

The Food Security Assessment model used in this report was developed at the USDA-ERS for use in projecting food consumption and access, and food gaps (previously called food needs) in 67 low-income countries through 2010. The reference to food includes 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 commercially minus nonfood use) and a consumption requirement. Although food aid is expected to be available during the projection period, it is not included in the projection of food consumption. It should be noted that while projection results will provide a baseline for the food security situation of the countries, they depend on assumptions and specifications of the model. Because 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 (1997-99) 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 recommended by the UN’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, work, or any activity other than food gathering.

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 additional 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 67 lower income countries. 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 is divided into yield and area response. Crop area is a function of 1-year lag 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. 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 projections of consumption for the “other” commodities are 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 to the diet of commodities such as meat and dairy products was overlooked. The plan is to enhance this aspect of the model in the future.

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) and changes in stocks ($CSTK$):

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

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

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

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

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

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

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

where *AR* is area, *YL* is yield, *LB* is rural labor, *FR* is fertilizer use, *K* is 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 level of income. 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 countries is the key factor preventing estimation of food consumption by income group. We attempted to fill this information gap by using an indirect method of projecting calorie consumption by different income groups based on income distribution data.¹ 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).

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

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

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

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

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

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

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 (67 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 1980-99 for most variables are from a USDA database. Data for grain production in 2000 for most countries are based on a USDA database as of October 2000. Food aid data are from the UN'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 use, are estimated from the FAO *Food Balance* series. The base year data used for projections are the average for 1997-99, except export earnings that are 1996-98.

Endogenous variables:

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

Exogenous variables:

Population— data are medium UN population projections as of 1998.

World prices—USDA/baseline projections data.

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—historical data from FAO; *no food aid* assumed during the projection period.

Gross Domestic Product—World Bank data.

¹ The method is similar to that used by Shlomo Reutlinger and Marcelo Selowsky in "Malnutrition and Poverty", World Bank, 1978.

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, 2000

	2000 food gaps				2000 food gaps		
	Status quo	Nutrition	Distribution		Status quo	Nutrition	Distribution
	1,000 tons				1,000 tons		
Cameroon	0	0	113	Algeria	361	518	755
Centr. Afr. Rep.	23	56	118	Egypt	0	0	0
Congo, Dem. Rep.	156	2,141	2,439	Morocco	0	1,045	1,215
Burundi	28	412	462	Tunisia	0	0	0
Eritrea	89	236	252	North Africa	361	1,563	1,970
Ethiopia	793	3,479	3,764				
Kenya	0	191	991	Afghanistan	1,273	1,928	2,103
Rwanda	443	436	462	Bangladesh	0	0	641
Somalia	159	939	991	India	0	0	1,557
Sudan	0	0	0	Indonesia	0	0	0
Tanzania	0	838	1,105	Korea, Dem. People's Rep.	1,155	997	1,121
Uganda	274	0	104	Nepal	165	0	68
Angola	231	440	577	Pakistan	0	0	0
Lesotho	25	34	82	Philippines	0	0	0
Madagascar	92	146	366	Sri Lanka	0	0	0
Malawi	0	0	35	Vietnam	33	0	0
Mozambique	132	558	1,034	Asia	2,627	2,925	5,489
Swaziland	10	0	18				
Zambia	0	479	582	Bolivia	128	189	277
Zimbabwe	0	373	619	Colombia	0	0	84
Benin	105	0	0	Dominican Rep.	0	0	43
Burkina Faso	0	28	221	Ecuador	0	0	246
Cape Verde	66	19	21	El Salvador	0	0	45
Chad	0	0	149	Guatemala	0	0	235
Côte d'Ivoire	0	0	0	Haiti	85	225	370
Gambia	18	1	17	Honduras	50	170	261
Ghana	0	0	39	Jamaica	0	0	0
Guinea	0	0	78	Nicaragua	24	152	213
Guinea-Bissau	10	0	10	Peru	0	0	124
Liberia	171	42	108	Latin America and			
Mali	0	0	93	the Caribbean	287	735	1,897
Mauritania	30	10	53				
Niger	0	0	37	Armenia	97	208	30
Nigeria	344	0	5	Azerbaijan	47	0	0
Senegal	0	0	79	Georgia	26	104	0
Sierra Leone	63	142	198	Kyrgyzstan	0	0	0
Togo	61	0	69	Tajikistan	256	520	322
Sub-Saharan Africa	3,325	10,999	15,294	New Independent States	426	832	352
				Total	7,026	17,054	25,004

Appendix table-2b--List of countries and their food gaps, 2010

	2010 food gaps				2010 food gaps		
	Status quo	Nutrition	Distribution		Status quo	Nutrition	Distribution
		1,000 tons				1,000 tons	
Cameroon	237	0	253	Algeria	718	909	1,131
Centr. Afr. Rep.	98	137	192	Egypt	0	0	0
Congo, Dem. Rep.	1,551	4,218	4,578	Morocco	0	0	0
Burundi	142	629	689	Tunisia	0	0	1
Eritrea	237	424	441	North Africa	781	909	1,132
Ethiopia	0	2,525	3,020				
Kenya	0	399	1,281	Afghanistan	1,847	2,795	3,048
Rwanda	595	585	616	Bangladesh	0	0	975
Somalia	548	1,640	1,700	India	0	0	0
Sudan	0	0	0	Indonesia	0	0	0
Tanzania	55	1,252	1,537	Korea, Dem. People's Rep.	835	658	861
Uganda	830	0	347	Nepal	536	0	182
Angola	785	1,065	1,201	Pakistan	0	0	0
Lesotho	87	97	138	Philippines	0	0	227
Madagascar	591	661	818	Sri Lanka	0	0	0
Malawi	14	401	461	Vietnam	0	0	0
Mozambique	0	95	844	Asia	3,218	3,454	5,294
Swaziland	45	21	45				
Zambia	70	862	976	Bolivia	0	0	19
Zimbabwe	0	62	444	Colombia	0	0	0
Benin	227	0	0	Dominican Rep.	0	0	0
Burkina Faso	129	264	459	Ecuador	0	0	175
Cape Verde	94	35	37	El Salvador	24	0	118
Chad	0	4	203	Guatemala	0	0	287
Côte d'Ivoire	0	0	0	Haiti	297	462	576
Gambia	82	60	68	Honduras	0	120	263
Ghana	0	0	43	Jamaica	0	0	0
Guinea	139	0	155	Nicaragua	148	313	375
Guinea-Bissau	32	0	18	Peru	0	0	0
Liberia	446	264	313	Latin America and			
Mali	81	119	250	the Caribbean	470	894	1,813
Mauritania	286	260	284				
Niger	451	77	276	Armenia	0	0	30
Nigeria	0	0	0	Azerbaijan	0	0	0
Senegal	265	108	383	Georgia	0	0	0
Sierra Leone	166	264	314	Kyrgyzstan	0	0	0
Togo	22	0	70	Tajikistan	0	285	322
Sub-Saharan Africa	8,303	16,530	22,454	New Independent States	0	285	352
				Total	12,709	22,072	31,045

Appendix 3--Country indicators

Region and country							Macroeconomic indicators				Official development assistance	External debt
	Population 2000	Population growth rate	Grain production		Root production growth 1980-99	Projected annual growth in supply	Per capita GNP 1998	Per capita GNP growth 1998	GDP growth 1998	Export earnings growth 1998	as a share of GNP 1998	(present value) as a share of GNP 1998
			Growth 1980-99	Coefficient of variation 1980-99								
		1,000	----- Percent -----				U.S. dollars		----- Percent -----			
North Africa:												
Algeria	31,471	2.3	0.1	45.9	4.4	0.8	1,550	3.6	5.1	3.5	0.9	66.0
Egypt	68,470	1.8	5.0	6.8	3.2	1.2	1,290	4.5	5.6	-7.7	2.3	29.0
Morocco	28,351	1.7	1.3	46.7	4.9	1.2	1,240	5.3	6.5	3.3	1.5	54.0
Tunisia	9,586	1.3	2.6	45.7	5.0	1.5	2,060	4.1	5.0	3.7	0.8	56.0
Central Africa:												
Cameroon	15,085	2.7	1.9	11.0	2.1	2.0	610	3.8	5.0	4.7	5.0	98.0
Central African Rep.	3,615	1.8	1.1	14.3	0.0	1.1	300	2.6	4.7	0.6	11.6	55.0
Congo, Dem. Rep.	51,654	2.6	3.6	9.8	1.5	1.9	110	0.7	3.0	14.3	2.0	196.0
West Africa:												
Benin	6,097	2.7	4.8	9.1	6.3	2.1	380	1.9	4.5	-1.0	9.2	46.0
Burkina Faso	11,937	2.8	5.3	13.7	-5.5	2.2	240	3.8	6.2	10.5	15.5	32.0
Cape Verde	428	2.4	9.3	56.3	1.2	0.6	1,200	2.2	5.0	-3.9	--	--
Chad	7,651	2.6	4.2	18.5	1.1	2.7	230	5.5	8.1	12.2	10.0	38.0
Côte d'Ivoire	14,786	1.8	2.7	6.0	2.3	1.9	700	3.9	5.4	0.9	7.6	122.0
Gambia	1,305	3.0	1.5	17.2	0.0	1.1	340	2.0	4.7	5.5	--	--
Ghana	20,212	2.7	7.1	15.3	8.5	2.4	390	1.9	4.6	14.4	9.6	55.0
Guinea	7,430	1.0	3.4	5.9	3.0	1.7	530	1.5	4.5	12.8	9.8	69.0
Guinea-Bissau	1,213	2.2	4.7	18.7	3.3	1.5	160	-30.4	-28.1	-35.8	--	--
Liberia	3,154	7.6	-5.5	34.4	-0.5	0.9	--	--	--	--	--	--
Mali	11,234	2.5	4.7	11.9	1.9	2.1	250	1.3	3.6	1.3	13.5	84.0
Mauritania	2,670	2.7	9.2	33.8	-0.3	0.6	410	1.5	3.5	8.7	17.8	148.0
Niger	10,730	3.2	2.9	14.7	0.6	2.0	200	4.8	8.4	8.7	14.4	55.0
Nigeria	111,506	2.4	5.9	16.8	9.4	2.0	300	-1.5	1.8	-8.3	0.5	74.0
Senegal	9,481	2.6	1.1	19.7	1.7	1.2	520	3.8	5.7	5.2	10.8	58.0
Sierra Leone	4,854	2.9	-2.5	9.3	5.7	1.3	140	-2.9	0.7	--	16.2	126.0
Togo	4,629	2.6	4.6	16.2	2.3	2.4	330	-3.5	-1.0	-0.3	8.6	68.0
East Africa:												
Burundi	6,695	2.0	-2.7	16.3	1.5	1.8	140	2.6	4.8	-8.6	8.8	72.0
Eritrea	3,850	3.5	1.0	53.9	0.5	1.0	200	-6.7	3.0	-33.5	19.7	11.0
Ethiopia	62,565	2.4	4.0	16.0	2.9	3.0	100	-4.2	-1.0	-9.4	10.0	135.0
Kenya	30,080	1.8	0.4	14.6	2.9	1.4	350	0.3	1.8	-5.8	4.2	45.0
Rwanda	7,733	2.9	-2.9	13.9	-2.6	1.6	230	7.1	9.5	-0.6	17.3	34.0
Somalia	10,097	2.7	-3.5	37.5	2.2	1.2	--	--	--	--	--	--
Sudan	29,490	2.1	3.9	30.7	-3.7	2.3	290	2.7	5.0	--	--	--
Tanzania	33,517	6.9	2.0	12.8	0.0	1.9	220	3.8	3.5	-10.0	12.5	71.0
Uganda	21,778	3.0	2.2	9.2	1.0	2.4	310	2.8	5.6	-14.9	7.0	35.0

See note at end of table.

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Appendix 3--Country indicators--Continued

Region and country	Population 2000 1,000	Population growth rate	Grain production		Root production growth 1980-99	Projected annual growth in supply	Per capita GNP 1998 U.S. dollars	Macroeconomic indicators			Official development assistance as a share of GNP 1998	External debt (present value) as a share of GNP 1998
			Growth 1980-99	Coefficient of variation 1980-99				Per capita GNP growth 1998	GDP growth 1998	Export earnings growth 1998		
			-----	Percent	-----					-----	Percent	-----
Southern Africa:												
Angola	12,878	3.2	2.0	26.1	5.0	1.4	380	16.3	5.0	-20.5	8.1	279.0
Lesotho	2,153	2.1	0.6	29.9	9.2	1.0	570	-5.3	-3.6	15.8	5.7	42.0
Madagascar	15,942	4.4	1.3	3.5	1.7	1.6	260	1.7	3.9	1.1	13.5	89.0
Malawi	10,925	3.0	1.8	22.9	0.5	1.8	210	-1.0	3.1	3.8	24.4	77.0
Mozambique	19,680	2.2	6.8	33.8	1.9	2.0	210	9.7	12.0	6.5	28.2	74.0
Swaziland	1,008	2.9	0.7	27.4	-1.0	1.5	1,400	-1.3	2.0	3.0		
Zambia	9,169	2.1	-1.2	33.0	5.7	1.9	330	-4.1	-2.0	-7.5	11.4	181.0
Zimbabwe	11,669	1.2	-1.1	31.9	5.3	1.9	620	-1.4	2.5	25.2	4.7	69.0
Asia:												
Afghanistan	22,720	3.6	-1.5	12.6	-0.8	1.3	--	--	--	--	--	--
Bangladesh	129,155	1.7	2.1	4.5	0.7	1.7	350	4.2	5.1	14.3	2.7	22.0
India	1,013,662	1.6	2.7	4.2	3.1	1.7	440	4.3	6.1	4.2	0.4	20.0
Indonesia	212,107	1.4	2.0	4.0	1.2	1.7	640	-18.0	-13.2	11.2	1.5	169.0
Korea, D. People's Rep.	24,039	1.4	-2.2	--	-1.3	0.0	--	--	--	--	0.0	43.0
Nepal	23,930	2.3	3.1	6.6	6.9	1.6	210	0.3	2.3	-10.0	8.3	31.0
Pakistan	156,483	2.7	2.5	4.9	6.0	2.3	470	0.5	3.3	3.7	1.6	41.0
Philippines	75,967	2.0	2.0	5.9	0.6	1.4	1,050	-2.1	-0.5	-10.4	0.9	66.0
Sri Lanka	18,827	1.0	0.7	8.3	-4.9	1.1	810	3.3	4.7	1.0	3.2	41.0
Vietnam	79,832	1.4	5.2	6.3	-2.2	1.7	350	4.3	5.8	--	4.3	76.0
Latin America and the Caribbean:												
Bolivia	8,329	2.3	3.0	13.3	0.6	3.6	1,010	2.7	4.7	2.7	7.5	59.0
Colombia	42,321	1.8	-1.5	11.8	1.4	2.6	2,470	-2.4	0.6	8.8	0.2	32.0
Dominican Republic	8,495	1.6	-1.2	10.8	1.8	3.9	1,770	4.9	7.3	4.4	0.8	28.0
Ecuador	12,646	1.9	1.9	18.4	8.2	2.1	1,520	2.2	0.6	-2.5	0.9	75.0
El Salvador	6,276	2.0	0.8	10.2	1.6	1.3	1,850	1.1	3.2	1.8	1.5	27.0
Guatemala	11,385	2.7	0.0	7.2	0.1	1.8	1,640	2.8	5.1	6.0	1.2	23.0
Haiti	8,222	1.7	1.9	16.5	4.0	0.7	410	1.1	3.1	21.8	10.5	16.0
Honduras	6,485	2.7	-3.6	13.0	2.7	2.7	740	1.1	3.0	1.8	6.3	64.0
Jamaica	2,583	0.9	1.5	51.1	3.2	0.8	1,740	0.1	0.1	-3.2	0.3	61.0
Nicaragua	5,074	2.8	3.9	15.7	0.6	1.5	370	3.3	4.0	-6.4	28.1	262.0
Peru	25,662	1.7	2.9	14.7	2.4	2.7	2,440	-3.3	0.3	3.3	0.8	55.0
New Independent States:												
Armenia	3,520	-0.2	1.7	17.0	2.0	1.4	460	3.1	7.2	-0.1	7.1	29.0
Azerbaijan	7,734	0.5	-1.5	15.3	13.2	1.4	480	8.9	10.0	-7.8	2.2	13.0
Georgia	4,968	-0.8	1.4	22.5	9.0	1.2	970	2.5	2.9	3.5	4.6	36.0
Kyrgyzstan	4,699	0.6	-0.2	17.6	17.7	1.5	380	2.8	3.6	-3.5	60.5	3.1
Tajikistan	6,188	1.4	6.7	31.1	-4.4	1.1	370	13.3	8.2	--	--	--

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

Source: Population=UN World Population Prospects, 1998; Macroeconomic indicators=World Bank.