Appendix 1--Country list, per capita nutritional requirement, share of grain and root crops in diet

Country	Per capita nutritional requirement *	Share of grain in diet	Share of root crops in diet	Country	Per capita nutritional requirement *	Share of grain in diet	Share of root crops in diet
	Kg. grain eq	Percent	Percent		Kg. grain eq	Percent	Percent
Asia				**East Africa**			
Afghanistan	194	78.4	1.5	Burundi	120	21.2	27.9
Bangladesh	207	82.6	1.4	Eritrea	194	77.2	4.1
India	169	63.1	1.8	Ethiopia	176	70.8	5.0
Indonesia	181	63.5	6.2	Kenya	145	51.3	7.9
Nepal	195	76.3	3.0	Rwanda	109	17.8	27.6
Pakistan	138	58.3	0.8	Somalia	109	45.4	0.9
Philippines	149	53.2	3.7	Sudan	141	57.2	0.6
Sri Lanka	154	57.9	2.1	Tanzania	165	45.5	23.8
Vietnam	192	71.9	6.9	Uganda	115	18.7	25.4
Latin America							
Bolivia	142	42.2	8.3	**Southern Africa**			
Colombia	86	32.3	1.8	Angola	155	32.2	31.4
Dominican Rep.	81	29.4	3.1	Lesotho	202	77.1	3.4
Ecuador	84	33.1	3.4	Madagascar	187	55.4	21.0
El Salvador	132	56.6	1.4	Malawi	181	70.2	3.9
Guatemala	134	60.2	0.4	Mozambique	193	39.2	37.2
Haiti	128	41.0	11.7	Swaziland	130	49.6	1.3
Honduras	112	49.0	0.3	Zambia	206	68.3	10.3
Jamaica	99	30.9	9.9	Zimbabwe	179	64.6	1.9
Nicaragua	121	49.6	1.6				
Peru	127	41.4	7.6	**West Africa**			
Former Soviet Union				Benin	188	38.2	34.4
Armenia	151	58.4	7.0	Burkina Faso	198	76.1	0.8
Azerbaijan	157	63.9	4.1	Cape Verde	133	51.1	2.2
Georgia	152	63.5	2.0	Chad	172	53.9	12.1
Kyrgyzstan	127	50.3	4.6	Cote d'Ivoire	172	37.1	28.8
Tajikistan	154	64.3	2.4	Gambia	133	50.8	0.9
				Ghana	187	29.9	42.9
North Africa				Guinea	149	46.0	12.5
Algeria	175	59.1	2.2	Guinea-Bissau	163	59.5	6.6
Egypt	175	66.5	1.8	Liberia	163	37.6	28.9
Morocco	186	55.1	2.1	Mali	185	72.1	0.5
Tunisia	147	50.8	1.5	Mauritania	144	55.9	0.5
				Niger	230	71.5	3.7
Central Africa				Nigeria	172	42.4	25.4
Cameroon	135	37.0	18.2	Senegal	162	58.0	1.1
Central Afr. Rep.	138	19.6	36.6	Sierra Leone	153	53.6	6.5
Congo (fka Zaire)	174	15.9	56.3	Togo	195	48.5	26.9

* Based on FAO's minimum caloric requirement and total share of grains and root crops in the diet.

APPENDIX 2—FOOD SECURITY MODEL: DEFINITION AND METHODOLOGY

The food security assessment model used in this report was developed at the USDA-ERS for use in projecting food availability and access, and the food gap (previously called food needs) in 66 low-income countries through 2007. The reference to food includes grains and root crops. These two food commodity groups account for as much as 80 percent of all calories consumed in the study countries. Root crops are generally not traded, while the bulk of all food imports of these countries, commercial or food aid, is in the form of grains.

Food security of a country is evaluated based on the gap between projected domestic food availability (produced domestically and imported commercially) 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 availability. 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. 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 (1994-96) is used for the per capita consumption target in order 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 and root crops) 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 availability 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 66 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 two commodity groups, grains and root crops. The production side of the model 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 production, 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 via commercial food imports.

Food availability is defined as the sum of grains and root crop availability. For each commodity group (c), food availability (FA) is defined as domestic supply (DS) minus nonfood use (NF). n is country index and t is time index.

$$FA_{cnt}=DS_{cnt}-NF_{cnt} \quad (1)$$

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:

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

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

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

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

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

where AR is area, YL is yield, LB is rural labor, FR is fertilizer use, CU is capital use, T is the indicator of technology change, DP is real domestic producer price, RPY is yield times real price, NDP is real domestic producer 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, *PR* is domestic production, and *M* is import restriction policies.

The real domestic producer 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 availability (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 fails 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. 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[1]. It should be noted that this approach ignores the consumption substitution of different food groups by income class (the plan is to improve this aspect of the model in the future). 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 ditributions are assumed constant during the projection period).

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

$$C = a + b \ln Y \quad (11)$$
$$C = C_o/P \quad (12)$$
$$P = P_1 + \ldots\ldots + P_i \quad (13)$$
$$Y = Y_o/P \quad (14)$$
$$i = 1 \text{ to } 5$$

where *C* and *Y* are known average per capita food consumption (calorie consmption) 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 country). To estimate per capita consumption by income group, the parameter of *b* was estimated based on cross country (66 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 1980-96 for most variables are from a USDA database. Data for grain production in 1997 for most countries are based on a USDA database as of October 1997. 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 1994-96, except export earnings that are 1993-95.

Endogenous variables:

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

Exogenous variables:

Population—data are UN population projections.
World prices—data are USDA/baseline projections.
Stocks—assumed constant during the projection period.
Seed use—projections are based on area projections using constant base seed/area ratio.
Industrial use—projections are based on extrapolation of historical trends.
Food exports—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.
Agricultural labor—projections are based on UN population projections, accounting for urbanization growth.
Net foreign credit—net real flow of 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).

[1]The method is similar to the method used by Shlomo Reutlinger and Marcelo Selowsky in "Malnutrition and Proverty", World Bank, 1978.

Appendix 3--Country indicators

Region and country	Population 1997	Population growth rate	Grain production: Growth 1981-96	Grain production: Coefficient of variation 1981-95	Root production growth 1981-96	Projected growth in supply	Macroeconomic indicators: Per capita GNP 1995	Macroeconomic indicators: Per capita GNP growth 1995	Macroeconomic indicators: GDP growth 1995	Export earnings growth 1995	Months of import coverage in reserves 1995	Debt service ratio 1995
	1,000		------Percent------				U.S. $	------ Percent-----			Number	Percent
North Africa												
Algeria	29,830	2.2	-1.3	43.9	5.6	2.4	1,600	1.2	4.4	--	5.0	38.7
Egypt	64,792	1.9	5.0	5.3	2.4	1.6	790	0.5	2.4	-0.8	11.8	14.6
Morocco	30,391	2.1	3.9	51.1	5.0	1.9	1,110	-8.7	-6.9	19.7	3.6	32.1
Tunisia	9,183	1.8	2.8	63.2	5.1	2.5	1,820	1.5	2.4	17.5	2.1	17.0
Central Africa												
Cameroon	14,678	2.9	0.5	8.0	1.6	2.0	650	-0.4	4.2	24.8	0.1	20.1
Central African Rep.	3,342	2.1	1.8	16.7	-1.4	1.2	340	-0.5	4.1	24.7	9.0	6.8
Congo (fka Zaire)	47,440	2.0	3.5	8.3	2.4	2.0	120	-5.9	--	4.5	--	--
West Africa												
Benin	5,902	3.4	4.4	10.6	5.4	1.9	370	6.4	--	--	3.2	8.4
Burkina Faso	10,891	2.5	6.6	13.7	-5.9	1.7	230	1.5	4.5	26.9	7.1	11.1
Cape Verde	462	3.0	11.8	89.1	-0.9	1.9	960	2.4	--	--	--	--
Chad	7,166	2.7	3.8	18.8	1.2	1.9	180	2.3	5.5	--	4.2	5.9
Cote d'Ivoire	15,150	2.6	3.9	7.4	2.4	2.1	660	17.8	6.6	38.0	1.5	23.1
Gambia	1,248	3.6	3.8	16.9	0.0	1.8	320	-3.6	3.2	-50.0	5.3	14.0
Ghana	18,101	2.3	3.2	22.2	6.7	4.3	390	1.7	4.4	--	4.3	23.1
Guinea	7,495	1.1	3.5	9.8	1.2	1.8	550	1.9	4.6	13.0		25.3
Guinea-Bissau	1,179	2.4	9.3	16.1	2.6	1.7	250	2.1	1.7	-28.1	2.5	66.9
Liberia	2,257	7.0	-6.0	40.7	9.2	2.7	--	--	--	--	--	--
Mali	9,945	3.0	6.5	13.9	-0.1	2.1	250	3.2	6.4	--	4.0	12.6
Mauritania	2,411	3.2	12.9	47.1	-0.6	1.7	460	2.2	4.6	--	1.7	21.5
Niger	9,389	3.0	2.2	16.0	1.7	2.0	220	1.0	3.2	--	2.6	19.8
Nigeria	107,129	3.1	0.2	18.2	10.3	2.4	260	1.3	2.3	24.4	1.5	12.3
Senegal	9,404	3.4	2.2	20.1	3.3	1.7	600	7.9	10.3	--	1.9	18.7
Sierra Leone	5,004	4.4	-2.6	11.3	4.6	1.0	180	-2.8	-9.2	-63.5	2.7	60.3
Togo	4,736	3.6	4.8	16.1	0.2	1.6	310	7.5	8.2	29.0	3.6	25.7
East Africa												
Burundi	6,053	1.8	-1.1	19.6	1.9	2.8	160	-5.9	-3.8	-1.9	8.7	27.7
Eritrea	4,142	5.9	1.0	--	1.3	2.0	--	--	--	--	--	--
Ethiopia	58,733	2.7	2.0	11.0	1.3	4.0	100	2.7	4.9	13.7	7.0	13.6
Kenya	28,803	2.2	1.1	14.8	2.3	2.0	280	4.2	4.4	16.7	1.2	25.7
Rwanda	7,738	12.9	-2.5	14.6	-1.6	3.2	180	19.7	23.0	36.4	4.7	--
Somalia	9,940	3.1	-1.8	37.1	0.5	1.2	--	--	--	--	--	--
Sudan	32,041	3.1	2.9	39.0	-5.0	1.6	--	--	--	6.0	--	--
Tanzania	29,461	1.4	1.4	12.6	0.3	2.0	120	1.0	4.0	23.1	1.5	17.4
Uganda	20,605	2.2	2.6	6.0	1.3	2.5	240	8.1	11.2	8.7	3.8	21.3

See note at end of table.

Continued--

Appendix 3--Country indicators--continued

Region and country	Population 1997	Population growth rate	Grain production Growth 1981-96	Grain production Coefficient of variation 1981-95	Root production growth 1981-96	Projected growth in supply	Macroeconomic indicators Per capita GNP 1995	Macroeconomic indicators Per capita GNP growth 1995	Macroeconomic indicators GDP growth 1995	Export earnings growth 1995	Months of import coverage in reserves 1995	Debt service ratio 1995
	1,000		------Percent------				U.S. $	------ Percent-----			Number	Percent
Southern Africa												
Angola	10,624	2.7	-1.9	19.3	4.5	2.2	410	13.0	6.3	16.9	--	12.5
Lesotho	2,008	1.9	1.2	30.2	9.2	1.6	770	7.4	10.0	--	5.4	6.0
Madagascar	14,062	2.9	1.4	3.1	2.1	1.8	230	-1.3	1.8	-10.3	1.1	9.2
Malawi	9,609	1.7	3.0	21.7	0.2	2.4	170	11.3	13.5	--	1.5	25.9
Mozambique	18,356	2.7	1.4	24.7	0.4	2.7	80	-0.9	4.3	12.7	--	35.3
Swaziland	1,032	3.3	2.5	30.8	0.0	2.4	1,070	0.1				
Zambia	9,350	2.1	2.0	31.7	4.6	2.2	400	-5.5	-3.1	--	--	174.4
Zimbabwe	11,423	1.4	1.1	37.4	5.4	1.7	540	-2.9	-1.8	--	--	25.6
Asia												
Afghanistan	23,738	4.7	-3.6	7.9	-0.5	1.9	--	--	--	--	--	--
Bangladesh	125,340	1.9	2.2	4.0	0.3	1.8	240	2.7	4.4	19.2	4.2	13.3
India	967,613	1.6	2.9	5.2	2.9	2.1	340	4.4	6.1	22.7	5.2	27.9
Indonesia	209,774	1.5	2.0	3.3	1.7	1.2	980	5.7	8.1	13.4	3.0	30.9
Nepal	22,641	2.5	3.2	8.3	7.2	1.8	200	1.0	3.3	-4.4	4.9	7.8
Pakistan	132,185	2.3	2.2	4.8	6.0	2.0	460	2.1	4.4	8.4	2.1	35.3
Philippines	76,104	2.2	2.5	4.5	0.4	1.7	1,050	3.1	4.8	31.6	2.6	16.0
Sri Lanka	18,762	1.1	0.9	9.1	-4.6	1.3	700	3.6	5.4	18.3	4.2	7.3
Vietnam	75,124	1.6	0.9	5.0	-1.9	1.5	240	--	9.5	39.5	0.0	5.2
Latin America												
Bolivia	7,295	1.8	3.1	15.2	0.6	1.7	800	1.4	3.7	6.7	6.7	28.9
Colombia	37,418	1.6	-3.5	6.2	0.0	2.0	1,910	1.5	5.3	16.3	5.0	25.2
Dominican Republic	8,228	1.7	0.1	9.7	2.5	1.9	1,460	3.0	2.5	20.9	0.7	7.8
Ecuador	11,691	2.0	0.7		0.0	1.8	1,390	-1.0	2.3	12.7	3.4	26.7
El Salvador	5,935	1.8	2.7	10.4	9.0	1.5	1,610	4.8	6.9	18.2	3.2	8.9
Guatemala	11,558	2.5	2.0	4.3	1.7	2.2	1,340	3.5	3.0	41.7	2.4	10.6
Haiti	6,851	1.8	-1.8	8.3	0.4	1.3	250	2.2	4.5	34.1	1.6	45.2
Honduras	5,751	2.6	3.1	12.0	4.3	1.9	600	0.9	3.9	25.9	1.5	31.0
Jamaica	2,616	0.8	-6.4	60.2	3.2	2.1	1,510	-0.5	0.5	18.6	2.0	17.9
Nicaragua	4,386	2.7	1.7	16.1	4.2	1.8	380	17.7	4.2	47.7	1.2	38.7
Peru	24,950	1.7	2.0	13.9	0.8	1.2	2,310	6.2	7.2	22.4	8.6	15.3
Former Soviet Union												
Armenia	3,466	0.1	2.0	53.6	0.8	1.9	730	30.8	6.9	25.5	--	2.9
Azerbaijan	7,736	0.8	2.0	52.7	0.8	2.7	480	-13.6	-13.0	-10.3	--	--
Georgia	5,175	-0.9	2.0	52.6	0.8	1.7	440	-5.5	-5.0	-8.9	--	--
Kyrgystan	4,540	0.2	2.0	51.8	0.8	1.2	700	-7.1	-6.3	20.3	--	4.8
Tajikistan	6,014	1.7	2.0	51.2	0.8	1.3	340	-15.9	-12.5	34.0	--	--

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

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