Appendix 1

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

Projections 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 three commodity groups, grains, root crops, and "other." 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. The projections 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 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.

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.

For each commodity group (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), food aid (FA), and changes in stocks (CSTK).

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

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

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

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

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

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

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

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:

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

where WPR is real world food price, NWPR is real world price of nonfood items, FEX is real foreign exchange availability, DR is real domestic price, and M is import restriction policies.

The real domestic price is defined as:

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

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. 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] 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.

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

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

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

$$P = P1 + \text{.....} + Pi \quad (13)$$

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

$$I = 1 \text{ to } 5 \quad (15)$$

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

where C and Y are known average per capita food consumption (calorie consumption) and per capita income (all quintiles), Co 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 is 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. In the next step, point consumption/income elasticities are estimated for each country using base level country income and consumption data. These elasticities are then used to estimate calorie consumption by different income groups in each country. The estimated distribution gap measures the food needed to bring food consumption of each income group up to the nutritional requirements. To estimate the number of people vulnerable to food insecurity, the portion of population that consumes less than the requirement is multiplied by the total population to estimate the number of people who have inadequate access to food. Country income distribution is assumed constant during the projection period. For countries where income distribution data are not available (mainly in Sub-Saharan Africa), average sub-regional income distribution data are used.

Appendix II

Data Sources and Assumptions

Historical Data

Historical supply and use data for 1980-97 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 1995-97, except export earnings, which are 1994-96.

Model Assumptions

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.

Food aid—assumed no food aid during the projection period (food aid is included only in the base year).

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.

Model Coefficients and Assumptions

Technical coefficients used in the model are either estimated, using cross country data, or synthesized from other sources. With the exception of countries with political problems, the model was validated using the historical data (1980-96). Growth in crop area and yield per hectare are functions of crop prices, fertilizer use, labor, and technological progress. Area response to price changes is small, in the range of 0.1 to 0.3. Similarly, yield response to fertilizer use is 0.1 to 0.2 and the labor/land ratio (as an indicator of intensification) is in the range of 0.2 to 0.3. The main determinant of commercial import growth is the availability of foreign exchange which is defined as the sum of exports and net flow of capital. World food prices, non-food prices, and expected domestic production (indicator of government import policy) also influence food imports. The food import response to foreign exchange availability is in the range of 0.6 to 0.8 and the response to food prices is in the range of 0.3 to 0.5. The response to non-food price changes is in the range of 0.1 to 0.2.