribution		Status quo	Nutrition	Distribution
		1,000 tons				*1,000 tons*	
Angola	192	0	51	Algeria	0	0	0
Benin	219	0	13	Egypt	0	0	0
Burkina Faso	222	9	423	Morocco	0	0	0
Burundi	101	429	511	Tunisia	0	0	0
Cameroon	69	0	80	**North Africa**	**0**	**0**	**0**
Cape Verde	9	0	0				
Central African Repubic	55	79	220	Afghanistan	0	0	305
Chad	266	335	468	Bangladesh	913	52	1,744
Congo, Dem. Rep.	791	3,595	4,063	India	0	0	4,133
Côte d'Ivoire	51	0	100	Indonesia	0	0	67
Eritrea	0	302	335	Korea, Dem. Rep.	27	0	120
Ethiopia	1,203	4,311	4,657	Nepal	547	0	308
Gambia	49	10	45	Pakistan	0	0	1,680
Ghana	61	0	63	Philippines	0	0	206
Guinea	105	0	82	Sri Lanka	0	0	8
Guinea-Bissau	30	7	43	Vietnam	0	0	40
Kenya	0	0	38	**Asia**	**1,487**	**52**	**8,612**
Lesotho	0	0	75				
Liberia	116	63	132	Bolivia	104	0	110
Madagascar	363	505	799	Colombia	0	0	562
Malawi	57	0	192	Dominican Republic	0	0	96
Mali	231	348	618	Ecuador	0	0	315
Mauritania	123	0	11	El Salvador	0	0	94
Mozambique	0	0	132	Guatemala	3	0	352
Niger	1,023	162	596	Haiti	0	71	305
Nigeria	2,263	0	251	Honduras	0	234	374
Rwanda	185	0	33	Jamaica	25	0	0
Senegal	0	0	25	Nicaragua	0	160	270
Sierra Leone	20	211	451	Peru	0	0	543
Somalia	541	1,419	1,447	**Latin America and the Caribbean**	**131**	**465**	**3,022**
Sudan	0	0	155				
Swaziland	2	0	15				
Tanzania	0	1,034	1,455	Armenia	0	0	0
Togo	114	0	78	Azerbaijan	0	0	0
Uganda	944	0	176	Georgia	0	0	24
Zambia	0	191	487	Kazakhstan	0	0	0
Zimbabwe	48	382	576	Kyrgyzstan	0	0	0
Sub-Saharan Africa	**9,454**	**13,394**	**18,900**	Tajikistan	0	0	15
				Turkmenistan	0	0	0
				Uzbekistan	0	0	0
				Commonwealth of Independent States	**0**	**0**	**38**
				Total	**11,073**	**13,912**	**30,572**

Source: ERS calculations.

Appendix table-2b—List of countries and their food gaps in 2014

	2014 food gaps				2014 food gaps		
	Status quo	Nutrition	Distribution		Status quo	Nutrition	Distribution
		1,000 tons				*1,000 tons*	
Angola	824	0	195	Algeria	0	0	0
Benin	192	0	10	Egypt	345	0	0
Burkina Faso	137	0	464	Morocco	0	0	0
Burundi	214	659	765	Tunisia	0	0	0
Cameroon	0	0	28	**North Africa**	**345**	**0**	**0**
Cape Verde	20	0	1				
Central African Repubic	131	159	295	Afghanistan	142	0	776
Chad	147	240	471	Bangladesh	0	0	524
Congo, Dem. Rep.	1,233	4,952	5,564	India	0	0	147
Côte d'Ivoire	0	0	78	Indonesia	0	0	33
Eritrea	202	709	740	Korea, Dem. Rep.	349	0	216
Ethiopia	0	1,164	1,962	Nepal	152	0	158
Gambia	14	0	31	Pakistan	0	0	999
Ghana	0	0	38	Philippines	0	0	92
Guinea	166	0	118	Sri Lanka	0	0	0
Guinea-Bissau	38	8	56	Vietnam	0	0	0
Kenya	0	0	0	**Asia**	**643**	**0**	**2,945**
Lesotho	0	0	14				
Liberia	302	233	296	Bolivia	0	0	45
Madagascar	411	598	1,001	Colombia	0	0	156
Malawi	0	0	178	Dominican Rep.	0	0	0
Mali	0	49	555	Ecuador	0	0	74
Mauritania	406	94	133	El Salvador	0	0	0
Mozambique	0	0	50	Guatemala	0	0	250
Niger	996	0	618	Haiti	0	147	392
Nigeria	2,765	0	310	Honduras	0	136	353
Rwanda	366	0	100	Jamaica	32	0	0
Senegal	0	0	0	Nicaragua	0	255	378
Sierra Leone	220	453	699	Peru	0	0	112
Somalia	264	1,522	1,576	**Latin America and the Caribbean**	**32**	**539**	**1,759**
Sudan	0	0	152				
Swaziland	0	0	2				
Tanzania	0	0	830	Armenia	0	0	0
Togo	36	0	53	Azerbaijan	0	0	0
Uganda	1,827	0	411	Georgia	0	0	0
Zambia	0	332	632	Kazakhstan	0	0	0
Zimbabwe	0	0	2	Kyrgyzstan	0	0	0
Sub-Saharan Africa	**10,912**	**11,171**	**18,430**	Tajikistan	0	107	176
				Turkmenistan	0	0	0
				Uzbekistan	0	0	53
				Commonwealth of Independent States	**0**	**107**	**229**
				Total	**11,931**	**11,817**	**23,363**

Source: ERS calculations.

Appendix 3—Country indicators

Region and country	Population 2004	Population growth rate, 2004	Grain production: Growth 1980-2003	Grain production: Coefficient of variation 1980-2002	Root production growth 1980-2003	Projected annual growth in supply 2004-2014
	1,000	*Percent*				
North Africa:						
Algeria	32,331	1.7	0.3	46.9	-1.0	2.2
Egypt	73,392	2.0	4.6	6.4	1.5	1.7
Morocco	31,059	1.6	0.7	47.6	2.8	1.2
Tunisia	9,936	1.1	1.5	47.8	3.9	1.8
Central Africa:						
Cameroon	16,281	1.7	2.7	14.0	1.3	2.3
Central African Rep.	3,914	1.2	1.6	14.4	0.4	0.7
Congo, Dem. Rep.	54,403	3.1	2.8	10.2	0.0	2.6
West Africa:						
Benin	6,916	2.7	4.9	9.4	4.5	2.7
Burkina Faso	13,395	3.0	4.6	13.7	-1.9	3.2
Cape Verde	472	2.0	6.7	59.5	-3.7	1.2
Chad	8,853	3.0	3.7	17.8	-0.1	3.3
Côte d'Ivoire	16,894	1.6	2.2	7.5	2.2	1.7
Gambia	1,461	2.6	3.4	19.6	0.8	3.3
Ghana	21,369	2.2	5.7	15.6	4.5	2.3
Guinea	8,643	1.7	3.5	6.1	5.2	2.2
Guinea-Bissau	1,538	3.0	2.5	22.5	2.7	2.9
Liberia	3,477	3.6	-4.6	32.4	1.3	1.2
Mali	13,415	2.8	4.1	12.4	2.8	3.8
Mauritania	2,979	3.0	6.8	38.4	0.3	0.1
Niger	12,414	3.7	3.4	15.0	-6.9	3.5
Nigeria	127,050	2.5	5.1	12.0	7.5	1.9
Senegal	10,337	2.4	1.1	17.9	4.3	3.8
Sierra Leone	5,141	3.9	-3.6	12.4	3.9	0.8
Togo	5,017	2.2	4.7	14.3	2.8	2.7
East Africa:						
Burundi	7,072	3.5	-2.9	15.9	1.6	2.8
Eritrea	4,295	3.7	-1.0	52.5	0.5	0.1
Ethiopia	72,404	2.5	3.5	17.3	1.4	4.2
Kenya	32,400	0.0	0.3	14.2	2.2	3.0
Rwanda	8,494	1.3	-2.0	15.6	3.5	1.5
Somalia	10,304	4.3	-2.5	36.7	3.9	4.9
Sudan	34,304	2.1	3.1	32.4	-1.6	1.8
Tanzania	37,656	1.9	1.7	12.2	2.1	3.1
Uganda	26,721	3.4	1.7	9.3	2.0	2.9

See note at end of table.

Continued——

Appendix 3—Country indicators--Continued

Region and country	Population 2004	Population growth rate, 2004	Grain production		Root production growth 1980-2003	Projected annual growth in supply 2004-2014
			Growth 1980-2003	Coefficient of variation 1980-2002		
	1,000	*Percent*				
Southern Africa:						
Angola	14,069	3.3	2.5	24.9	2.9	1.9
Lesotho	1,798	-0.1	-0.9	27.5	7.6	3.5
Madagascar	17,897	2.9	1.2	4.9	0.9	2.7
Malawi	12,334	1.9	1.7	24.0	5.6	2.1
Mozambique	19,170	1.7	6.8	29.0	0.5	2.7
Swaziland	1,081	0.6	0.7	27.9	-0.3	2.5
Zambia	10,927	1.1	-0.4	32.1	5.8	1.8
Zimbabwe	12,920	0.3	-1.9	32.9	4.3	3.6
Asia:						
Afghanistan	24,810	4.2	-1.6	16.0	-1.1	2.7
Bangladesh	149,607	2.0	2.7	7.7	2.2	2.4
India	1,080,895	1.5	2.3	5.3	1.4	2.2
Indonesia	222,552	1.2	1.7	4.1	-0.2	1.8
Korea, Dem. Rep.	26,838	1.2	-2.7	13.0	5.3	0.0
Nepal	25,717	2.2	2.8	6.1	3.8	2.4
Pakistan	157,314	2.4	2.5	5.6	4.3	2.7
Philippines	81,375	1.8	2.0	5.4	-0.5	2.1
Sri Lanka	19,213	0.8	1.0	8.3	-3.5	1.1
Vietnam	82,468	1.4	4.9	5.5	-1.9	4.1
Latin America and the Caribbean:						
Bolivia	8,971	1.9	2.6	15.2	-0.1	3.0
Colombia	44,898	1.6	-0.7	11.5	0.5	3.5
Dominican Republic	8,869	1.5	-0.3	11.1	0.7	7.2
Ecuador	13,187	1.5	2.6	19.1	1.3	6.4
El Salvador	6,610	1.5	1.3	11.3	5.2	5.7
Guatemala	12,656	2.5	0.1	8.6	0.6	5.8
Haiti	8,437	1.3	-0.2	20.1	0.0	0.5
Honduras	7,095	2.3	0.8	15.1	3.5	3.8
Jamaica	2,676	0.9	-5.6	52.5	-1.3	3.7
Nicaragua	5,593	2.4	3.0	14.1	2.7	1.8
Peru	27,562	1.5	4.1	18.6	1.7	4.1
Commonwealth of Independent States:						
Armenia	3,053	-0.3	1.2	44.8	0.4	1.1
Azerbaijan	8,450	0.9	3.2	41.2	14.1	1.4
Georgia	5,076	-1.0	1.1	46.7	6.0	1.8
Kazakhstan	15,935	-0.4	-4.2	75.7	-3.9	1.7
Kyrgyzstan	5,207	1.4	0.7	44.2	9.9	2.1
Tajikistan	6,302	0.9	5.3	45.9	10.9	0.3
Turkmenistan	5,107	1.9	11.7	40.4	3.2	0.3
Uzbekistan	26,306	1.4	9.2	23.3	1.5	0.7

See note at end of table.

Continued——

Appendix 3—Country indicators--Continued

Region development and country	Macroeconomic indicators					
	Per capita GNI 2003	Per capita GDP growth 2002	GDP growth 2002	Export earnings growth 2002	Official development assistance as a share of GNI 2002	External debt Present value as a share of GNI 2002
	U.S. dollars	*Percent*				
North Africa:						
Algeria	1,890	2.5	4.1	4.7	0.7	42.5
Egypt	1,390	1.1	3.0	-10.4	1.4	34.2
Morocco	1,320	1.6	3.2	6.3	1.8	52.6
Tunisia	2,240	0.6	1.7	-2.1	2.4	63.0
Central Africa:						
Cameroon	640	2.3	4.4	1.6	7.3	98.1
Central African Rep.	260	-2.2	-0.8	--	5.8	102.6
Congo, Dem. Rep.	100	0.0	3.0	8.0	14.7	158.5
West Africa:						
Benin	440	3.3	6.0	-0.2	8.3	69.0
Burkina Faso	300	2.1	4.6	11.7	15.2	50.6
Cape Verde	1,490	1.9	4.6	8.5	15.2	68.2
Chad	250	6.7	9.9	-2.2	11.8	65.0
Côte d'Ivoire	660	-3.8	-1.8	21.7	9.6	106.1
Gambia	310	-5.7	-3.1	-3.9	17.3	163.8
Ghana	320	2.7	4.5	-1.7	10.8	121.7
Guinea	430	2.0	4.2	-6.5	7.9	107.8
Guinea-Bissau	140	-9.8	-7.2	-4.6	30.5	358.9
Liberia	130	0.8	3.3	--	11.0	487.3
Mali	290	1.9	4.4	29.2	15.1	89.9
Mauritania	430	0.8	3.3	-7.3	45.4	295.3
Niger	200	-0.1	3.0	--	13.8	83.3
Nigeria	320	-3.1	-0.9	-17.6	0.8	75.1
Senegal	550	-1.3	1.1	1.7	9.2	80.0
Sierra Leone	150	4.2	6.3	1.1	47.0	192.5
Togo	310	2.4	4.6	7.0	3.8	116.7
East Africa:						
Burundi	100	1.7	3.6	6.4	24.2	169.2
Eritrea	190	-0.5	1.8	24.8	30.8	70.6
Ethiopia	90	0.5	2.7	13.2	21.7	108.6
Kenya	390	-0.9	1.0	5.0	3.2	49.4
Rwanda	220	6.3	9.4	-4.1	20.8	83.8
Somalia	--	--	--	--	--	--
Sudan	460	3.3	5.5	2.6	2.7	126.7
Tanzania	290	4.1	6.3	4.6	13.2	77.6
Uganda	240	3.8	6.7	11.4	11.2	72.1

See note at end of table.

Continued——

Appendix 3—Country indicators--Continued

Region development and country	Macroeconomic indicators					
	Per capita GNI 2003	Per capita GDP growth 2002	GDP growth 2002	Export earnings growth 2002	Official development assistance as a share of GNI 2002	External debt Present value as a share of GNI 2002
	U.S. dollars	*Percent*				
Southern Africa:						
Angola	740	12	15.3	--	4.3	104.3
Lesotho	590	2.8	3.8	25	8.7	72.7
Madagascar	290	-15.2	-12.7	-43.7	8.6	104.3
Malawi	170	-0.2	1.8	-3.8	20.2	156.2
Mozambique	210	5.6	7.7	14.1	60.4	135.2
Swaziland	1,350	1.7	3.6	2.1	2	27.7
Zambia	380	1.6	3.3	11.4	18.1	168.5
Zimbabwe	480	-6.7	-5.6	-0.8	--	--
Asia:						
Afghanistan	--	--	--	--	--	--
Bangladesh	400	2.6	4.4	-2.3	1.8	34.2
India	530	3.0	4.6	21.8	0.3	20.6
Indonesia	810	2.3	3.7	-1.2	0.8	80.3
Korea, Dem. Rep.	--	--	--	--	--	--
Nepal	240	-2.7	-0.5	..	6.6	53.3
Pakistan	470	0.4	2.8	10.3	3.6	56.5
Philippines	1,080	2.3	4.4	3.6	--	71.4
Sri Lanka	930	2.7	4.0	5.6	2.1	58.9
Vietnam	480	5.8	7.0	--	3.6	38.0
Latin America and the Caribbean:						
Bolivia	890	0.5	2.8	12.4	9.0	64.0
Colombia	1,810	0.0	1.6	-4.4	0.6	43.3
Dominican Republic	2,070	2.5	4.1	13.0	0.8	30.6
Ecuador	1,790	1.8	3.4	0.9	1.0	72.5
El Salvador	2,200	0.4	2.1	5.7	1.7	41.6
Guatemala	1,910	-0.4	2.2	-3.2	1.1	20.3
Haiti	380	-2.7	-0.9	-2.7	4.5	36.2
Honduras	970	0.0	2.5	2.1	6.8	84.4
Jamaica	2,760	0.3	1.1	--	0.3	75.3
Nicaragua	730	-1.6	1.0	-3.3	13.6	170.2
Peru	2,150	3.3	4.9	6.8	0.9	51.2
Commonwealth of Independent States:						
Armenia	950	13.6	12.9	29.0	12.0	46.8
Azerbaijan	810	9.8	10.6	16.6	6.1	24.5
Georgia	830	6.6	5.6	5.7	9.2	53.8
Kazakhstan	1,780	10.1	9.8	22.6	0.8	74.3
Kyrgyzstan	330	-1.5	-0.5	6.7	12.0	116.4
Tajikistan	190	8.5	9.1	--	14.6	99.9
Turkmenistan	1,120	13.1	14.9	13.0	--	--
Uzbekistan	420	2.9	4.2	-8.8	2.4	58.7

Note: -- = Data unavailable or not applicable due to inconsistent data set.

Source: Population = FAOSTAT, Macroeconomic indicators = World Development Indicators, 2004, World Development Report 2004, World Bank.