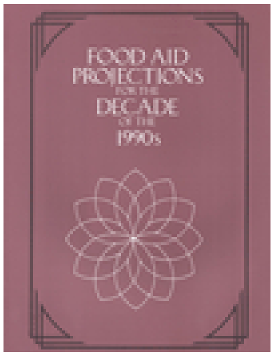
Food Aid Projections for the Decade of the 1990s



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Food Aid Projections for the Decade of the 1990s

Report of an Ad Hoc Panel Meeting October 6 & 7, 1988

Board on Science and Technology for International Development
Office of International Affairs
National Research Council
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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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This report has been prepared by an ad hoc advisory panel of the Board on Science and Technology for International Development, Office of International Affairs, National Research Council. Staff support was funded by the Agency for International Development, under Grant No. DAN-5052-C-00-6037-00.

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Preface

At the request of the Agency for International Development's Bureau for Food for Peace and Private and Voluntary Assistance (AID/FVA) the Board on Science and Technology for International Development (BOSTID) of the National Research Council (NRC) arranged for an NRC-appointed panel and a group of experts to convene for two days of discussions concerning projections of needs for food aid in the decade 1990-2000. The objective of the meeting was to examine the projections of food commodity trade and, either directly or by deduction, food aid needs of developing countries, relying upon work of six principal groups engaged in food commodity analysis—the United Nations Food and Agriculture Organization (FAO) Commodities and Trade Division (and others), the World Bank International Commodity Markets Division, the U.S. Department of Agriculture (USDA) Economics Research Service Commodity Trade and Analysis Branch (and others), the International Food Policy Research Institute (IFPRI), the Iowa State University Center for Agricultural Research and Development (CARD), and the International Institute of Applied Systems Analysis (IIASA). Their projections were discussed from the perspective of a number of specialists engaged in parallel types of analysis of future global economic, regional econo-political, demographic, and climatic impact, scientific and technological research impact, and risk forecasting.

Working closely with Raymond Hopkins of Swarthmore College, chairman of the NRC-appointed panel, and Jon O'Rourke of AID/FVA, a substantive agenda was drawn up for a two-day meeting involving approximately thirty distinguished participants drawn from academia, government, and industry. (The list of participants, agenda, and contributed papers are included as annexes to this report.)

The workshop was convened October 6-7, 1988, at the National Academy of Sciences' Georgetown Facility. What follows is a two-part report of the meeting: an executive summary, which attempts to review the issues raised at the workshop and the conclusions reached in non-technical language, and a summary report of the workshop discussions, including a brief description of the food aid estimation methodologies. As with all endeavors that attempt to bring together many different perspectives and distill large amounts of information into a coherent form accessible to the non-specialist, based on only two days of discussions, a number of challenges were faced in the design and implementation

of this project. As a result, a number of people deserve special thanks: the modelers, Ronald Duncan of the International Commodity Markets Division, the World Bank; Hannah Ezekiel, International Food Policy Research Institute, Klaus Frohberg, International Institute for Applied Systems Analysis, Laxenburg, Austria, and the Organization for Economic Cooperation and Development, Paris, Willi Meyers, Center for Agricultural and Rural Development, Iowa State University, Bruno Larue and Karl Meilke, Department of Agricultural Economics, University of Guelph, Ontario, Ray Nightingale and Ronald Trostle, Economic Research Service, USDA, and Richard Perkins, Food and Agriculture Organization of the UN, Rome; Edward Clay, Director of the Relief and Development Institute, London, Bruce Johnston, Food Research Institute, Stanford University, and Lawrence Klein, Economics Department, University of Pennsylvania, who reviewed the draft report on behalf of the NRC; Jon O'Rourke for his able technical liaison at AID/FVA and substantive assistance; the panelists, for their helpful comments and suggestions; and Raymond Hopkins, who served most ably as chairman, rewrote and edited many versions of the report, and supplied good counsel throughout the process.

MICHAEL MCD. DOW

MITCHELL B. WALLERSTEIN

OFFICE OF INTERNATIONAL AFFAIRS

NATIONAL RESEARCH COUNCIL

FEBRUARY 28, 1989

Panel on Food Aid Requirements for the 1990s

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Robert Kates, Director, Alan Shawn Feinstein World Hunger Program, Brown University
Per Pinstrup-Andersen, Nutrition Surveillance Unit, Division of Nutritional Sciences, Cornell University
Donald L. Plucknett, Senior Scientific Adviser, The World Bank
Beatrice Rogers, School of Nutrition, Tufts University
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Contents

Executive Summary

Efforts to estimate future world food aid needs are fraught with difficulties. At the outset, one must distinguish between estimates of pure need and estimates of the amount that is likely to be provided. Second, difficulties of definition arise between food export subsidies and food aid. Third, obtaining reliable data from Third World countries regarding such essential information as food supplies (including imports and exports) and population growth presents a serious constraint to analysts. Then, even when the data are relatively firm, those engaged in food need projections do not always agree on the methods of processing the data to obtain meaningful estimates. And finally, country-specific food aid "needs" estimates often imply not only economic and political failures on the part of the recipients, but also certain ill-defined and complex ethical responsibilities and political-economic objectives on the part of the donors. It is hardly surprising, therefore, that food aid needs estimates invariably generate considerable interest and discussion, and often disagreement.

The premise of the meeting was that recent efforts to estimate global, regional, and country-specific food trade and food aid needs are sufficiently advanced to warrant a systematic review of the various methodologies, and a comparison of the resulting projections, in the hope that it would yield valuable findings for those concerned with alleviating world hunger.

To this end, representatives of the following organizations met in October 1988 under the aegis of the National Research Council to compare food aid projections and methodologies:

United Nations Food and Agriculture Organization (FAO)
Iowa State University Center for Agriculture and Rural Development (CARD)
World Bank
U.S. Department of Agriculture (USDA)
International Institute for Applied Systems Analysis (IIASA)
International Food Policy Research Institute (IFPRI)
Cornell University Food & Nutrition Policy Program
The Alan S. Feinstein World Hunger Program, Brown University
The Food Policy Program, Swarthmore College

U.S. Agency for International Development
University of Guelph, Ontario, Canada
Tufts University, Massachusetts
Project Link, University of Pennsylvania.
The principal findings, and the discussions on which they were based, are summarized below.

PRINCIPAL FINDINGS

1. Doubling food aid over present levels of about 10 million metric tons per year would be necessary to meet projected market needs throughout the decade of the nineties.
2. Projected nutritional needs estimates are much higher: a quadrupling (or more) over present levels could be needed by the year 2000.
3. While there is a high likelihood that a major drought or other natural catastrophe will depress food supplies during the 1990s, there is no way to predict the time, place, or size of occurrence. The best that modelers can offer, therefore, is to recalculate food aid need estimates after the occurrence, while urging planners, beforehand, to add the equivalent of insurance reserves against unforeseen events. Developing methods of making projections that allow for the effects of natural disasters is a research priority.
4. There is no evidence that the "greenhouse effect" is already exerting a measurable influence on food production, and the consensus is that, during the 1990s, natural forces will not reverse the slow downward trend of commodity prices and slow upward trend in per capita income that have been observed in developing countries over the past several decades.
5. Africa will continue to be the important focus of concern for food aid—and the region of greatest uncertainty—because of continuing conflict, locust plagues, cycles of drought and flood, and low economic growth combined with high rates of population growth. However, in the long run, Asia may again be the most troubling food-deficient area. An unfavorable man/land ratio in Asia may be unable to support continued improvements in agricultural productivity that the "green revolution" sustained over the 1970s and 1980s, while increased population and prosperity will increase demand, especially for animal feed grains.

DEFINITIONS OF FOOD AID

Food aid "needs" are defined in two principal ways:

1. Price-stabilizing food aid: food commodities, or entitlements to buy them at concessional rates, that will make up a shortfall between historical domestic availability and consumption in the recipient country, thereby keeping food prices and the incidence of hunger from rising; and
2. Hunger-reducing food aid: food commodities or cash supplied to recipient countries that not only stabilizes prices but also, through targeting, increases the food intake of historically hungry populations.

Neither of these definitions specifically includes emergency food aid, nor would they pick up commodity imports subsidized under export promotion programs. These additional types of "food aid", however, may be taken into account in the historical database from which projections of future trade and aid needs are made.

In practice, "need" estimates are not predictions of anticipated future food aid flows. Food aid flows are governed by domestic politics of donors, shifting priority given food aid in the international community, and the supply-demand situation of particular commodities, especially in donor countries.

Needs for food aid reflect principally recipient country situations. Because of the difficulties inherent in estimating the amounts of commodity required to stabilize prices and alleviate hunger, and the uncertainty that any given level of food aid could, in fact, achieve its purposes (especially given that hunger-reducing aid is difficult and costly to administer and therefore politically difficult to justify), forecasts of food aid needs should be seen as judgments as to reasonable targets. These are formulated by projecting past aid and import levels as adjusted to future economic and population changes, and, as appropriate, to take into account other foreseeable short-term factors.

In discussing these projections of food aid needs in the next decade, the group did not advocate substituting food aid for other types of aid, or vice versa, and made no special assumptions about its legislative support *per se*. Food aid is historical phenomenon of forty years' standing, and promises to continue at some level. The workshop addressed what ranges and roughly what areas would be eligible to use it, based on trade projections. It should be pointed out, however, that there is a school of thought that advocates abolishing food aid *per se*, allowing financial aid to assist recipient countries to make up food import shortfalls. Financial aid instead of food aid, it is believed, would enable donor countries to dispense with complex and cumbersome systems of administering food aid, and allow free market forces to operate more efficiently, in the expectation that in the long term this would give greater impetus to economic growth in recipient countries, removing more quickly the need for assistance with food imports.

In fact, however, food aid programs historically have operated in just this self-correcting fashion. Optimism about the ability of free markets alone to provide a long-term solution to filling food deficits, moreover, is countered by preliminary evidence from the International Institute for Applied Systems Analysis Basic Linked Systems (IIASA/BLS) general equilibrium model. Results indicate that removal of subsidies and other restrictions on free trade would be likely to widen the food gap in Third World countries. In the short run, the economic growth effect of free trade for developing countries would be lower than with targeted transfers of funds and continuation of food aid and the maintenance of trade barriers. This topic remains, however, a point of contention among economists, and further study is needed of "absorptive capacity" of developing countries with respect to aid mechanisms, the role of parastatals in food distribution (and the problems caused by their "rent seeking"), as well as on the opportunity costs of other forms of aid.

METHODOLOGIES

There is no single generally accepted methodology for estimating food aid needs. Several approaches were discussed at the workshop, reflecting the different assumptions made by participants in their forecasting efforts.

One view proposed is that it would be best, where possible, to employ general analysis to determine food aid needs. Modeling future food aid contributions simultaneously with all other relevant economic variables in recipient countries, however, requires both complex analysis and availability of reliable data, and modelers have so far been discouraged from searching for results from this approach. Many economists believe that partial analysis can yield satisfactory results by holding a number of the variables in the economy constant, whereas food aid estimates are calculated on the basis of variation among a small number of factors directly connected with food systems. If economic equilibrium is assumed or achieved (which, apart from a few financial markets, is the exception, not the rule) the methods are respectively general or partial equilibrium analysis.

The partial approach, however, is less useful for analyzing the effects of policy. Both approaches lose their usefulness for forecasting beyond shorter-term projections. The problem is whether feedback effects exist from the estimated dependent variables to the assumed independent variables. The main contribution of the general models is to incorporate secondary or indirect effects; when these are large in relation to primary effects, partial models can be misleading. Over periods as short as ten-year estimates, especially if modest perturbations of the economy and exogenous political constraints are included, a wide range of estimates can be derived. In addition, problems arise because developing basic model features and estimating parameters inevitably involves compromises. As a result, different models have evolved for different purposes. Ultimately, apart from the International Food Policy Research Institute (IFPRI) method, the estimates proposed during the workshop were based on rather simple projections and logical deductions from world grain commodities trade models. They relied heavily on expert judgment in their underlying assumptions and implications, rather than on complex modeling techniques.

DEMOGRAPHIC CONSIDERATIONS

Greater "need" for food arises from population growth and greater economic wealth. Projections of population growth, especially in Africa, have tended to underestimate the range of uncertainty significantly, even for projections a few years into the future. For example, decline in fertility rates has not yet begun in many African countries, and substantial variations in projections of future African population growth remain. Much of this growth will take place in cities; UN figures show an African urban population of more than 400 million by the year 2000, and, notably, these projections do not allow for surprises like the proliferation of AIDS, or for interactions with economic, social, or technological trends. Thus, the assumption that population can be treated exogenously in those models could prove to be dangerous.

The composition of the diet—in terms of the proportion of food calories consumed as animal products—can have a significant effect on the quantity of agricultural commodities needed. Rising income is the major force driving up non-cereal food demand. Using FAO/WHO/UNU standards for caloric needs and computing food supply from FAO data shows that there is enough food in the world at present to feed some 6 billion people if most foods are directly consumed. However, as the demand for animal products rises, the need for primary agricultural products also increases. A diet for everyone in the world consisting of about 30 percent animal products doubles the need for primary agricultural products—significantly above what is currently produced in the world. This variation due to dietary composition is much larger than the potential differences in projected demand due to different population growth projections.

Over the past several decades, the proportion of hungry in the developing world as defined by the FAO standard declined from about 34 percent in 1948-50 to 17 percent in 1978-80. However, the rate of decline appears to have leveled off in the past decade, with only about a 1-percent decline in the subsequent 5-year period. Projecting this current slow rate of decline into the future, the actual numbers of hungry could still rise during the next decade, even if the proportion of hungry continues to decline, because of the increase in total population.

NUTRITIONAL CONSIDERATIONS

Nutritional status is influenced by food and health, both of which are influenced, in turn, by prices and incomes. Food aid influences nutrition and health. It is not a question of total food quantity *per se*, nor average supply and demand *per se*, but rather how food prices are determined and the extent to which the incomes of populations at risk are insufficient to afford adequate food. Program food aid can have an important impact on nutrition by lowering prices, or at least keeping them level; that is, there is an impact beyond targeted nutrition projects. There are two components of need: a market-demonstrated price response to need, and the physical response of malnutrition from those who cannot satisfy their need through the market. If food aid is really intended to eliminate malnutrition, it must not only provide adequate amounts of cereals to the market, but also reach beyond market exchanges. In this way, effective demand can be met without lower prices reaching the point at which producers are hurt.

Combining the goals of stabilizing prices and meeting nutritional needs would be the most effective use of food aid from a nutritional standpoint. Using food aid to increase the incomes of the poor could be accomplished by targeting food aid to the malnourished through selective systems such as food stamps or ration cards. In this approach, targeted food aid is used as a resource to maintain prices (perhaps substituting for imports) and at the same time aimed selectively to eliminate malnutrition. An additional benefit would be to provide an outlet for surplus food aid grain, which may be important for producers. The IFPRI estimate is that by 1995 37 million metric tons (MMT) will be needed annually just to keep prices stable in developing countries, using current commercial mechanisms of non-targeted food aid. This is double the FAO estimate for 1988-89 though the basis for the two estimates are different.

Nutritional needs require definition. The FAO uses as a minimum need 1.2-1.4 times the Basal Metabolic Rate (BMR), the amount of energy required to maintain body processes at rest. Assuming household uniformity and distribution efficiency, this minimum need was seen as simply inadequate. Not only are the assumptions about equitable distribution dubious, but the BMR figure allows little energy for productive work. There is also a need, some believed, for an upward revision of protein requirements. Based on recent Massachusetts Institute of Technology studies, consumption behavior should be examined for *variety* in diets, including a balanced calorie: protein ratio, rather than just calories, and should predict requirements higher than the 1,700-1,900 kcals/head/day (equivalent to 1.2-1.4 BMR) so that allowances for normal movement and work are included.

ESTIMATES COMPARED

Estimates generated by different groups of specialists and based on different definitions are shown in Table 1.

The average of demand-based estimates for the decade 1990-2000 projected by the five groups show substantial convergence. One simplification of annual food aid estimates presented at the meeting offered the following:

10 MMT	actual food aid delivery 1987-88
20 MMT	estimated aid to meet food price stabilization needs in 1990; also, low range estimates of food price stabilization needs for 1995
30 MMT	average annual price stabilization needs for 1995-2000
40 MMT	high range estimates of annual food price stabilization needs 1995-2000
50 MMT	average annual food aid to achieve price stabilization plus food aid for hunger/nutritional adequacy 1995-2000.

These crude figures simplify:

- the results of the modelers regarding the demand for food based on projected population numbers;
- growth of GNP per capita (which stimulates increases in grain consumption, even in middle-income countries, through a demand for feed grains for animal feedstuffs);
- the future imports of food commodities by developing countries; and
- the ability of countries to pay for imports of commodities.

Much of the detail from which this ladder of numbers was derived is found in the projections below, and in the papers presented, which are included as annexes to this report. Estimates tended to be conservative. The highest figures among the results, from IFPRI, are also based on the most complex and detailed methods of projection; further, they lack any "political" constraints.

Variations among the estimates arise for several reasons. One is that each model includes or excludes different countries from its analysis. For example, Korea, which has the ability to pay for its import needs, is not in every analysis although it still receives food aid shipments. Similarly, China, which is largely self-sufficient, also receives food aid and is not always included. This inclusion or exclusion of countries from any analysis significantly alters its overall projections. In spite of this, there is surprising agreement among the models on aggregate and regional trade projections. Consequently these projections seemed reasonably useful for policy planning, at least as assessed by the experts at the workshop. Average, high, and low range values as shown in Table 1 indicate a reliability or robustness among estimates of food aid needs.

The commitment of the industrial countries to meet food aid needs, however, falls short of the minimum food stabilization requirements of the poorest countries. Current food aid shipments (10-11 MMT in 1987) meet only half of these needs. Satisfying the lower estimates of stabilization needs would therefore require a doubling of food aid in the near term. It was estimated that existing calorie deficiencies owing to lack of purchasing power amount to roughly 15-18 MMT of cereals per year. Assuming a perfect targeting of food aid to poorest households suffering from such deficiencies, and further assuming that each metric ton will result in a net increase in consumption within those households of one-half of each metric ton targeted to such households because of an estimated 50 percent substitution "leakage" factor, 30-36 MMT of grain would have to be targeted on these households. This would result in a net increase in market demand of 15-18 MMT among the targeted population and the use of the other 15-18 MMT to meet market demand so as to stabilize, but not reduce, local food prices, while saving foreign exchange expenditures.

Current levels of food aid, representing only 50 percent of near-term minimum stabilization needs, reflect political priorities and constraints on the part of the industrial countries. Although doubling food aid could reduce hunger without distorting global supply or price conditions during the coming decade, it would not happen automatically, and to be effective it would have to be allocated according to need. Moreover, this doubling in itself, even if allocated to countries in most need, might still not reach the people targeted, since they are left unaffected by many current food aid modalities. The targeting task requires additional resources *and* mechanisms of distribution through food for work, food stamps, or entitlement measures, all of which target food beyond those currently included. Innovative mechanisms might improve the ability to distribute food through the private sector at no additional government cost, and achieve price stabilization (and linked development) and nutritional objectives.

TABLE 1 Estimates of Annual Food Aid Needs for 1990-2000

Institutional Source	Low	Average	High
IFPRI[a]	29-39	37-56	55-74
IIASA/BLS		30	
USDA	21	29	56
Nutritional Need[b]	30	42	55
Iowa State U./FAPRI		34	
FAO	19	30	38

Note: All estimates were made in million metric tons of cereal equivalent, MMT/CE. All except IFPRI estimates were deductions from trade flows assuming some constant fraction of food aid.
[1] Variations based on including different countries.
[2] Pinstrup-Andersen calculation based on IFPRI figures.

The history of food aid availability shows that it has been governed substantially by donor supply and trade pressures. This orientation has tended to keep food aid levels lower than estimated needs. Global food stabilization goals compete with these other pressures, as seen in the 1973-74 period of tight supplies, quite unfavorably. While donors are concerned with world hunger—it is a major political issue in the industrial countries—other forces, such as domestic economic priorities, are ultimately more important policy determinants. In addition, political and diplomatic concerns also have led to substantial political control over food aid allocations. Skepticism was expressed by modeling experts, therefore, regarding donor willingness to add substantial resources to food aid, even for innovative targeted programs so as to satisfy minimum nutritional needs.

SHOCKS THAT COULD AFFECT FUTURE PROJECTIONS

The workshop also considered distortions and shocks to the system of food commodity trade and aid. Major distortions to commodity flows arise more from the policies of the rich countries than from the performance of poor countries.

Weather and Climate

There is a constant prospect of shocks owing to climatic forces, such as the drought in the United States in 1988. Participants agreed that it is highly likely that some shocks will affect supplies during the coming decade. Climate effects are very difficult to predict. Although experts now agree that there is strong evidence for expecting a "greenhouse" effect to increase average global temperatures as a result of the cumulative effects of emissions of gases into the atmosphere, including particularly carbon dioxide and chlorinated fluorocarbons, there is no firm evidence as to when this effect will occur, or where and how it will affect agriculture. Effects of such weather-related factors as erosion of soil and salinization of croplands from irrigation with insufficient drainage are causes of more immediate concern, while technical questions exist for the long period as to the ultimate biological constraints on production as farm efficiency approaches theoretical limits. None of these factors is believed likely to present especially limiting conditions during the next decade. Growth in global commodity production has continued in a steady upward trend, through periods of perturbation, since the 1950s. This has been accompanied by a secular downward trend in world food market prices. It is felt that overall, though there may be local or even worldwide shortages for which emergency food assistance will be needed, there is no indication that historic upward production trends will be reversed during the coming decade.

Other External Factors

Among other types of shocks considered that might affect global food production during the decade of the 1990s were those principally linked to relations among the great powers, including the possibility of the "nuclear winter" of war. It was concluded that recent developments in relations between the U.S. and the Soviet Union had reduced the likelihood of this type of catastrophe. Optimistic forecasts saw increased diversion of funds from defense expenditures to investments in support of economic development. The consequence of this optimistic projection would be to raise global demand for food and feed grains, though it would probably take longer than the next decade to show measurable impact.

While it was agreed that there is a high probability of a major drought, or other natural catastrophe, occurring during the 1990s, the best that modelers can do at present is to recalculate estimates after its occurrence, or add to their estimates the equivalent of an insurance reserve against unforeseen events. Employing stochastic simulations to model the effects of a large number of variables, such as those of weather and climate, was suggested as a worthwhile avenue for research.

Food Aid Projections for the 1990s: Workshop Proceedings

INTRODUCTION

At the request of the Agency for International Development's Bureau for Food for Peace and Private and Voluntary Organizations, the Board on Science and Technology for International Development (BOSTID) of the National Research Council (NRC) arranged for an NRC-appointed panel and a group of experts to convene for two days of discussions concerning projections of needs for food aid in the decade 1990-2000. The objective of the meeting was to examine the projections of food commodity trade and, either directly or by deduction, food aid needs of developing countries, relying upon work of six principal groups engaged in food commodity analysis—the United Nations Food and Agriculture Organization (FAO) Commodities and Trade Division (and others), the World Bank International Commodity Markets Division, the U.S. Department of Agriculture (USDA) Economics Research Service Commodity Trade & Analysis Branch (and others), the International Food Policy Research Institute (IFPRI), the Iowa State University Center for Agricultural Research and Development (CARD), and the International Institute of Applied Systems Analysis (IIASA). The projections of these groups were discussed from the perspective of a number of specialists engaged in parallel types of analysis of future global economic, regional econo-political, demographic, and climatic impact, scientific and technological research impact, and risk forecasting.

DEFINITIONS

There are two basic approaches to defining food aid needs:

- *"Supply-stabilization" food aid*—to stabilize market prices in the recipient country by making up the shortfall ("need gap") between production and consumption. Such aid is thus "demand-based" or "demand-driven". Most typically it is delivered into the local governmental or commercial food distribution system; seldom is there an attempt to target local populations *beyond* existing policies. Food stabilization aid of this type helps developing countries with economic growth, through saving foreign exchange, assisting in generating local income, and insuring against domestic economic instability. It can help to cushion their vulnerability with respect to world commodity markets, though food aid volumes may decline when prices increase, as many donors make allocations in money terms.

- *"Hunger-responsive" food aid*—aid sufficient to alleviate hunger through making up nutritional deficiencies. This estimate of food needs attempts to identify populations at nutritional risk. The goal is to provide food to affected populations, such as women and children, suffering disproportionate deprivation, attempting to alleviate both chronic hunger and acute periodic deprivation. This goal leads to estimates of need necessarily higher than the minimum caloric shortfall for any specified hungry population, since some substitution effects occur among this population. Currently, relatively little regular food aid is based on this hunger-responsive type of estimate.

Projections for "supply stabilization" and "hunger-responsive" food aid do not include soft credit programs of the European Community or the United States, such as the Guaranteed Market Supply (GMS) or Export Enhancement Program (EEP) entitlements, but they do include sales under Title I of Public Law 480, as well as U.S. and other donor nation *grant* aid. Past emergency aid, because of its stabilizing effect, as well as its humanitarian motivation, is used for calculating the trade proportion of food aid in some estimates (not those of IFPRI).

In calendar year 1987 alone, export subsidies on wheat and flour provided by the European Economic Community and the United States to developing countries amount to about $1.6 billion, or more than half the value of all food aid recently provided by all countries in the Organization for Economic Cooperation and Development (OECD). Although these programs also provide importers an opportunity to use their foreign exchange for other uses, perhaps for development-oriented investments or for debt repayments, they are not appropriately defined as food aid.

METHODOLOGY

Projecting food commodity trade and aid has consistently been attempted since the Second World War, thanks, in part, to the creation of the FAO, and the expansion of trade and development concerns in industrial countries. Mostly, estimates were based on immediate demand and supply availability rather than on detailed need estimates. However, with improvements in the global system of reporting production and export and import statistics, and, more recently, with the ability to store and process large amounts of information on computers, sophistication in using agricultural statistics for forecasting has improved. But the complex interdependence among the variables requires models that account for many relationships. There are, therefore, no entirely satisfactory methods of predicting food trade and food aid needs, even over periods as short as five or ten years, let alone the fifty-year time horizon set by Brown University's Hunger Program (Kates *et al* ., 1988). The most widely used studies on food aid (cereal) needs or requirements are those prepared by the FAO and USDA. These are principally made for the coming year, or at most, the year after.

The methods that are used to project future trade, and derivatively, aid needs, all involve a complex set of estimates and assumptions. These include estimates of relevant forces affecting individual countries, for example, the expected rate of general economic growth (which reflects purchasing power), the growth of population (which together with income is the major determinant of demand for food), and the amount of cereal grain production. Assumptions leading to these estimates, along with decisions as to which countries to include in estimates (such as China and India, whose size tends to swamp the data on international trends arising from smaller countries) account for the primary differences among the main forecasts.

There is no general agreement about the validity of various assumptions. Most economists agree that a general equilibrium model, in which as many as possible of the variables of relevant countries' economies are allowed to interact together to assess the impact of varying any or each of them, including the insertion of food aid, would be able to give the most fully considered estimates. However, these general equilibrium models are so complex that none currently exists that is agreed to be especially useful in projecting food aid needs. The International Institute for Applied Systems Analysis (IIASA), in Laxenburg, Austria, a center for international cooperation in developing this type of modeling, among other types of research, has created one basic world food model.

Since suitable general equilibrium models are not available, many economists use partial equilibrium models, in which a number of the variables are assumed to remain constant, or to grow at an assumed fixed (positive or negative) rate, while other variables are projected. Partial equilibrium analysis is widely considered to be a valid means to assess the impact of limited changes in the dependent variables. However, the longer the period and the greater the changes projected, the less confidence there is in the results.

For an economic factor as important to some countries as food aid, it is likely that supplying food aid over a number of years will create economic changes that will alter economic variables assumed to remain constant. In the extreme this could mean that food aid supplied over the first half of a projected period would cause economic growth rates to rise, hence incomes would rise, local food prices would rise without large increases in supply, and therefore the numbers of nutritionally disadvantaged would increase. After some lag, however, higher food prices could stimulate both income growth among rural producers and large increases in production, as occurred in China in the early 1980s, for example. The implicit expectation is that eventually the effects of food aid could actually result in a decline in its need, as agricultural growth would be adequate to cover growing domestic demand.

The estimates presented at the workshop, with the exception of those prepared by the IFPRI, were *derived as rather simple projections* or logical deductions. They were put forward within the framework of fairly robust estimates of LDC food imports in the 1990s, generated by models of international commodity trade in cereals and national staple foods consumption behavior. Developing the estimates of hunger-responsive and price-stabilizing food aid amounts involved a recognition of "normative" elements in forecasting. That is, they included those elements which, from prior experience, are taken to be normal or reasonable amounts. In addition to the needs projected from import gaps or nutritional requirements, there are food aid needs arising from exceptional circumstances. These may result from political, economic or "exogenous shock" factors (such as drought, civil strife, or other unforeseen occurrences).

Actual food aid deliveries, as opposed to needs, may be expected to be lower than the workshop projections of food aid needs, if we assume no changes in donor country policies. This reflects constraints on the ability of donors to provide the estimated amounts. As Ascher (1978) points out, "The introduction of 'normative' forecasting, which is the use of projections to systematically explore and select goals and alternatives, is the most prominent indication of the effort to transform the forecast from isolated information into a decision-making process in its own right." Aside from the key assumptions of a normative nature regarding target goals for food aid, other assumptions regarding economic behavior were involved in the estimates derived at the workshop.

A second point about the estimates is that they were based on *expert judgment*. A considerable degree of consensus among the experts encouraged a certain degree of confidence in the average figures derived, and the boundaries around them. The ultimate test of estimates which forecast future food aid flows and levels of food aid needs lies in their accuracy. In the 1990s, actual deliveries of food aid will occur. Whether these satisfy either of the two "needs"—supply-stabilization for poor developing countries (the FAO low-income food deficit countries), and hunger-responsive food aid—will be difficult to assess, certainly more difficult than whether forecasts of actual flows are accurate or not. Both needs estimates require, in turn, projections of the demographic composition and amounts of food needed to eliminate the caloric deficiency of hungry people in the affected countries—a subject of widely varying estimates and observations of uneven reliability, depending on the criteria adopted.

FOOD COMMODITY TRADE AND AID FORECASTING

In introductory remarks, Owen Cylke, Assistant Administrator for FVA, pointed out that food aid is one of the most widely shared instruments of international cooperation among executive branch agencies of the U.S. government. With the impending change in administration it is timely to look at future requirements. The concern is for efficient food systems and food security in the Third World, not just for food aid.

The following is a synopsis of the papers contributed by the six principal organizations. The synopsis is derived from the synthesis evaluation paper presented to the meeting by Bruno Larue of the University of Guelph, and from the ensuing discussions of participants.

Dr. Larue pointed out that it is always easier to judge forecasting models than to create them. Forecasts are only as good as the available data, and, because they require many compromises between what should ideally be included and what is practical to include, they are inherently limited. There are also many uncertainties, arising from such causes as the weather—for example, Hurricane Gilbert in Jamaica and floods in Bangladesh—and unexpected market demands arising from political changes, such as the coup d'état in Haiti and other so-called exogenous factors. Most of the "models" reviewed at the workshop are designed to predict future prices and tonnages in the export-import trade market. Except for the IFPRI process employed by Hannah Ezekiel, they are not explicitly designed to predict food aid requirements.

Three models, the Food and Agricultural Policy Research Institute (FAPRI) model developed by Iowa State University and the University of Missouri, the Static World Policy Simulation Modeling (SWOPSIM) of the U.S. Department of Agriculture, and the World Bank model, predict export-import trends in commodities, mainly cereal grains, not food aid. The FAPRI model is based primarily on predictions of trade to and from the United States, while the Bank and others treat U.S. policies in detail in their models because of their importance to world food trade and aid.

The IFPRI effort, which does project food aid needs, is based on the aggregate importation of food by developing countries, translated into cereal equivalents.* The import gap is then calculated as the difference between total domestic use of the major food crops and production. Food and feed use projections are obtained from estimates of per capita GNP, population growth, and income elasticities of demand. Commercial import projections are subtracted from the import gap. These are based on growth rates of per capita income

* Using cereal equivalents for oilseeds, roots, and tubers assumes that foods are equally interchangeable; since the bulk of food aid is in the form of cereals, there is no great error introduced by this assumption.

applied to base period commercial imports as a measure of the ability to pay for food. The balance is the projected food aid needed for food price stabilization.

Some issues arise from these assumptions: there are problems in looking only at the demand side, since if you know how much food aid you can expect to receive, it can affect your demand for commercial imports of food and other goods. Theoretically, food aid demand should not be limiting, since it is a free good. On the other hand, modeling the supply side is difficult, since you are modeling political and economic behavior. For one thing, it would have to be based on assumed relations specifying political propensity to tie food exports to economic aid or new loans in order to reduce undesirably large domestic stocks. However, given the data available over the short period in developing countries, the existing LDC demand side at projected prices and availabilities remains the normal basis for estimates. This "need", as distinct from food aid policy implementation, is affected by many exogenous factors, and it is very difficult to predict or control.

OUTPUT OF THE MODELS

All models show better economic situations for developing countries in the high-growth scenario; low growth has a negative effect. The FAPRI and World Bank models are surprisingly close on production forecasts. FAPRI predicts a substantial increase in commodity prices, whereas the World Bank and SWOPSIM models predict a decrease in prices in real terms.

Net trade prediction figures for the period 1990-1995 show 10-15 percent growth in exports from the producing countries, and 10-17 percent growth in LDC imports. Figures for the Centrally Planned Economies (Figures 1 and 2) show a swing from net exporters to net importers. Corn trade shows an increase in exports by 30-40 percent, with imports by developing countries increasing 36 percent in response to rising incomes and demand for animal products. Growth in soybean trade will be much smaller than wheat or corn trade. The import gap of demand exceeding domestic supply should get wider by 2000.

An interesting implication is that high growth, stimulated through resource transfer to developing countries from industrial countries, has a greater economic impact than freer trade resulting from removal of restrictions on commodity trade.

Comparison of the IFPRI and FAPRI models yields different results, but not surprisingly since they have different assumptions and countries included. The import gap estimates of these two models (all figures in million metric tonnes [MMT] of cereal equivalents) are:

	FAPRI	IFPRI
High Income E. Asia	16	19.2
Asia (excluding China & India)	30	22.6
Latin America (excluding Argentina)	21	13.2

The proportion of food aid needed to close the import gap is anticipated to become larger as import needs rise faster than foreign exchange earnings. One reason for this is the expectation that the growth impact of the "green revolution" package of technologies and support to farmers, a factor in high food production growth in the 1970s and 1980s, is largely over and will not continue into the next decade. High-yielding varieties produced by recent research are more likely to lead to greater stability in crop yield, rather than much higher yields. There is, however, a prospect for greater gains from a marketing and distribution revolution. It is increasingly possible to deliver food across national and international

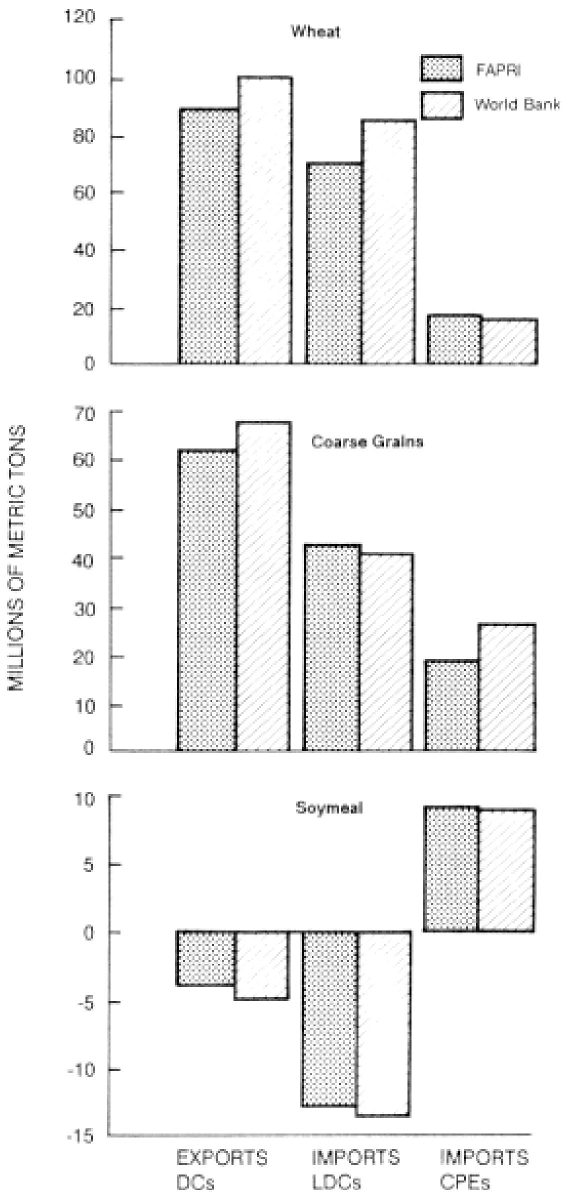


FIGURE 1 Projected 1995 Net Trade. SOURCE: Adapted from Larue and Meilke, **1988.**

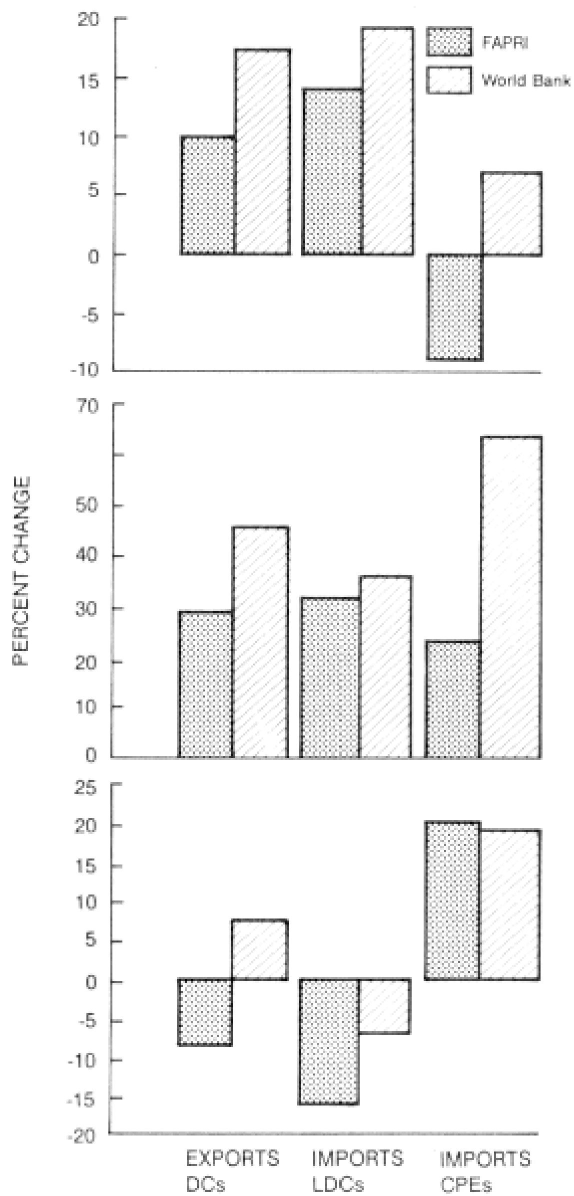


FIGURE 2 Percentage Change in Net Trade-1990 to 1995. SOURCE: Adapted from Meilke and Larue, 1988.

regions to feed people. More efficient means of marketing food, therefore, would have a positive impact on food needs, even without increases in the rates of production growth to keep up with population and economic growth.

PRESENTATION OF THE IFPRI FIGURES

Hannah Ezekiel, International Food Policy Research Institute

Dr. Ezekiel indicated that the IFPRI method estimates demand-based food aid needs. It does not deal with the gap between need and the ability to pay. It assumes that prices are kept reasonable through food aid, and do not cause a reduction of demand on the part of the poor. One methodological problem is to distinguish between demand and nutritional need; adequate data for estimating nutritional deficiencies satisfactorily are not available. Another problem—access of poor to the food—is beyond the scope of the present IFPRI study. Increasing the incomes of the poor (or the average incomes of the country as a whole) to the levels at which the poor are able to buy the food they require is a gigantic problem, one far beyond the solution of food aid by itself.

Food import gaps cannot always be filled commercially because of countries' foreign exchange shortages; food aid fills this unfilled gap. There is no such thing as food aid "needs" *per se*, however. "Needs" derive from assumptions about stable per capita food availability and commercial import capacity. Ultimately they are determined by donor policies, which result in suitable criteria being framed for the purpose. Seeing food aid as a tool for development helps to set these criteria properly. In addition, there is an important need for equity which, because of the nature of food, must be estimated independently, and addressing it by, say, feeding the urban poor, must be done without leading to neglect of agriculture. If used properly, food aid should increase commercial demand faster because it supports good policies, thereby increasing incomes. However, if it supports bad policies, decreasing incomes may lead to more need for food aid to avoid starvation. Thus, future food aid needs are in part a product of its effectiveness in earlier periods. In every case, food aid must be seen in a specific context, or else it is only a mechanical response and is not likely to be used as an important development resource. Specific IFPRI projections for market stabilizing program food aid are given in tables in the paper presented (Appendix A; Ezekiel, 1988b.)

These IFPRI estimates are based on trends. Income trends combined with a population growth factor are used to estimate demand, which, in turn, is the basis for import gap estimates. In principle, food aid should fluctuate in response to production in recipient countries, though the volume of food aid exports may lag behind production changes, based on food stock adjustments taking place first (Johnson, 1979). Upper and lower limits for need can be projected around a central trend, assuming average variability. Data are aggregated over a large number of countries from FAO supply utilization accounts, without modification. The period 1972-1983 is used to estimate trends because using a long base period (the 23 years from 1961-1983) to make projections misses significant recent alterations in the trends in some countries, both positive and negative. The future is likely to be more like the immediate past 10-12 years than like the last 23.

PRESENTATION OF FAO FIGURES

Richard Perkins, Commodities and Trade Division

Dr. Perkins pointed out that food aid is already included in historic trade data, and therefore appears in the estimates of countries' future import needs, which assume that supplies of donated food will continue. Using country import statements may give rise to anomalies, he noted. Factors that cause this may be upward revisions of production estimates without revisions in income or population estimates. This could lead, for example, to Ethiopia being seen as requiring no food aid, and/or, as in the Sudan, refugees not being counted since they are absorbed into the population without distinction for their special food aid needs. Needs estimates based on national averages do not account for distribution inequities and are therefore very inaccurate.

The FAO gathers a great deal of data, and much of it is used in studies of future world food trends. It has not, however, made projections for food aid requirements recently. The most recent FAO food aid requirements estimates are based on production, demand, and trade projections for the 1985-1990 period, using mathematical models similar to the USDA/GOL (Grain, Oilseed, and Livestock) model and planning-type models with a fairly optimistic production and trade scenario. For the 1985 estimates of food aid requirements, a revised approach was adopted to include separate components reflecting balance of payments support and project food aid (for example, for Food for Work and food security reserves) plus an emergency component based on shortfalls in cereal production. The total requirement was estimated at 20.2 MMT of cereals. The projection models are usually neutral with respect to income distribution and food price policies. They are also neutral about targeting populations or leakage limits.

Another approach adopted by FAO has been to base food aid needs on nutritional considerations—to increase food intake to "acceptable levels." The guidelines for food aid adopted by FAO in 1981 give priority to low income food deficit countries. Out of 12 MMT of food aid in 1987, 10 MMT went to low income food deficit countries, an allocation trend to be welcomed. The definition of a nutritionally "minimal level of intake" was established by the Fifth World Food Survey of 1985, based on the distribution of food energy intake measured through recent household consumption surveys. Very conservative low limits were set of 1.2-1.4 BMR units per capita (corresponding to 1450-1610 KCal/day in India and 1550-1720 KCal/day in Egypt) as minimum maintenance requirements for energy, with no allowance for movement or work energy for adults. It then calculated the minimum additional amounts of energy (as cereal equivalents) required to bring the average daily intake up to these minimum levels for the people in developing countries which at the time were below this level. These estimates, without allowing for leakage or targeting difficulties, amount to 8-14 MMT respectively for reaching the 1.2-1.4 BMR limits.

The energy distribution curves used in the survey in 1979-1981 implicitly included in their established base the approximately 9 MMT of food aid actually provided during that period. Therefore the 8-14 MMT plus any further increase required for the portion of food aid that "leaks" (that is, fails to reach the targeted malnourished population) should be added to the existing food aid levels in any projection of extra needs of that period. As a basis for extrapolating such figures, by the year 2000 FAO projections for the absolute number of malnourished people in LDCs indicate an increase over 1979-1981 figures of roughly 10 percent. (While the fraction of the world's population receiving lower than a minimum calorie need will drop, the absolute numbers are not expected to do so.) A further 10 percent allowance for leakage would give a total estimate of 20.6-27.8 MMT additional food required.*

* The calculations are: 9 MMT + 8 MMT + 10% of 17 = 18.7, + 10% of 18.7 = 20.6 MMT; 9 MMT + 14 MMT + 10% of 23 = 25.3, + 10% of 25.3 = 27.8 MMT.

Such figures are based, however, on the assumptions that 1) all countries would be able to purchase their net import requirements commercially by 2000; and 2) real world market prices equal to those in 1983-1985 would prevail. It may be noted, however, that a rather large decline is projected in the agricultural trade surplus of the developing countries as a whole, which could undermine such assumptions.

PRESENTATION OF WORLD BANK FIGURES

Ronald Duncan, International Commodity Markets Division

Dr. Duncan indicated that World Bank figures are not for food aid, but projections of production of grains and soybeans. The World Bank projections see short-run price increases through 1989, as the last year of a 3-year cycle, then falling prices in 1990-1991. In the long run, to 2000, they see prices in real terms declining as a continuation of the post-Second World War trend. Growth in LDCs' per capita GNP will increase food demand. Their ability to meet this demand will depend on policy responses within the LDCs to restraints on production, and on import policies. Areas of particular concern for food imports are sub-Saharan Africa, Bangladesh, and the small southeast Asian countries (excluding China and India). The World Bank focuses on LDCs in its projections. Other world bodies are taking care of projections for the industrial countries. Major countries within the World Bank's area of interest, however, and which the World Bank is assisting with policy reforms, include countries other than those included above, such as India, Indonesia, Thailand and Argentina, and also China.

Macroeconomic assumptions indicate a 1989-1990 slowdown in industrial country economic growth, and then a rather optimistic period—1990-2000—during which economic growth in OECD countries should be greater than 3 percent, with real interest rates falling, boosting investments compared with 1970-1985—a period when investments fell as real interest rates rose. LDCs' growth averages are predicted to be 4.5 percent, but this includes China, with 6-7 percent, and India with 4.5 percent, as well as African and Latin American growth, which is much lower. The Centrally Planned Economies (excluding China) are projected at a somewhat pessimistic 2.3 percent. If the CPEs grow faster, the grain trade market could be much larger.

The outlook for grains trade is the subject of some dispute within the World Bank. When growth in grain yields slows, some tend to assume that more investment in irrigation will lead to higher rice yields. However, with increasing incomes in LDCs, there will be a further shift in relative demand toward coarse grains and from rice to wheat (Japan's market for grains in 1955 was 95 percent rice, but fell to less than 70 percent in 1985). Bennet's Law suggests the inevitability of the growth in demand for coarse grains for feeding livestock. There should thus be less alarm at falling rice consumption. Africa is different, showing increased rice consumption with rising incomes. There will therefore be a projected annual import growth in wheat and coarse grains to both LDCs and CPEs of 5-8 percent. The actual rate of growth will, it is believed, depend on the rate of implementation of price/ policy reform.

The emphasis on the economic environment is justified because, as in the case of demand for rice, food consumption reflects several factors—for instance, subsidized urban prices. That it is possible to remove subsidies without economic chaos was shown in one province in China where the price was tripled, and consumers were given a lump sum to assist their adjustment to the new prices. There was no upheaval; a 25 percent decline in rice purchases reflected mainly an end to feeding cheap rice to chickens.

There is a major problem in using aggregated commodity trade figures because of the huge influence of the large countries such as India and China.

PRESENTATION OF THE FAPRI FIGURES

W. Meyers, Center for Agriculture and Rural Development, Iowa State University

Dr. Meyers observed that the meeting was an important step in bringing together the commodity trade modelers with those making food aid projections to compare the output of the models and understand why differences might occur. Key assumptions used in the FAPRI model are macroeconomic, based on Wharton/Chase econometrics and Project Link (the University of Pennsylvania macroeconomic modeling project) data rather than World Bank projections. Its forecast is for an average GNP growth rate of less than 4.5 percent. The baseline used in the paper circulated to participants was that presented at the Buenos Aires XX International Conference of Agricultural Economists in August 1988, but prepared before the drought in the United States, and does not include changes in U.S. policies in response to drought.

The model's major conclusions were that U.S. acreage planted, as opposed to idled through set-aside programs, will increase towards the minimum limit of 40 million acres conservation reserve mandated in the 1985 Food Security Act, leaving the United States with reduced flexibility to respond to future stresses. The effect of the drought on prices has driven up estimates for 1988-1989, but these should return to the trend as long as policies remain the same. A slight increase in prices for 1986-1996 is foreseen, returning to resume the long-term decline thereafter (Figure 3). Cereal stocks will also be drawn clown to the pre-1985-1986 level by the drought, and there will be much less criticism of the reserve policy than there was in 1987 (Figure 4).

FAPRI trade trends project growth of net imports by LDCs, less by the Centrally Planned Economies (CPEs) and industrial countries. There will be greater pressure on foreign exchange in developing countries. This will reflect factors such as the growing impact of debt servicing.

Real income growth in Africa (ranging from 0-3 percent per year) is expected to result in a widening trade gap in wheat and coarse grains (Figures 5 and 6). A gap requiring imports is broadly typical of all developing country areas. Even though Asian economic growth will stay at about a constant 5 percent per year, well above African growth, the higher African growth in its import gap probably reflects the low base starting point for African predictions and higher marginal propensity to import food as incomes rise.

Though the improved economic trends are encouraging, in many countries growth in production cannot keep pace with growth in demand from population and income increases. While countries in east Asia with high growth can cover their increased grain imports using foreign exchange generated by exports, many other LDCs have heavy debt burdens and foreign exchange constraints that will limit their ability to increase imports substantially. Importers' costs will also depend heavily on whether the local currency is likely to appreciate or depreciate with respect to the U.S. dollar, and it is the same countries with foreign exchange shortages whose currencies are likely to depreciate, causing the costs of imported commodities to rise.

The region under the greatest pressure, in terms of potential reductions in per capita consumption of commodities, is Africa, followed by the Middle East and Latin America, excluding Argentina. The Asian region is likely to do better, because production growth is

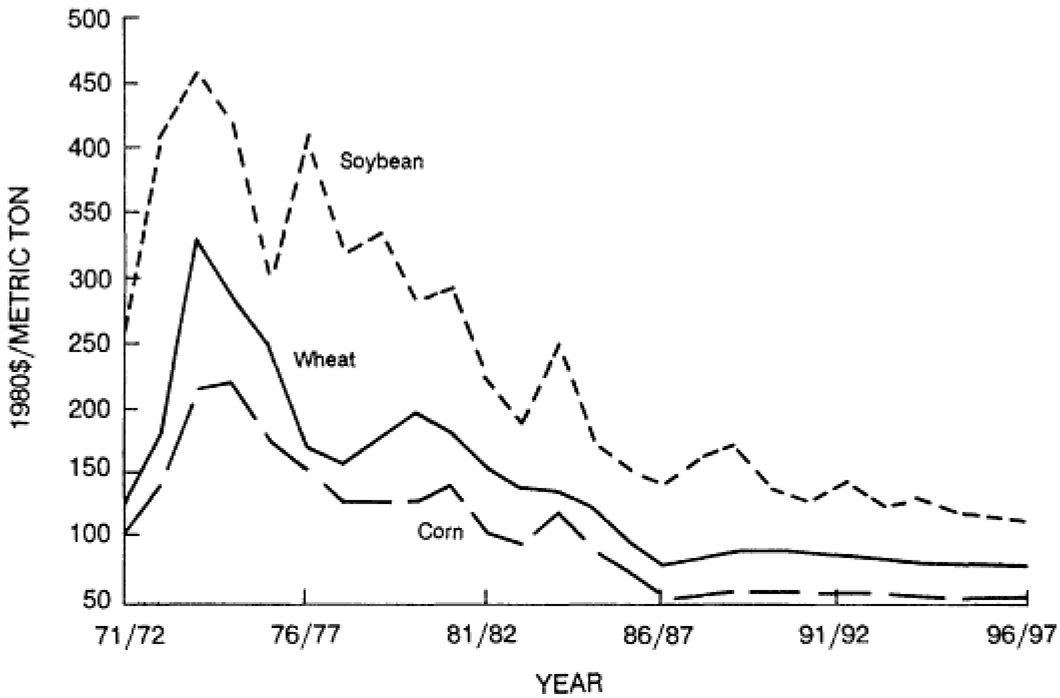


Figure 3
Major Cereals: U.S. Gulf Port Real Prices—FAPRI Model

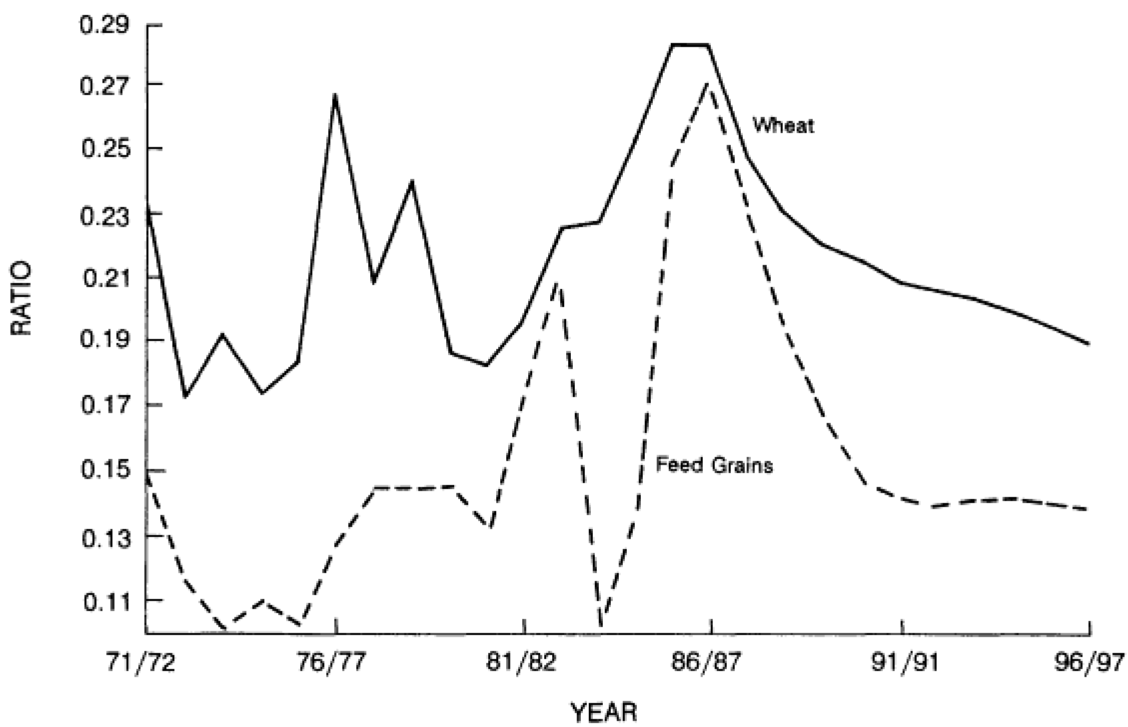


Figure 4
World Cereal Levels: Stocks-to-Use Ratio—FAPRI Model

expected to keep pace with population growth rate. Although imports are increasing in all developing regions, they are insufficient to offset the slower rates of growth in production. The most desirable solution to these problems would be to increase productivity. Another important measure would be to resolve the debt problem. Food assistance programs are

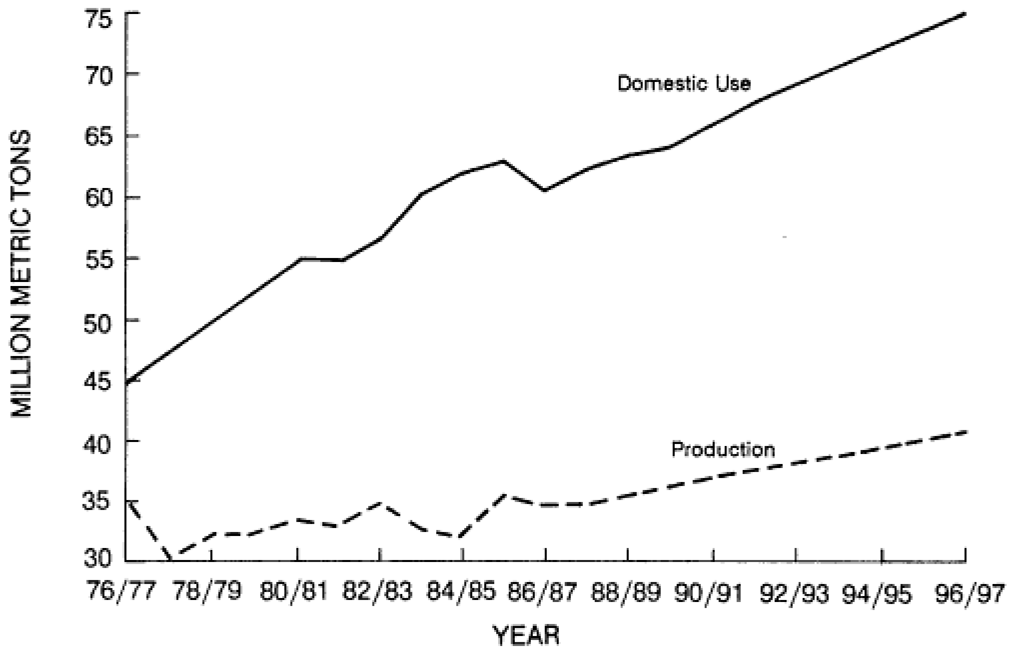


Figure 5
Africa and Middle East Wheat

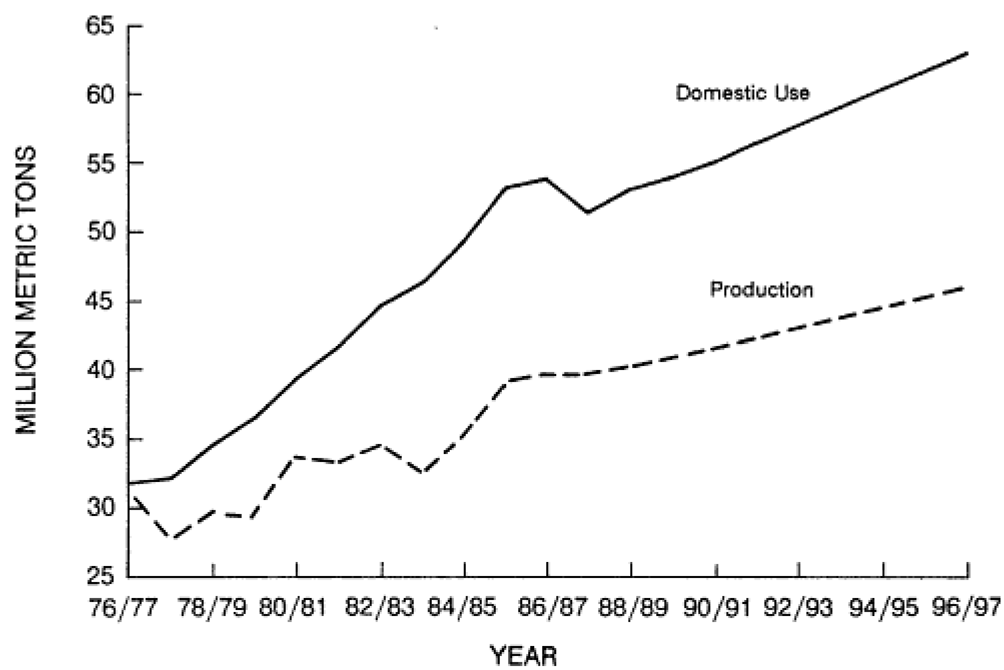


Figure 6
Africa and Middle East Coarse Grains

a short-term measure, not a solution to static or declining per capita consumption levels. Targeted export subsidies can have a similar effect, provided they are based on need rather than on geopolitical or strategy considerations.

There needs to be a shift in priorities. Poorer Third World countries must have more assistance to develop their entire infrastructure (education, health, transport, marketing, and distribution systems) as well as agriculture and industry if the growing import gap projected is to be avoided. Only through long-term sustainable growth will food security problems be solved. When the Third World countries can produce and sell products for which they have a comparative advantage, they will command the resources necessary to feed their populations.

PRESENTATION OF USDA FIGURES

R. Nightingale and R. Trostle, Economic Research Service

Dr. Nightingale indicated that IFPRI and ERS short-term food aid projections use similar data sources and assumptions, but that food need in the ERS analysis is based on maintenance of per capita consumption (the status quo) and on nutrition requirements rather than income-based economic demand. However, the ERS method (FNA) has not been extended to longer periods because the analyses are directed to Congressional and National Security Council requirements for frequent short-term reporting. Short-range projections have been undertaken since 1975, and the basic methodology has been stable since 1981. Since then, methods have been introduced to assess cereal needs to maintain stocks or to meet explicit national food stock objectives. Methods have also been developed to project debt repayment, a factor entering into estimation of commercial import capacity. The FNA analysis is at the national aggregate level and does not address internal distribution issues.

The Economic Research Service uses a number of models to project commodity trade. These include the Static World Policy Simulation Model (SWOPSIM) and the domestically focused Food and Agriculture Policy Simulation Model (FAPSIM). Both are comparative static equilibrium rather than dynamic projection models. Dr. Trostle summarized the model assumptions and projections: population growth will slow, incomes will rise; debt servicing will constrain consumption, but lower agricultural prices will be an offsetting stimulus to consumption. LDC agricultural production averaged a 2.9-percent compound annual growth rate between 1950 and 1987, but is expected to decline in the 1990s to 2.4 percent. Countries approaching 100 percent self-sufficiency in food will slow production rather than export food at low prices. Debt servicing will restrain the ability to import food commercially. There are no radical technical production breakthroughs on the shelf that will raise yields sharply during the next decade. An exception may be animal growth hormones, coupled with improvement in livestock management, but this will not cause a large effect in overall estimates.

LDC area planted to crops has expanded a modest 0.7 percent per year. Much of the growth has been on poor land. Area expansion will slow unless prices increase significantly. Grain prices are projected to follow a downward trend of about 2 percent per year, roughly offsetting increases in productivity. Grain and oilseed output has shown a 2.7-percent growth, 1.9 percent due to yield increase, 0.8 to area planted. Slower growth is forecast, with cereal yield increases declining to 1.7 percent per year. Consumption is likely to increase faster, and self-sufficiency will decline. LDC net cereal imports have been increasing by 8 percent per year, but will probably slow to 5-6 percent per year. The net agricultural trade surplus of LDCs fell from $15 billion in the mid-1970s to zero in recent years. Some countries are doing well; others very badly. Since 1975, food aid shipments have risen 3.7 percent per year. Foreign exchange will be a major factor affecting future growth of commercial imports. In 69 countries, food imports use 10 percent or more of available foreign exchange.

TABLE 2 IIASA/BLS Projections of the Incidence of Hunger

	Year	
	1990	2000
As Percentage of Population in LDCs	17	11
In Millions of People:		
In All LDCs	470	400
In Middle-Income Countries		30
In Low-to Middle-Income Countries		60
In Low-Income Countries		310

PRESENTATION OF IIASA FIGURES

K. Frohberg, OECD, Paris

Dr. Frohberg indicated that the IIASA model is a general equilibrium model, while the others are partial equilibrium models. The IIASA Basic Linked System (BLS) model looks at income and demand aspects, explicitly including what actually happens. It is based on the system of 20 national models and 14 regional models. It is deterministic, and while one must resist the temptation to use it as a forecasting tool, it is used to simulate the impact of policies over a 20-year perspective, including 9 agricultural commodities, and 1 nonagricultural commodity.

The model generates the following information: 1) at the international level, prices, volumes traded, produced, consumed; 2) at the national level, population, production, human consumption, feed use, intermediate consumption, net trade volumes, stocks, prices for producers and consumers, and input use: labor, capital, land, fertilizer. Table 2 gives the projections for the incidence of hunger 1990-2000.

Table 3 shows the share of global demand among the Industrial Market Economies (IME), developing countries (LDCs), China, and the Countries for Mutual Economic Assistance (CMEA). Table 4 gives the results of a reference run estimating the numbers of hungry people in selected countries for which the BLS models have a common structure.

Tables 5 and 6 show the projections from the BLS models of different scenarios of the impact on hunger.

TABLE 3 Share of Global Demand in 1980 and 2000 (percent)

	IME		LDCs		China		CMEA	
	1980	2000	1980	2000	1980	2000	1980	2000
Wheat	23	21	28	38	12	11	33	27
Rice	6	5	56	66	36	28	1	1
Coarse Grain	42	44	20	27	10	9	24	18
Beef, Mutton, Lamb	49	43	29	36	6	6	17	15
Dairy Products	44	39	23	32	1	2	30	26
Other Animals[a]	41	38	20	28	19	22	50	9
Protein Food	50	48	15	21	12	13	9	6
Other Food[b]	22	18	42	52	16	14	15	11
Fibres	35	26	30	31	14	18	27	30

[a] Pork, poultry, eggs, fish.
[b] Oils and fats, sugar, vegetables, fruits, nonalcoholic beverages.

TABLE 4 Numbers of People Hungry (in Millions), Reference Run

	1980	2000
Argentina	1	1
Brazil	12	3
Mexico	3	3
Egypt	1	0
Kenya	6	7
Nigeria	25	2
India	219	156
Indonesia	21	0
Pakistan	9	6
Thailand	8	4
Turkey	1	1

Note: The low year-2000 figures for Egypt and Indonesia derive from a continuation of the trend of high percent per capita per annum economic growth. (See the text of Frohberg's paper for the explanation.)

TABLE 5 Impact of Some Scenarios on Hunger (Changes in Percent from Reference Run)

50 MMT Wheat as "Manna" (Gift)	-3.0
Reduced Meat Consumption in IMEs	-1.4
"Green" Scenario of Reduced Use of Fertilizer and Pesticides in OECD Countries	+9.0
Drought in the North	+8.6
Drought in the South	+8.2

TABLE 6 Alternative Aid Scenarios for All LDCs (Millions of People Hungry, Percentage Change)

	Reference Run		A-Cap[a]		A-Bop[b]	
	1990	2000	1990	2000	1990	2000
All LDCs	470	400	-13	-32	-24	-32
Poorest LDCs	345	305	-15	-40	-29	-40

[a] Aid added to capital investment.
[b] Aid support of balance of payments.

MACROECONOMIC CONTEXT COMMENTARY

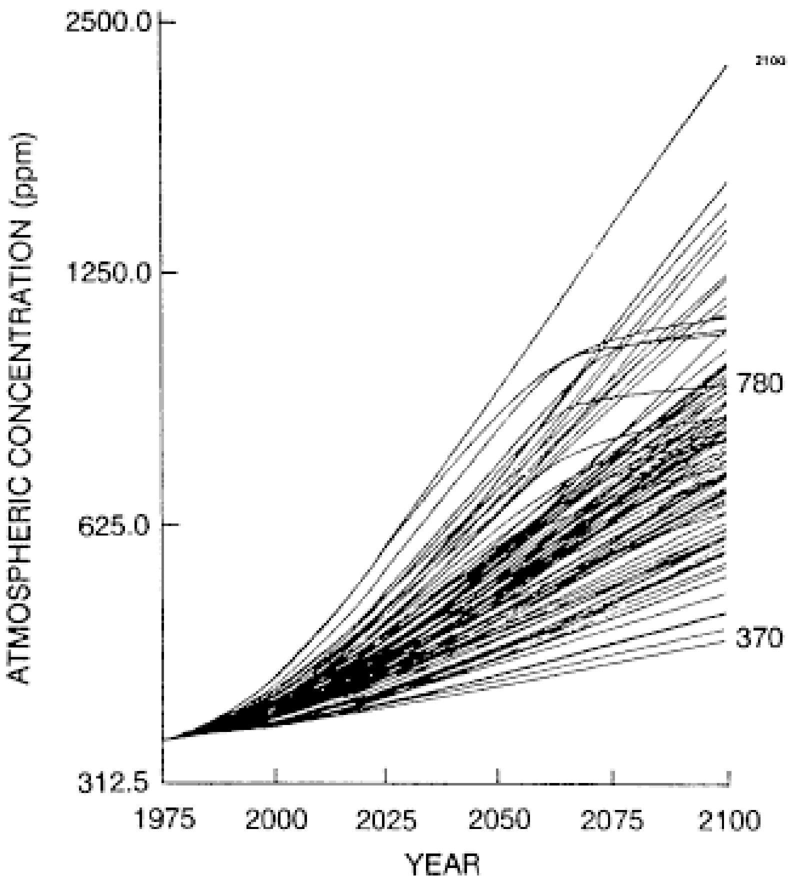
Lawrence Klein, Economics Department, University of Pennsylvania

Dr. Klein noted that the Project Link macroeconomic model, which the University of Pennsylvania Department of Economics has developed to project changes in the global economic picture as a result of different variable assumptions, uses the same assumptions as the IIASA BLS model. He observed that it is difficult to think of assumptions for the next 10 years. Only one year ago, long-range projections of food aid needs would have been low. But was the drought of 1988 a one-year blip, like the stock market crash of October 1987? Will the growth in world economies continue on the same trend line as before? It is possible to be horrendously wrong in making these important predictions.

Oil prices were high, are now low, and will again be high. The stock market is back to its pre-crash level in some countries (not the U.S.). Droughts are a major feature of food forecasting and led to depletion of grain stocks in 1972-3. India suffered a major drought in 1987, the U.S. in 1988, and there is the possibility of more frequent climatic impact events.

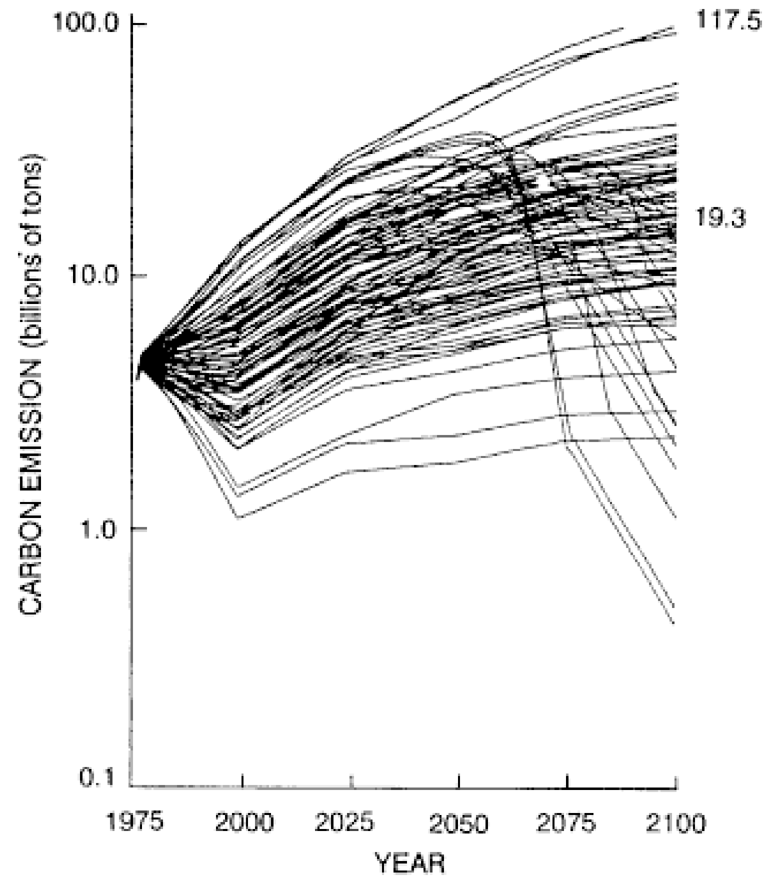
He made a suggestion with regard to methodology: employ stochastic simulations using better input from the climatologists; this would be better than a purely random draw. Stochastic simulation allows realism based on past errors, by running a large number of variations which can be checked against reality. Weather and climate may be particularly important variables to check. (Figures 7 and 8 give examples of the graphic output of stochastic model random runs of models of carbon dioxide production and atmospheric levels, from the 1983 NRC report on Climatic Change.)

Regarding the assumptions of growth, he thought that World Bank projections of



Parts per million. Outcomes of 100 randomly Selected runs; the numbers on the right-hand side Indicate the mean concentration for the year 2100 and the extreme high and low outcomes.

FIGURE 7 Atmospheric Concentration of Carbon Dioxide Source: Changing Climate. Report of the Carbon Dioxide Assessment Committee. National Academy Press, Washington, D.C. 1983



Billions of tons of carbon per year. The numbers On the right-hand side indicate the mean projected yearly emissions for the year 2100 and extreme high and low outcomes.

FIGURE 8 Carbon Dioxide Emissions, 100 Randomly Drawn around 3 percent were probably good; LDC growth rates of 4.5 percent are on the high side (including China: global LDC figures are raised or lowered by ±0.5 percent and LDC Asia figures by ±1.0 percent if China is included or not included). Estimates of CPE's growth of 2.3-2.8 percent are on the low side. Recent discussions with Soviet economists elicited their projections of around 4 percent, which may be on the high side. However, if China can achieve growth rates of 6-8 percent per year, the Soviet Union through its own reforms may come closer to that level of growth than 2.8. Inflation estimates are very low: in 1987 OECD countries' rates of inflation averaged 5.5 percent; LDC inflation rates were much higher, and 4 percent projected for 1990-2000 may be low.

Regarding the FAPRI projections, if one were to measure the impact of the Reagan Administration on the economy for the period 1981-1988, performance would be much worse than for the period from 1982-1988—it depends where you start. He suggested testing whether different time periods might account for different values in the projections. The FAPRI 1981-1986 figures show an annual negative growth rate of-0.23 percent for LDCs, because of the impact of oil prices on African countries and oil-importing countries of the Middle East—1981 is a misleading year from which to start projections.

Regarding LDC growth projections, Asia's average is 5-6 percent (6 with China in or 5 with China out), and Hong Kong, Singapore, Taiwan, and Korea are all in the 7-10 percent range; with the other Asian countries, growth is lower. Projections for sub-Saharan Africa are very depressing, showing negative per capita growth because population is growing faster than GDP. In the period 1945-1970s the OECD countries' economies grew at over 4 percent. Trade in the 1960s often grew at over 10 percent. The question is whether the 1990s will be like the 1970s, or will recovery in growth lead to a recurrence of the 1960s' conditions, with a high growth scenario and higher inflation? He indicated that he felt that the conditions responsible for slowing growth in the 1970s were no longer operating, and therefore higher growth rates might be more likely in the 1990s. In the high growth scenario, interest rates may be higher than World Bank projections, because high growth and inflation drive interest rates up. Interest rates depend on savings and rebuilding capital stock, such as re-equipping industry. However, the impact of modern electronics and other new technologies in industry is not major capital re-equipment, but largely tearing down old industries.

LDCs must not focus only on primary agricultural products; they must diversify. If there is a productive tendency to increase the value added to primary products, there may not be such a decline in their commodity prices, since less will be available for export. The gradual increase in prices in 1987-88 was partially due to the weakness of the dollar, and there may be less overproduction of commodities than anticipated.

Dr. Kates observed that in recent discussions with Soviet scientists, they felt that the Soviet Union may be entering a rising phase of the Kondratieff[*] cycle, and the United States may have bottomed-out in its falling phase. He wondered whether there might be some hidden surprises—trend extrapolation should be sensitive to surprises, since their likelihood becomes quite large over a decade. There may be a recurrence of the energy crisis in the 1990s.

Dr. Klein mentioned several surprise possibilities: debt renunciation; greater harvest failures; nuclear winter (the long-term lowering of global temperature by 3-5 degrees); the greenhouse effect—all might occur in "big change" scenarios. His own positive surprise

[*] The Kondratieff cycle, named for Russian economist Nikolai D. Kondratieff, is a business cycle with a periodicity of between 50 and 60 years.

would be disarmament and development—the transfer of capital from defense to development. The UN, many governments, and many academics, were enthusiastic about it, but the U.S. government, although supporting both disarmament and development, regards them as separate policies, and is against the linkage of the two. Regarding the effect of debt renunciation, the impact on money markets should not show up directly in food. It would show up in the cost of money, maybe adding 2-3 percentage points to the interest rates, and driving the U.S. prime rate up to 10 percent for the longer term. U.S. trade and OECD exports to LDCs have suffered because of debt. U.S. exports to LDCs were 40 percent of total exports, but now are only 30 percent. U.S. and LDCs have gained less from the debt than other countries. Many LDCs showed negative growth in food imports and consumption. Those with minerals were not as badly off as those dependent on cash crops, such as cocoa and coffee, the prices for which are now low. If disarmament could make available a $50 billion development fund, LDC growth rates could be increased by 0.5 annual percentage points, and even more in Africa and the Middle East.

Regarding the potential impact of the green revolution, discussions indicated that in the short run (the coming decade) biotechnology might be more likely to reduce crop losses than increase yields, since yields are multigenic (determined by a number of genes) while resistance to disease can be influenced by single genes. Dr. Duncan reported that the recent Buenos Aires XX International Agricultural Economics Conference discussions saw no big technology improvement until after 2000. The green revolution was not a surprise: it was foreseen and achieved operating within known technologies. However, the impact of Chinese cultural and economic reforms on the supply side was not foreseen. An NAS panel visiting China in 1979 estimated annual agricultural growth at 3-4 percent—it actually shot up to 10 percent.

Dr. Ezekiel felt that risk had been increased by greater variability in climatic and economic conditions, and we have to learn how to manage variability better, including financial and economic variability. Dr. Trostle thought it unlikely that the Soviet Union could emulate the major structural changes that allowed the growth of Chinese productivity in agriculture. Though there may be production surprises as prices increase, these are unlikely to be a major factor in commodity trade in the 1990s.

DEMOGRAPHIC CONSIDERATIONS COMMENTARY

Robert Chen, Alan Shawn Feinstein World Hunger Program

Dr. Chen pointed out that UN projections of African population growth have tended to underestimate range of uncertainty significantly, even for projections a few years into the future (Figure 9). Moreover, UN assumptions about the demographic transition in Africa are clearly suspect, since the assumed decline in fertility does not follow the actual pattern observed in most other regions of the world (Figure 10). Indeed fertility declines have not yet begun in many African countries. Substantial variations in projections of future African population growth remain, especially beyond the year 2000 (Figure 11). Much of this growth will take place in cities; UN figures show an African urban population of more than 400 million by the year 2000 (Figure 12). Notably, these projections do not allow for unpredictable factors like AIDS, or for interactions with economic, social, or technological trends. For example, migration is assumed to dwindle to zero in the future, even though the level of migration itself is likely to be a function of food needs, among other things. Thus, the assumption that population can be treated exogenously in those models could prove to be dangerous.

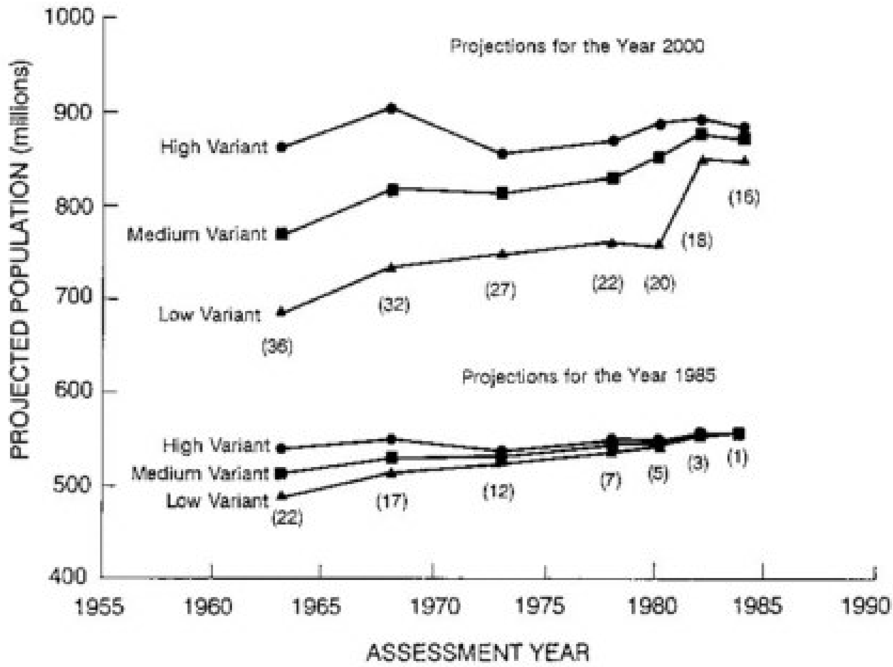


Figure 9
Trends in U.N. Projections for the African Population as Assessed Since 1963

The composition of the diet—in terms of the proportion of food calories consumed as animal products—can have an important effect on the quantity of primary agricultural products needed. Using FAO/WHO/UNU standards for caloric needs and computing food supply from FAO data there is presently enough food in the world to feed some 6 billion people if almost all foods are consumed directly (Figure 13). However, as diets increase in the utilization of animal products, the need for primary agricultural products also increases. For a diet consisting of about 30 percent animal products (lower that that currently consumed in much of the industrial world), the need for primary agricultural products doubles, rising significantly above what is presently produced in the world. This increase due to dietary composition is much larger than the potential differences in projected demand due to different population growth projections.

The World Hunger Program has also made a back-of-the-envelope estimate of the number of hungry people there will be in the world by the turn of the century. Over the past several decades, the proportion of hungry in the developing world as defined by the FAO standard has declined from about 34 percent in 1948-1950 to 17 percent in 1978-1980. However, the rate of decline appears to have levelled off in the past decade, with only about a I percent decline in the subsequent five-year period. Projecting this current slow rate of decline into the future, and applying it to the UN medium variant population projections, we find that the actual numbers of hungry could still rise during the next decade, even if the proportion of hungry declines. The FAO estimates of the numbers of hungry do not include China. According to recent Chinese statistics, roughly 7 percent of the population, or 70 million people, fall below the poverty line. The World Hunger Program uses half this number (35 million) in its estimates of the numbers of hungry by FAO standards.

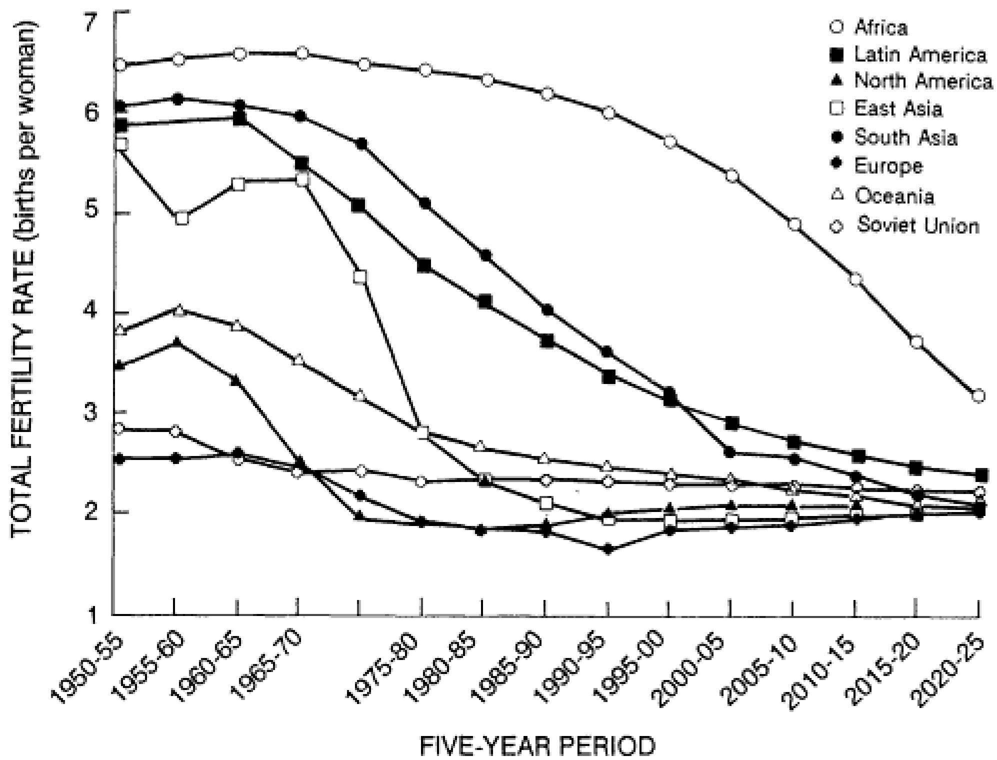


Figure 10
Estimated and Projected Fertility Rates, World Regions, 1950-2025 (UN Medium Variant)

NUTRITIONAL CONTEXT COMMENTARY

Per Pinstrup-Andersen, Food and Nutrition Policy Program, Cornell University

Dr. Pinstrup-Andersen observed that nutritional status is influenced by food and health, both of which are influenced in turn by prices and incomes. Food aid must influence nutrition or health. It is not a question of total food quantity *per se*, nor average supply and demand *per se*, but rather how food prices are determined and why incomes of populations at risk are insufficient to afford them. One cannot simply convert MMT of cereal into calories and divide by the population; nutrition is not adequately described by average calories or tons of grain.

The assumption is that:

food aid need (to keep prices level) = demand-production/supply at that price level.

There are two components of need: a market-demonstrated response to need, and a lack of response from those who cannot express need through the market.

Program food aid can have an important impact on nutrition by lowering prices, or at least keeping them level; that is, there is an impact beyond nutrition projects. Program food aid to support subsidy schemes and project food aid to make up the rest of the deficiencies do not add up to meeting nutritional needs. If food aid is really intended to eliminate malnutrition, we cannot just dump cereals on the market, since this only meets effective demand and lowers prices to the point that producers are hurt.

Combining the goals of stabilizing prices and meeting nutritional needs would be the

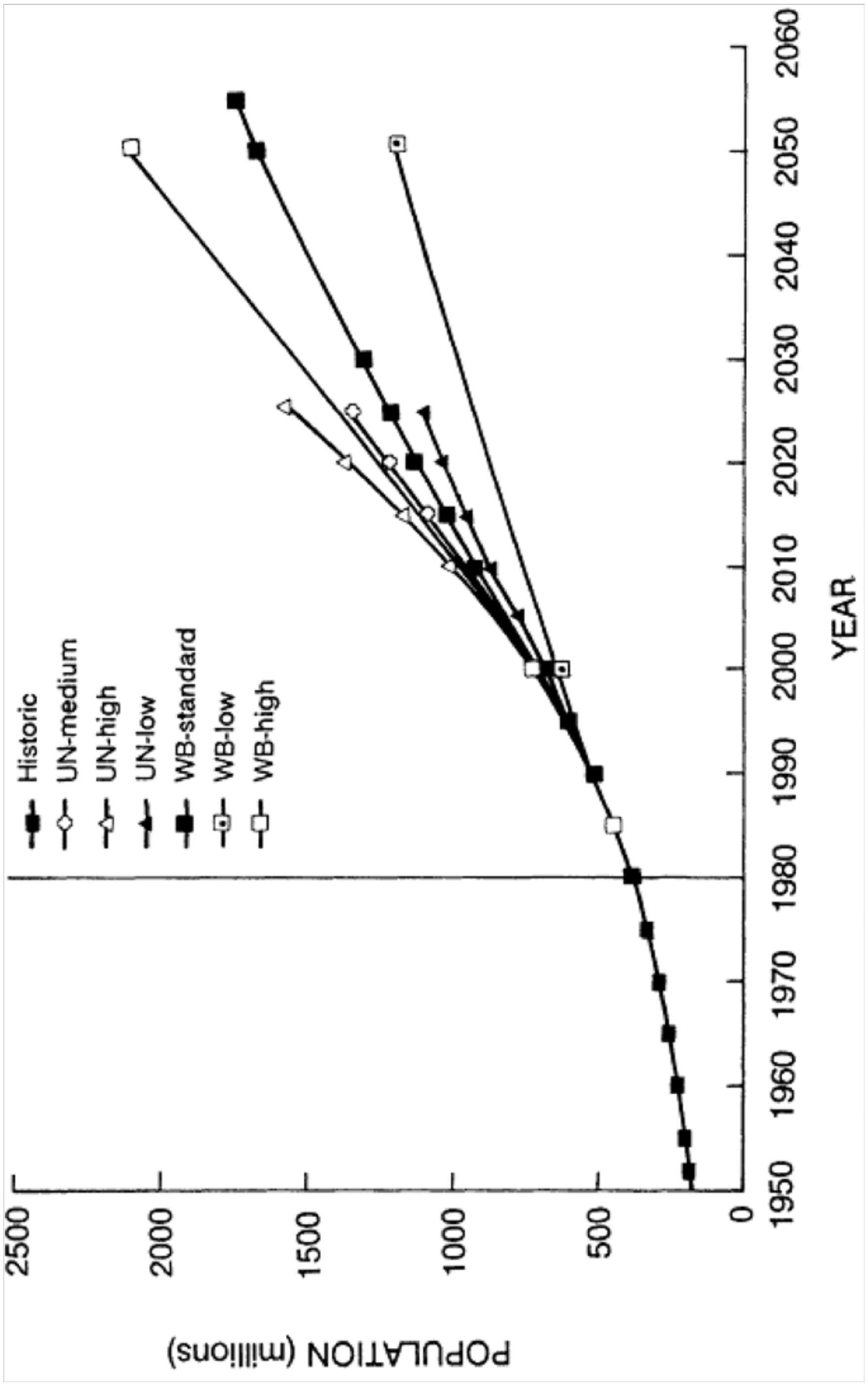


Figure 11
Estimated and Projected Population, Sub-Saharan Africa, 1950-2005

most effective use of food aid from a nutritional point of view. How could food aid be used to increase the incomes of the poor, and what are the final impacts on incomes and prices? One suggestion would be to direct (target) food aid to the malnourished through a system of food stamps or ration cards. Assuming 50 percent efficiency (a net addition in food consumption equal to one-half of the food aid received) the way the program would work is that if the targeted individual is projected to require an additional 300 calories a day, he or she would be given food stamps or a ration allocation of 600 calories-equivalent.

The total food deficit is estimated at 15 MMT/year (current FAO figures), which at 50 percent substitution is equivalent to 30 MMT/year cereal equivalent as food aid entitlement to the poor. The poor would actually use 15 MMT and the other 15 MMT would serve to keep prices stable in the local market. The IFPRI estimate is that 37 MMT will be needed just to keep prices stable, using current commercial mechanisms of nontargeted food aid. Therefore if we are willing to entertain imaginative solutions, it would be possible to use targeted food aid as a resource and to maintain prices (or substitute for imports) and at the same time eliminate malnutrition. An additional benefit would be to provide an outlet for more food aid grain, which may be important for producers.

Dr. Rogers commented that (as far as meeting nutritional needs is concerned) demand does not work, and distribution is the main issue. We need to look at actual behavior of income categories to project income/price situations to predict what would have to happen to raise poor peoples' intake. FAO figures of 1.2-1.4 BMR assuming household uniformity and distribution efficiency are simply insufficient. In a recent keynote address at the Smithsonian "Closing the Food Gap" Symposium, Prof. Nevin Scrimshaw of the Massachusetts Institute of Technology (MIT) indicated that recent MIT studies of dietary amino-acid requirements by Vernon Young et al. had indicated that there was a need for an upward revision of protein requirements. There is also need to look at the consumption behavior for the *variety* of the diet and calorie:protein ratio rather than just calories, and requirements are going to be much higher than the 1,200, 1,400 or even 1,700 calories per person per day, when normal movement and work are included and "everybody knows over 2000 are needed".

Dr. Ezekiel expressed delight with the way in which Dr. Andersen used the figures from the IFPRI model to project needs to eliminate malnutrition, and also that his proposed scheme would eliminate the cost of transaction. He felt that the employment/asset creation aspect of supplying the additional 50 percent would furnish an important development resource, and have a substantial multiplier effect in the economy.

Dr. Duncan observed that food aid is a paternalistic and inefficient instrument for meeting needs, and financial assistance should be provided. If food aid could be monetized, it would be possible to shift all needs to the market, otherwise, the transaction costs of administering programs is too high. However, Dr. Ezekiel and Dr. Rogers pointed out that this does not change the need for movement of food, or avoid the costs of moving it, but only transfers costs to the commercial sector.

Dr. Riley pointed out that most food aid is provided under Title II of the Foreign Assistance Act loans to countries to purchase food, and since the loans are tied to purchases in the United States, the purchases mean mainly wheat, which does not meet the needs for rice, maize or sorghum in rural areas of many poorest countries. Dr. Andersen suggested that there is no reason why his suggested scheme should not be handled entirely by the private sector at both wholesale and retail levels, and the commercial sector could find triangular arrangements for matching country needs with supplies of commodities on the world market.

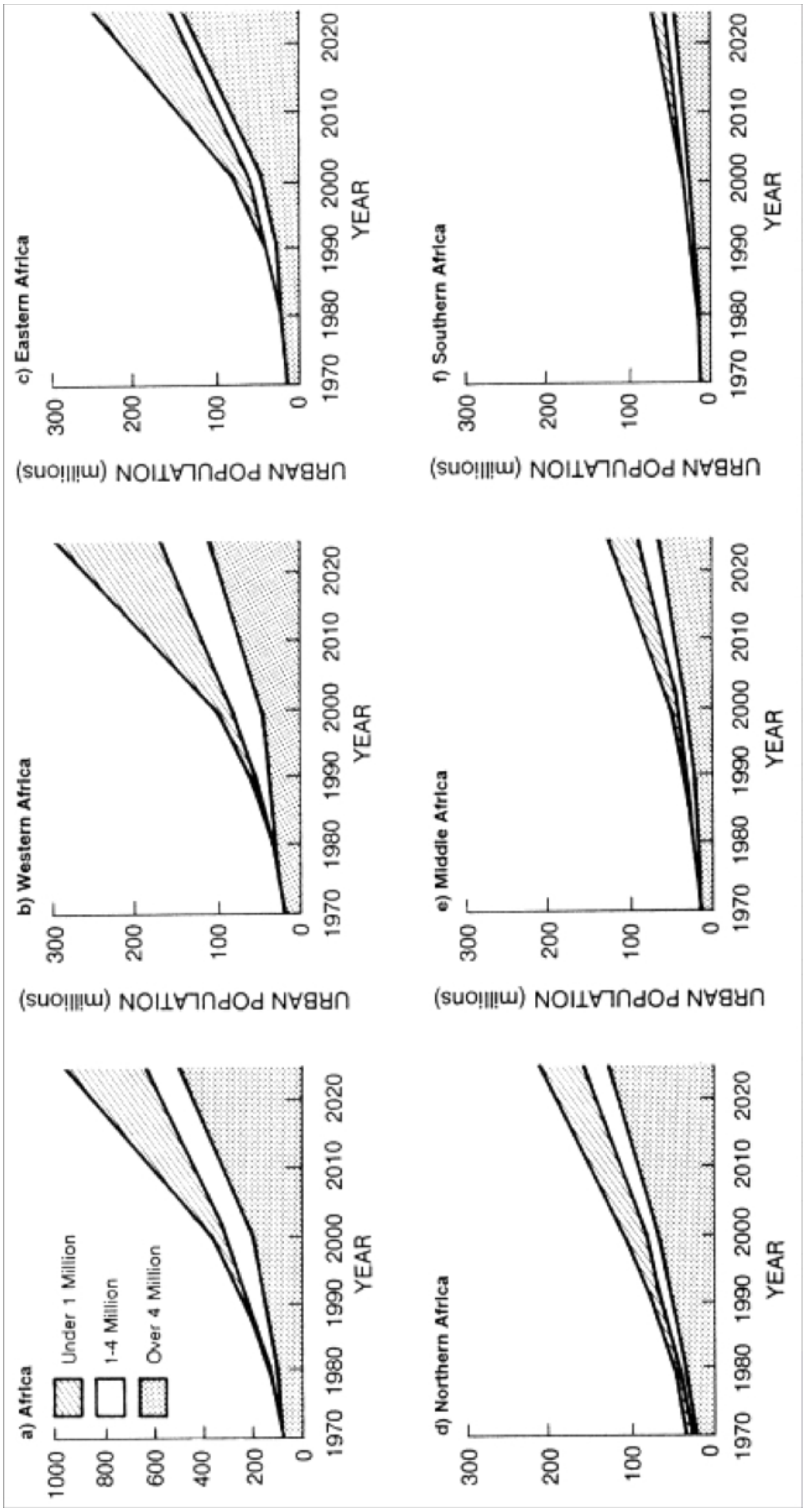


Figure 12
Estimated and Projected Change in Total African Urban Population by City Size, 1970-2025 (UN 1982 Assessment)

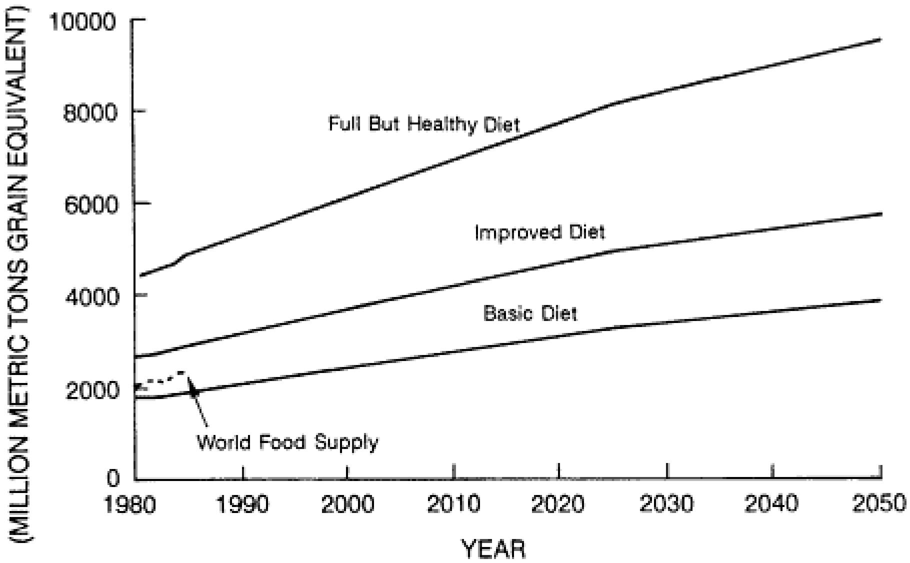


Figure 13
Projected Primary Food Supply/Demand for the World, 1980-2050. Source: Kates et al., 1988, p. 31. (The "basic" diet assumes that all primary food production is consumed directly by humans at FAO/WHO/UNU-recommended caloric levels, whereas the "improved" and "full-but-healthy" diets assume that 10% and 30% of food calories, respectively, come from animal products are derived from primary foods.)

TECHNICAL RESEARCH AND DEVELOPMENT CONTEXT

Donald Plucknett, Senior Scientific Adviser, World Bank

Dr. Plucknett observed that the announcement of the death of the green revolution was premature. It is very much in operation, and must be sustained. It is still largely based on dwarf high-yielding varieties of rice and wheat responsible for the early successes, mainly in Asia, Mexico and Brazil. Grain production continues to climb, but the rate of increase will not climb as quickly to 2 and 3 times the levels of current yields. Yields will show slow incremental gains of 2-3 percent per year based on yield stability, disease resistance and tolerance to stress. There remains a gap between yields on-farm and on the experiment station, though the gap is narrowing in some countries. The maximum yields currently possible are in the 11-14 MT per crop per ha range (Figure 14).

Anything that will give a boost to increase rice yields beyond the current experiment station 11-14 MT per ha per crop must be accomplished through increasing the biomass production of the rice crop. Wheat yields may be increased through increased yield stability, dependant on multigenic resistance factors. Substitutions of wheat for rice will be difficult in Asian countries; wheatlands are drier and more difficult to manage, so the potential for increasing wheat production is poor except through increased application of irrigation. There is more hope through genetic improvement of some other crops, such as sorghums, which could show a significant expansion in the 1990s analogous to rice and wheat in the 1970s and 1980s. Improvements in shortening life cycles of some crops could provide greater security of crops in areas with uncertain rainfall; millets are now available that mature in 70-80 days, and cowpeas mature in 60-70 days.

The models agree that for the 1990s, yield trends will continue upwards, and exogenous risks could be reduced through research input. One important difference over earlier times is the unprecedented level of research collaboration around the world, with access to research data through the CGIAR global agricultural research system. The response time has been shortened between undertaking the research to solve specific problems and being able to implement solutions in the field.

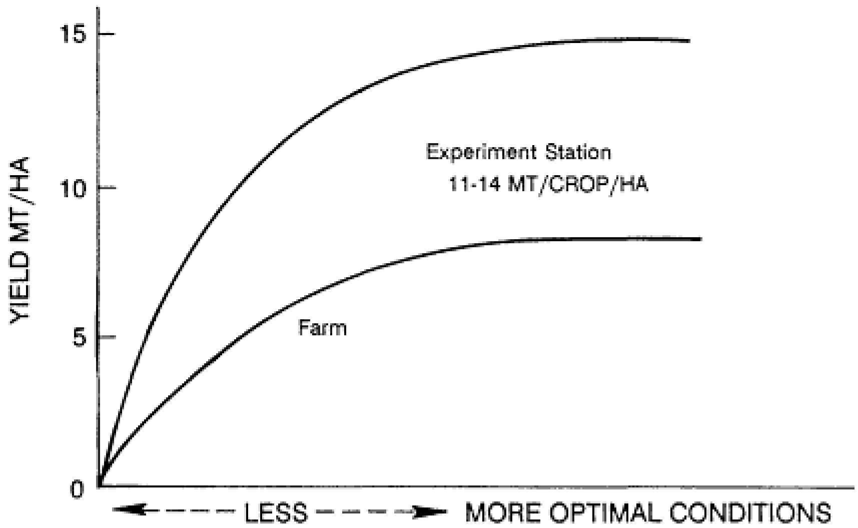


Figure 14
Yield Potential of Cereals

The biggest research problem is understanding the biological limits of theoretical production of the major crops, so that the limits to land productivity can be understood. The biggest animal disease problem is malnutrition; when stable food supplies are available with adequate amounts to feed animals, improving the genetic potential of livestock will pay off. An important point to remember is the limits to recycling nutrients in farming systems; sooner or later we have to replace mined nutrients, and this means supplying fertilizer.

Improving crop productivity will be increasingly difficult as populations increase and higher yields need more complex inputs, which in turn brings non-biological problems of organization and management. It took India until 1950 to harvest the first 50 MMT national crop, until 1973 for the first 100 MMT, and until 1985 for a 150 MMT crop. A population of 1.4 billion Indians in 2015 will require an additional 50 MMT every 8-10 years to achieve the 400 MMT that will be necessary in 2015. This will need an amount of fertilizer to be produced at the rate of one railroad carload every 20 seconds, and the railroad capacity to deliver it to where it is needed, as well as the irrigation to sustain productivity without causing salinity. Research will be needed to breed crop adaptation to a broader range of environmental conditions. Sustained research will be necessary to support continuous productivity in face of the constant threat of environmental degradation. Some countries, such as Haiti and Nepal, may be already past the environmental point of no return. Priority for future stabilization of food production through food aid is likely to be in Asia rather than Africa, because of greater man/land ratio and much higher numbers of hungry people.

CLIMATIC IMPACT CONTEXT

Norman J. Rosenberg, Climate Resources Program, Resources for the Future

Dr. Rosenberg indicated that the climatic context has two questions: Are climate forecasts adequately incorporated into projection models? Are projections improving to the point they can be of any use?

The modern availability of statistical techniques, computers, and modelling can be employed to link economic/climatic/ecosystem information to models of plant growth. Forecasts are improving in the short range through information from satellites, and more sensitive global climatic models. In the medium scale, accuracy decays beyond 2-3 days. Microscale forecasting is expected to improve dramatically because of better instruments for detecting phenomena like windshear at airports.

Improvements in seasonal forecasts are much more difficult because of the absence of real understanding about global climatic systems, and their extraordinary complexity. One recent improvement was the discovery of connections between global phenomena such as the E1 Niño Southern Oscillation, drought in the southwest United States, and the timing and duration of monsoons in the Indian Ocean. Predictions of temperature and precipitation in the next growing season are only possible with at best 60 percent confidence, which is of little use to farmers.

CLIMATE CHANGE

The main factor implicated in possible climatic change is the detected increase in carbon dioxide (CO_2) concentrations in the atmosphere. At Moana Loa over the period 1958-1988, CO_2 increased from 250 ppm to 350 ppm. Observations made in Antarctica over the same period show similar increases. The "greenhouse effect" is the result of the increased CO_2 concentration, as well as other radiation-interactive gases such as methane, nitrous oxide, tropospheric ozone, and chlorinated fluorocarbons (CFCs). These gases are transparent to most of the solar radiation reaching earth, but are partially opaque to the infrared radiation emitted by the earth's surfaces and the gases of the atmosphere itself. The aggregate effect is to warm the lower layers of the atmosphere while cooling the stratosphere. Greatest warming will occur in the high latitudes because of increased absorption of solar radiation as the highly reflective ice melts there. Warming in the tropics will be moderate. Accordingly, the temperature gradient between the poles and tropics which drives the weather systems will diminish in strength. Weather systems are therefore likely to change.

The impact of this change is still obscure. Three modelling groups—the Geophysical Fluid Dynamics Laboratory (GFDL), the Goddard Institute of Space Studies (GISS), and the National Center for Atmospheric Research (NCAR)—have modelled the impact of doubling atmospheric CO_2 from its pre-industrial level (about 280 ppm) or the equivalent effect due to all of the greenhouse gases. The models disagree profoundly with respect to the geographic distribution of changes in temperature, precipitation, and soil moisture (Figures 15, 16, and 17).

Soil moisture content in summer is predicted by the GDFL model to decrease throughout all of North America. The other models show less drastic changes. From an examination of these figures one gains an idea of the current "state of the art" in modeling the possible impacts of the greenhouse effect. The models do not yet provide information on inter-seasonal variability as it might be affected by greenhouse warming nor on changes in sunshine, windiness, relative humidity and other climatic factors at least as important as temperature in determining crop and forest growth and yield.

DROUGHT IMPACT

Over the period 1905-1986, yields of wheat in the Great Plains increased as a result of improved varieties and technology, but this increase was interrupted a number of times by drought. Droughts were especially severe in the 1930s, 1950s, and mid-1970s. Wheat

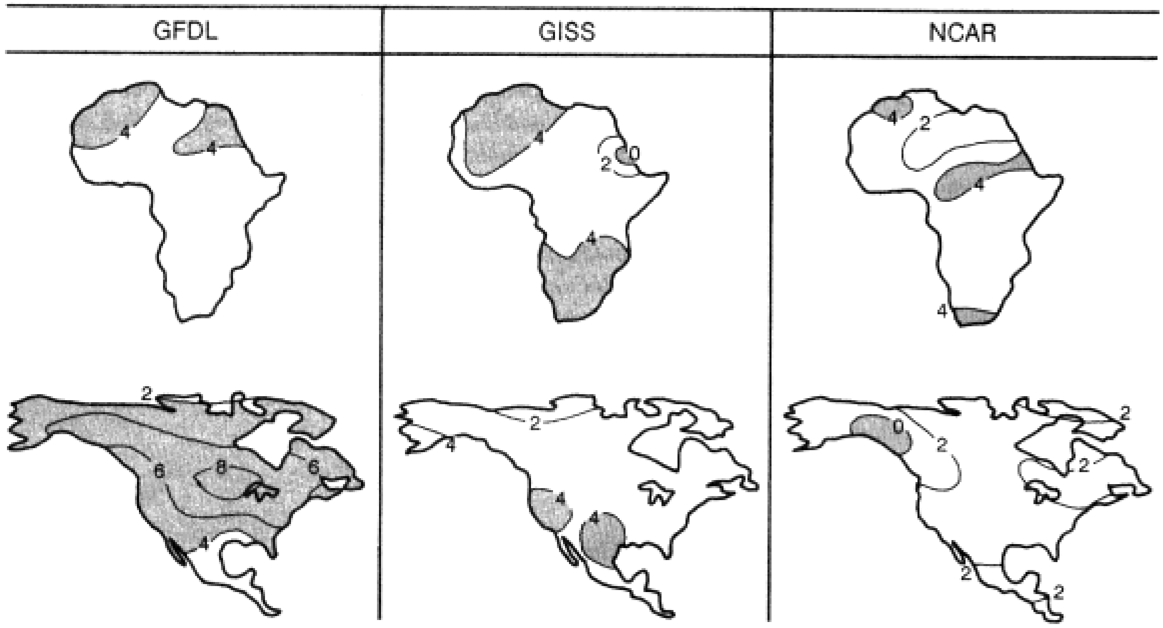


Figure 15
Temperature (June, July, August). The distribution of surface air temperature change (°C) for a doubling of atmospheric carbon dioxide concentration for June, July, and August simulated by the global climatic models of GFDL (left), GISS (center), and NCAR (right). Stipple indicates temperature increases greater than 4°C.

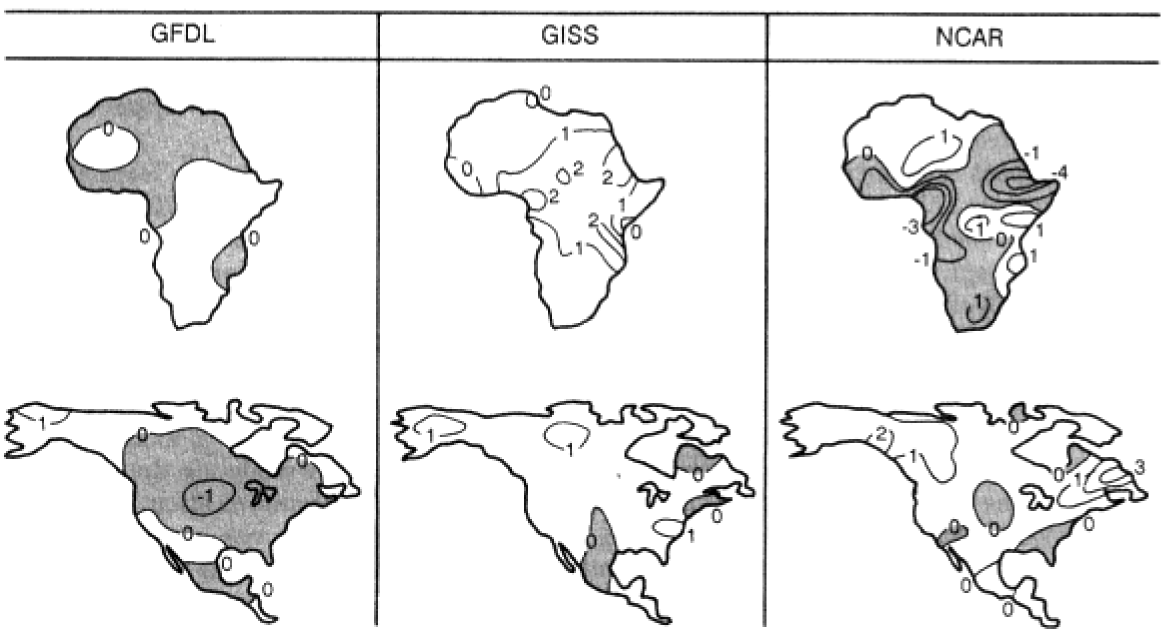


Figure 16
Precipitation (June, July, August). The distribution of precipitation rate change (ram/day) for a doubling of atmospheric carbon dioxide concentration for June, July, and August simulated by the global climatic models of GFDL (left), GISS (center), and NCAR (right). Stipple indicates a decrease in precipitation rate.

yields have been generally high and stable since the mid-1970s in the Great Plains region because the weather has been generally good—until, of course, spring and summer of 1988. Some have attributed the 1988 drought to the long-awaited appearance of the greenhouse effect. COs concentration has been increasing throughout the 20th century. How then do we explain the generally benign weather of the last decade? Hot years, cold years, wet years, and drought years are all well known in the Great Plains. One need not invoke the greenhouse effect to explain the most recent drought.

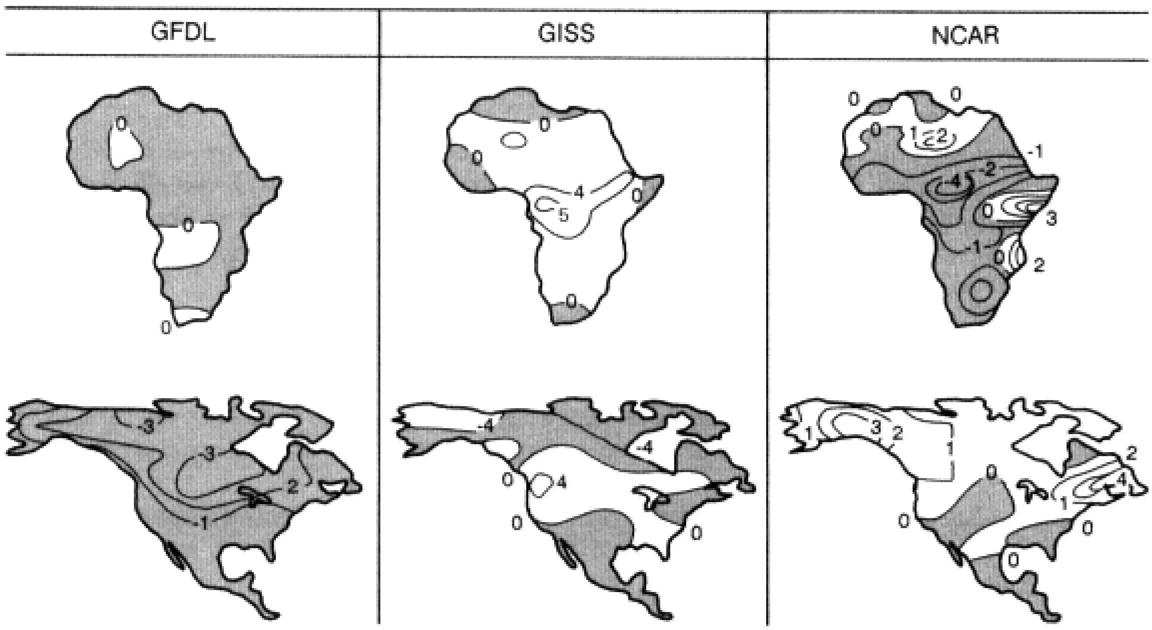


Figure 17
Soil Water Content (June, July, August). The distribution of soil water change (cm) for a doubling of atmospheric carbon dioxide concentration for June, July, and August simulated by the global climatic models of GFDL (left), GISS (center), and NCAR (right). Stipple indicates a decrease in soil water.

Jones and Wigley in the United Kingdom and Hansen and Lebedeff in the United States have shown an increase in global mean temperature of about 0.5°C since 1900. Their records show that the warming trend was interrupted by cooling for about 20 years between 1940-1960. Since 1960, warming has resumed. Karl et al. (1988) have computed the average temperature for the 48 contiguous states during the same period. They observe a warming trend until the mid-1930s. From then on, temperatures have decreased not only until 1960 but, for all intents and purposes, to this time, although there has been a slight upswing since the mid-1970s. Although the Karl et al. data show that the mean temperature in the 48 states is now about 0.4°C warmer than it was in 1905, it is 0.5°C cooler than it was in 1935.

The impact of increased temperature and consequent changes in climate could change the comparative agricultural advantage many countries now enjoy. Canada and Japan and parts of the Soviet Union might benefit with yields increasing in a warmer world. Other countries such as the United States might suffer losses particularly if the scenarios of reduced precipitation come to pass. However, some adjustments are possible, for example, changes in planting dates, changes in varieties, introduction of new crops. Most agricultural scientists hold that there are many tactics and strategies available to help agriculture adapt to the kinds of temperature change that are predicted by the global climate models. Major changes in precipitation might be more difficult to deal with. However, the certainty assignable to model predictions of regional precipitation changes is much lower than that assignable to predictions of temperature change.

Another factor to consider is that plants will respond to the higher concentration of CO_2 in the air with increased rates of photosynthesis and with improved water use efficiency, that is photosynthesis per unit of water consumed. These responses, often termed the "CO_2 fertilization effect" should act to moderate detrimental climate changes and perhaps augment the effects of beneficial climate changes.

Dr. Hutchinson discussed the ability to predict emergency food aid requirements, and concluded that in the 1990s our ability to predict drought or famine will not improve enough to make any effective difference to the farmer. He pointed out that we must be able to monitor better, and though remote sensing is very useful for observing changes over time in soil moisture and crop acreage, there is a need to improve ground truth with better data. We really do not know people's needs, market situations, patterns of drought and famine, and the ability of people to respond to them. The 1974/1975 famine-affected population in the Sahel should not have survived, but they did. What did they do? What institutional responses are needed? Drought will continue, and will be incorporated in some models, so that there should be plans for drought in national planning, as we are admonished in biblical tradition.

AFRICAN REGIONAL CONTEXT

Christopher Delgado, IFPRI

Dr. Delgado observed that world food price projections can be useful to the policy debates concerning the particular problems of Africa. He underlined the African situation: on the demand side it is useful to distinguish three types of commodities—rice and wheat, other cereals, and non-cereals. The main factors influencing demand are income and population growth in the urban and rural areas.

He agreed that world commodity prices will decline. The *composition* of cereal import needs of LDCs are driven by GNP per capita. There is a shift in commodity composition which is not linked to price, and usually not much discussion of non-cereal food aid, which is relatively important in some parts of Africa.

There are five issues touched on by the conference discussion that are especially relevant to food aid in Africa:

1. The projected continued decline in world food prices. This is very important, because it is acting in opposition to the strategy for increasing African food production through price incentives to farmers.
2. The continued rising share of income in urban areas. This is more important in determining the commodity composition of demand than any other factor; the latter is a prime determinant of the demand for imported wheat and rice—there has been a shift in commodity consumption in West Africa since the 1960s, according to FAO figures, where rice and wheat consumption rose by 16 kg per head while sorghum fell by 23 kg per head;
3. IMF structural adjustment policies are working in Africa, but the debt situation is grim and demand on foreign exchange for debt servicing is a major constraint on growth; this will tend to reduce the ability to import food commercially;
4. Hard times ahead suggest that political stability will be a major issue: food aid is an important tool for reducing pressure on governments;

5. The non-cereal food aid picture is confused by subsidies to farmers in the industrial countries: milk is cheaper in the Sahel than it is in Europe, where there is a large surplus; the impact of this on production incentives in Africa will be the hot political issue in food aid in the 1990s.

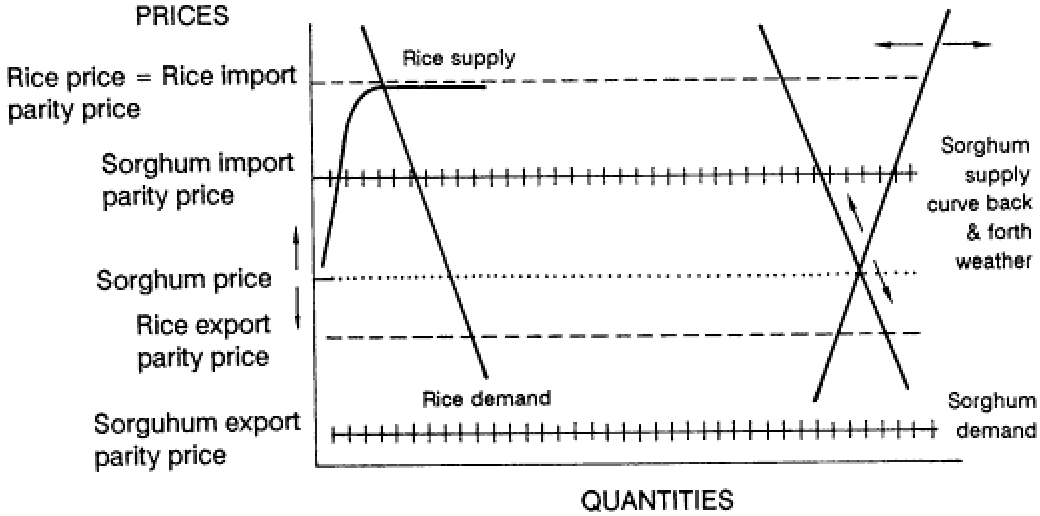


Figure 18
Commodity Domestic Supply and Demand in Africa

Food aid in Africa in the 1980s is very controversial, because it is linked to structural adjustment, price policies, devaluation, and the commodity demand for rice and wheat. The commodity composition in consumption is not synchronous with production and leads to very important equilibrium issues. Some donors want African governments to resist using food aid. However, rice and wheat play an important role in assuring the food security of the poor under increasing urbanization in Africa, particularly West Africa, which is particularly ill-suited to produce these crops locally. Food aid is thus very important in stabilizing prices of these commodities and keeping governments in power.

The main problem is that governments have little control over relative prices among cereals because of the large gap between export and import parity prices for major cereals (due to high internal transport and marketing costs—see Figure 18). However, food aid can play a role in helping governments to stabilize relative cereals prices. Political stability requires rice and wheat imports which governments cannot buy, hence the need for food aid. Triangular arrangements offer the potential for even relatively rich countries to use food aid productively, for example, for Zimbabwe to import wheat and export maize to countries like Mozambique.

Structural adjustment to get agriculture moving will increase the benefit/cost ratio of domestic production, but prices are beyond the ability of governments to control. Therefore, the only way to get benefits to farmers is to decrease unit production costs. This requires a massive increase in capital investment. Public investment in infrastructure and institutions can be a major catalyst to help price incentives encourage the massive private investment (by farmers) to do the job. Delgado suggested food aid could be used to allow farmers not to plant for one season and instead use their labor for capital improvement.

In the ensuing discussion, the dilemma was underlined in which African countries typically base food security policies on increasing food prices. Governments cannot bank on a long-term downward trend in prices, yet this is what has happened over the past

100 years. They may be right, since it is possible that the agricultural policy dilemmas of overproduction in the industrial countries may not continue. Demand for food marches on at an average 3 percent increase per year, while supply fluctuates. In the long run, a change will occur to the benefit of producers when livestock demand increases in the LDCs, as incomes rise, perhaps in 20 years. This implies that the concentration on coarse grains is correct, since in addition to human consumption they will be required to feed livestock, and must therefore be produced in Africa on a large and growing scale.

ESTIMATING FOOD AID

The Chairman pointed out that earlier projections of needs were made by a few people on the basis of very primitive figures and guesswork. Now complex methodologies are available for processing data, and we have 25 years experience; what have we been able to learn, and can we forecast food aid with any degree of accuracy?

Projections are complicated when they are made for longer than short run: 1990 projections should be reliable, 1995 fairly good, 2000 less reliable. Complications arise from regional breakdowns for different commodity demand, exogenous shocks, and other factors. They are based on demand-driven analysis, projections of trade numbers, and supply-side forecasting.

The latter—a supply-side forecast—is relatively simple:

$$FA_t = FA_{t-n} \cdot b$$

(where Food Aid, FA, at time t, is estimated from a previous food aid—time t minus n years ago—times a weighting factor b—reflecting institutional inertia in the budget. Other factors such as price effect and growth forces, either high or low, might also be added to this equation.)

The AID representatives observed that they not only need numbers, but must be able to explain the numbers to Congress. How do the numbers relate to commercial markets, non-commercial supplies and other subsidy programs? Are we looking for a single figure for food aid, or trends? There is now a very large export subsidy program, the Export Enhancement Program (EEP), amounting in 1987 to $2 billion. How do we account for a need that is partially satisfied by these concessional but non-aid programs?

Since actual food aid allocations are made in a highly political environment which is largely divorced from "need criteria", and since most (50 percent or more) food aid in fact replaces commercial imports (even though by international convention it is supposed to be "in addition" to commercial food trade), would it not be valid to *first* estimate how much food will likely flow through *commercial* trade channels (as the BLS/IIASA, World Bank and FAPRI models do), and *then* separately estimate how many people would still be hungry or severely malnourished given these food trade levels, and finally derive the food aid need estimate from these trade and malnourished projections?

There followed a discussion concerning the ability to model food aid estimates. There is a methodological dilemma inherent in the validity of the modeling process. On the one hand it is argued that a sound methodological approach to medium-term food aid estimates (5-10 years) must be based on a general equilibrium model. (A general equilibrium model requires that the interrelationships among the many variables of the entire economy can only be described validly by including all the variables together in the analysis.) The IIASA model described by Dr. Frohberg is such a general equilibrium model, but because of the complexity of the economy and data constraints, it is still fairly primitive and it may be some time before an adequate general equilibrium model is available to assess food aid needs and their impact, if supplied, on the economies into which they are inserted. On the other hand, many economists argue that it is not necessary to include all the variables simultaneously, and that a partial equilibrium model, in which the outcome of changing key factors such as world cereal prices, or supplying food aid at varying levels to a country or region, can be modeled independently of other factors (such as GNP growth rates) that can essentially be treated as constants. The IFPRI, World Bank and USDA estimates assume that this partial equilibrium modeling is valid.

As there was no way to resolve this methodological dilemma in the time available for discussion, the modelers agreed that the only way to arrive at estimates was to assume that many of the factors could be held constant and see what food aid projections would result. Dr. Kates also requested the modelers to indicate both high and low levels of food aid that would surprise them if they were the actual levels in 1995 or 2000.

In exchanges that followed, various approximations and extrapolations from trade projections using assumptions about the future proportion of food aid, allowed various participants to propose food aid need estimates as starting points for refinement, but not as conclusions of their research.

Estimates

USDA Projection to 2000

56 MMT	represents annual nutritional needs of 69 countries (1988/89 level of 37.5 MMT at compounded 3.8 percent growth to 2000)
29.4 MMT	status quo current annual amount at 3.8 percent growth to 2000
21.1 MMT	annual food aid shipments 1976-85 trend extrapolated to 2000 (excluding export subsidies)
17.6 MMT	lean year trend extrapolated to 2000.
56 MMT	is the high side surprise limit; 21.1 the low side.

World Bank Projection

By the year 2000, 229.3 MMT is the projected net industrial country commodity export to LDCs. In 1988, 10 percent of industrial country commodity exports to LDCs are food aid; if this level is maintained to 2000, the Bank estimate of food aid will thus be 23 MMT.

IIASA/BLS Estimate

Projection Of The Model To 2000 Shows 165 Mmt Net Imports Annually By Ldcs (Excluding China). Food Aid Or Other Subsidized Imports Estimates For 2000 Are Around 30 Mmt/Year.

"Food Gap" (Nutritional) Deficit Is Estimated At 50 Mmt, Calculated From 400 Million Hungry People.

IFPRI Estimate

Based on 85 low-income LDCs, excluding China, India, Nigeria, and Brazil, and at 2 levels of per capita GNP cutoff:

Program Food Aid Requirements in MMT Cereal Equivalents (CE) per year

	By 1990	By 2000	By 1995
All countries	37	74	55
Countries with < $800 average GNP/head	19	39	29
FAPRI Estimate			
Net average imports by LDCs (MMT CE/yr)	1990	2000	1995
World Bank estimate	103	177	129
FAPRI	95	—	117
IIASA/BLS	—	165+11	—
Net exports from industrial countries			
World Bank	134	229	171
FAPRI	129	—	151
World Bank shortfall	31	52	42
FAPRI shortfall	36	34	

Nutritional Need Estimates

Dr. Pinstrup-Andersen projected three levels (A, B, and C) with slightly different assumptions, based on Dr. Ezekiel's IFPRI figures, as shown in Table 7.

FAO Estimate

The 1979 projection of food aid need in 1985 was 17-18 MMT, reasonably close to the actual estimate of need in 1985 of 22 MMT. Actual food aid provided was 10 MMT. In 1988, the actual food aid supplied is projected to approximate 9 MMT. The unofficial estimate of need for 1990 is 18-20 MMT, and 8-10 MMT is likely to be a "politically acceptable estimate" of actual amount to be supplied.

Food aid approximates 10 percent of total overseas development assistance (ODA). OECD countries are unlikely to increase the total ODA level in 2000.

FAO estimates of net cereal import needs of all countries in 2000 are 115 MMT, and the gross needs (including China and India) 160 MMT. These figures do not include an estimated additional 10 percent for dairy, fish and fruit components.

For the low-income food deficit countries, based on requests and percentage of food aid in imports 1984-86 (with very little for feed), food aid needs are 19 MMT minimum and 38 MMT maximum. The average is thus about 30 MMT. The lower end of the range assumes an optimistic domestic cereal production scenario for developing countries.

POINTS OF CONSENSUS REACHED BY THE WORKSHOP

1. There will be an increase in trade of cereals with LDCs, especially imports.
2. There will be, on average, a decline in real-term commodity prices.
3. The shortfall between domestic production and requirements will increase.
4. More ambitious domestic policies on nutrition using food targeting would increase the estimates of food aid needed.
5. African needs have the widest boundaries, showing the greatest uncertainty. Ten years is very short to expect dramatic change in growth rates in agricultural production.

TABLE 7 Pinstrup-Andersen Estimate of Nutritional Food Aid Needs

	A	B	C
Estimated numbers of food deficient people (in millions)[1]	400	500	400
Assumed calorie deficiency/person/day	300	300	300
Numbers and calories expressed as MMT grain per year[2]	15	18	15
Substitution (percent)[3]	50	50	67
Food aid total (from need/substitution)[4]	30	36	45
Net addition to food supply[5]	15	18	30

[1] Two alternative scenarios
[2] Additional grain consumption by calorie deficient population to eliminate deficits
[3] percent of food aid used for replacing current consumption. Two alternative scenarios.
[4] Amount of food aid targeted on deficient households needed to eliminate deficiencies.
[5] Since the net addition to market supply is less than what is projected to be needed to keep prices stable (IFPRI estimates 37 MMT), no price-depressing effect will occur.

These often require investment in economic infrastructure, as well as development of agricultural technology. It takes 20 years to introduce a new improved crop variety widely enough to farmers to make an impact on national production. If production grows, however, income grows (the rule of thumb is: one job created in agriculture creates five jobs in the general economy) and demand grows, both production and demand changes, affecting "need". Asia may be a larger arena of growth in need by the year 2000.

How much food aid is possible? Just to achieve a minimum estimate of 19 MMT by 2000 requires doubling current levels, and this would mean a 10 percent per year increase, whereas current budget plans do not anticipate such a rise. A growing "needs" gap, especially in Africa, is possible, therefore, although not certain, given the uncertainty already noted.

6. Exogenous shocks create the need for systematic projection planning under uncertainty. Food aid projections are not good at including exogenous shocks. *Negative* exogenous shocks include:

- Climatic effects

—increased variability
—increased UV affecting photosynthesis
—change in ozone layer
—volcanism, and "volcanic winter" effect
—occurrence of worst weather events together in the eastern and western or northern and southern hemispheres.

- Economic effects

—debt renunciation

—recurrence of rapidly rising energy costs
—recession due to industrial countries' policies.

Positive exogenous shocks include:

- Climatic effects

—climatic improvements in short-growing areas of the USSR, Canada, etc.

- Economic effects

—diversion of armament expenditures to development funding.

- Technology effects

—unexpected research breakthroughs in plant breeding, production, storage or marketing technologies.

There is little likely impact of research on productivity during the next decade, because of the length of time it takes for research to be translated into technology available widely to farmers. Research is able to respond more quickly to outbreaks of disease than previously, because of increased sophistication in both biotechnology and communications among researchers. Short-term research contributions may be anticipated in improving postharvest technology.

The only way of handling exogenous shocks is to recalculate the estimates to take into account their projected effects, because including exogenous shocks in forecasts would make modelling impossible because of the number of variables. The only way they can be handled is analogous to the disclaimer included in insurance policies: "in the event of exogenous shocks, the estimates have to be revised". This is therefore a potentially fruitful area for research, including the stochastic modeling suggested by Dr. Klein.

7. Numbers of hungry people.

Dr. Kates pointed out that the estimates of hungry people vary by a factor of 6, from Dr. Duncan's conservative 100 million to Dr. Pinstrup-Andersen's 400-500 million, with FAO's "Food-Poor Population" of 350 million close to the mean. This is partly as a result of differences in definition of "hunger", partly because of the difficulty in obtaining reliable figures. In fact, there has been remarkable progress in reducing the percentage of hungry in the population, from close to 35 percent in 1950 to 17 percent in 1988 (Figure 19). There is some evidence that the rate of improvement slowed over the past 5-6 years, and the curve may not continue downward. It needs to be underscored that the program to reduce hunger is stagnating and must be improved over the next decade to overcome a serious hiatus. Dr. Rogers pointed out the need to revise the definition of hunger, to take into account the different thresholds of need for women, children and growth and activity.

Dr. Perkins noted that in 1988 10 MMT is the total amount of food aid estimated to be delivered to low-income food deficit countries, while 20 MMT is the minimum actual level of need. Doubling the present level is the maximum that could be realistically expected by 2000 from the standpoint of political acceptance, since it involves a 10 percent annual increment.

Dr. Perkins indicated the actual commitments of food aid in
1967 4.7 MMT committed by the food aid convention
1980 7.6 MMT
2000 16 MMT projected.

The range of figures derives from a number of different sources. Dr. Andersen suggested that the most useful references include the FAO Fifth World Food Survey (1985) and the *Agriculture: toward 2000* (1987 revision), the Kates et al. Hunger Report 1988, and the Sub-Committee on Nutrition report (ACC/SCN, 1987).

It was agreed there is need to revise upward the nutritional need thresholds to take into account the special needs of women and children, and to stress that the demand-based estimates of need do not represent nutritional needs estimates—these must be more precisely targetted by country and by needy groups within countries. Nutritional needs must be met by methods that go beyond food aid, through entitlement, food for work, food stamp programs, or other mechanisms.

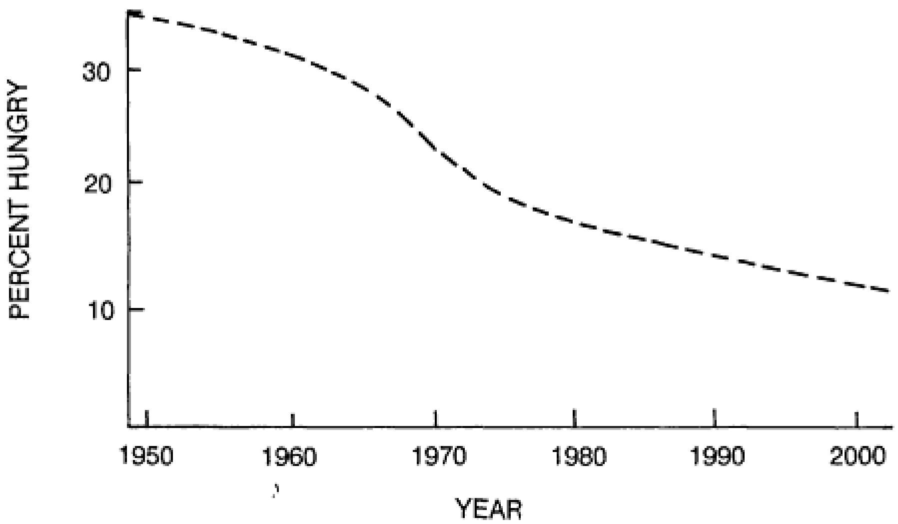


Figure 19
Change in Percentage of Hungry People with Time

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Appendix A

Medium Term Estimates of Demand-Based Food Aid Requirements and Their Variability

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1 INTRODUCTION

Scope of Study

This study of the likely program food aid requirements of developing countries in the medium-term future is a follow-up of the earlier study entitled *Medium Term Estimates of Food Aid Needs and Their Variability* (Ezekiel, 1988).

The main objectives of the present study are:

(1) to update the estimates on the basis of more recent data;
(2) to extend the estimates up to the year 2000; and
(3) to bring about such improvements in the scope and methodology of the estimates as might be feasible.

In part 1, the report summarizes the basic methodology adopted in the study and also presents the changes in scope and methodology that have been made in the present study. In part 2, the report presents the new estimates of program food aid requirements for future years, extending to the year 2000, that have been obtained for all the developing countries covered as well as separately for low-income developing countries. In part 3, the report discusses the estimation of the variability of food aid requirements and presents new estimates of variability for individual countries and for regions and sub-regions. It also presents the results for the variability of food aid requirements for regions and sub-regions when food aid is assumed to be provided only to low-income countries.

Nature of Food Aid

Food aid can be of different types. It may be (a) program food aid, (b) project food aid, or (c) emergency food aid. Various special types of food aid, including food aid for building security food stocks or for supporting adjustment programs of various kinds, can be classified into these types. This study makes estimates of the *program* food aid requirements of developing countries up to the year 2000, while recognising that there are important relationships between it and other types of food aid.

Program food aid is intended for sale in the markets of developing countries. The object of such aid is to meet unsatisfied demand at some explicit or implicit level of prices. The demand-supply gap at those prices arises because the demand for food tends to grow at a faster rate than domestic production and the capacity of developing countries to import food on a commercial basis to fill this gap is limited. Sharp increases in population and some increases in per capita income raise the demand for food rapidly. At the same time, scarcity of resources and the difficulties involved in developing appropriate new technologies and bringing them into use prevent food production from rising quickly. The same factors prevent an adequate increase in foreign exchange earnings, which in any case also have to satisfy other important developmental needs.

Food aid is a resource. While filling existing demand-supply gaps in any given year, it should therefore promote development so as to raise incomes and food production in the future at a faster rate. This becomes particularly important in determining the required volume of commercial imports for estimating program food aid needs. When food aid substitutes for commercial imports, it saves foreign exchange. When it is additional to such imports, it generates domestic currency resources. Both of these play a very important developmental role. The volume of food that a country should be expected to import commercially in relation to its food import gap is therefore a policy variable and should not be determined merely from the past behavior of such imports.

Estimation of Food Aid Requirements

In this study, food aid requirements are defined as that part of the food import requirements of developing countries determined at a reasonable price level that are not filled by commercial food imports. In turn, food import requirements are defined as the gap between total domestic use (TDU) and the total domestic production of food. The food import gap is estimated by projecting past trends either in the variables themselves or in the variables on which they depend. Commercial food imports cannot be determined in this way. The reasons for this are briefly discussed below. The approach adopted is set out there. For any single year, changes in stocks also affect the picture. In the long term, however, such changes tend to offset one another. It is assumed that they would not affect the trend estimates that are made here.

Food is defined to cover the major staple foods in each country. These include both cereals and non-cereals. All of these are measured in terms of their cereal equivalents. This framework assumes free substitutability between different staple foods in terms of cereal equivalents. In particular, it assumes that the import gap obtained by deducting the production of staple foods in cereal equivalent from total domestic use of staple foods in cereal equivalent can be filled by cereal imports irrespective of the actual composition (in staple foods) of the calculated gap. This assumption is carried forward to food aid needs, which are measured by the difference between the food import gap and commercial cereal imports.

Production is projected for future years at trend rates of growth for each of the staple food crops.

Total domestic use of staple foods is the sum of the (1) food use, (2) feed use, (3) seed use, and (4) waste and other uses of staple foods.

The *food use* of the staple foods is taken, depending on actual consumption patterns in different countries, as the sum of the food use of (i) cereals, (ii) root crops, (iii) pulses (iv) groundnuts, and (v) bananas and plantains. Estimates of per capita consumption of each of these staple food groups are obtained for future years at five-yearly intervals by *applying*

(1) trend rates of growth of per capita GNP, *and*
(2) FAO projections of the relevant income elasticities of demand at five yearly intervals, *to* the respective estimate of trend per capita consumption in 1983.

The per capita food use of all staples is then obtained by summing the separate per capita estimates for each year. This sum is multiplied by the population in that year—as estimated by the UN in its medium variant projections—to obtain the total food use of all staples in those years.

The *feed use* of all staples in various years is estimated in basically the same way as the separate components of food use, using the income elasticity of the demand for meat as a proxy for the income elasticity of the demand for feed.

The *seed use* of staples is estimated by applying the proportion of seed use to production prevailing in a base period to the production estimates of the various staples in different future years.

The *other uses* of staples, consisting of industrial uses and wastes, are estimated by applying the proportion that such uses formed to the sum of food and feed use in the base period to the estimated sum of food and feed use in different future years.

These estimates of the various uses of all staples are then summed for each future year to obtain the required estimates of total domestic use. The method followed in making these estimates of total domestic use is basically the same as that adopted in Leonardo Paulino's study at IFPRI of food trends and projections (Paulino, 1986).

In general, the estimates of production trends make use of the time-series data formed by aggregates of country estimates for past years. Following the approach of previous IFPRI studies, a semi-logarithmic trend equation is fitted to the data of different variables to obtain the respective growth rates.

The Basic Model

In this section, an attempt is made to provide an algebraic representation of the approach underlying these estimates that has been described above. The general equation fitted to each data set is:

$$Y_t = e^{a+bt} \qquad (1)$$

where
Y_t= estimate of the variable in year t
a = constant term (the logarithm of the variables estimate for t = o, the base year)
b = logarithm of the value of one plus the annual rate of change of the variable
t = period in years, starting from the base year
The equation can be replaced by its equivalent:

$$Y_t = Y_o(1+r)^t \qquad (2)$$

where
Y = the value or estimate of the variable
t = the year of the estimate
r = the annual rate of change of the variable

For the population and production variables, an equation of this form can be used to derive—or to represent the derivation of—the relevant estimates. However, consumption is not derived from the rate of growth of consumption. For two of its four components—food use and feed use—it is derived from the rate of growth of per capita GNP and the relevant income elasticity of demand. Therefore, in equation (2) for computing food and feed use, r is replaced by the product of these two. Where the elasticities are available at five-yearly intervals, estimates are obtained through a step-wise process, with the results of each five year projection forming the base for the next five year calculation. An estimate of waste and other uses is obtained as a proportion of the sum of food and feed use, while seed use is taken as a proportion of production.

Aggregate food aid needs are then given by the equation:

$$F_{at} = N_o(1+r_N)^t \sum_{n=1}^{5}(1+x_n)[C_{n1o}(1+r_Y e_{n1})^t + C_{n2o}(1+r_Y e_{n2})^t] - \sum_{n=1}^{5}(1-y_{nt})P_{no}(1+r_{Pn})^t - M_t \quad (3)$$

-

where:

C = consumption (total domestic use) of staple foods in cereal equivalent.

F = food aid requirements in cereals

M = commercial imports of cereals

N = population

P = domestic production of staple foods in cereal equivalent

Y = per capita GNP

and where:

a = aggregate

e = Income elasticity of demand

n = different staple foods (n = 1 .... 5)

n1 = food use of each staple food

n2 = feed use of each staple food

r = rate of growth of variable

t = the number of the year, with the base year being zero

x = the proportion of waste and other uses of a staple food to the total of the food and feed uses of that staple food.

y = the proportion of seed use to aggregate domestic production of each staple food.

The first two of the three terms on the right hand side of this equation represent the computation of the food import gap. Food aid requirements are obtained by deducting commercial cereal imports from that gap. Given the import gap estimate, the estimate of food aid requirements depends on the assumptions made regarding commercial cereal imports. However, the estimate of food aid requirements ultimately depends as much on the food gap itself and therefore also on the first two terms of the equation. What this equation brings out is that aggregate food aid requirements in cereal terms depend on:

(1) the base year levels of population, consumption and production,
(2) the rates of growth of population, per capita GNP and production,
(3) the income elasticities of demand for various staple foods for both food and feed uses,
(4) the proportion of food and feed uses that is covered by waste and other uses,
(5) the proportion of seed to production,
(6) the volume of commercial cereal imports.

Of critical importance among these are the rates of growth, the income elasticities and the volume of commercial imports.

Cereal Exports and Commercial Cereal Imports

Some developing countries which have a food import gap and even some which are unable to fill this gap with commercial cereal imports nevertheless export a part of their domestic food production. Such exports may consist of cereals differing in type or quality from the imported cereals. Also, exports could take place from one region or at one time, while imports occur in another region or at another time. The fact that these countries export cereals reflects the complex nature of food, which is not only essential for life but is also a commodity like any other. It is, therefore, assumed that such exports would continue and even grow—at the rate of growth of production.

Since demand based food aid requirements are estimated by deducting commercial food imports from the food import gap, it becomes necessary to generate an estimate of commercial imports. However, without a clear conception of the policy-related nature of demand-based food aid requirements, and, therefore, without any statement of the policy objectives underlying the provision of food aid for sale in the market, earlier studies were not able to provide a rationale for determining the extent to which commercial imports of food should fill the food import gap in order to determine the residual requirement for food aid. Each of these studies devised rules for determining the volume of a country's commercial imports, but presented no real justification for them related to the nature of food aid and its objectives. Commercial imports were obtained in some studies as proportions of import gaps or of foreign exchange earnings. In others, they were estimated on the basis of a function showing the relationship between commercial cereal imports and other variables such as foreign exchange earnings, foreign indebtedness, and domestic and international food prices.

There are three major methodological difficulties with this approach. First, there is the difficulty involved in obtaining functions that are really satisfactory in explaining the past behavior of commercial food imports. Although many such functions have been used, their statistical quality is often doubtful. Sometimes even the signs of the relationship are wrong and in most cases the explanatory power of the selected function is quite limited. Second, there are the problems that arise in using these selected functions for predictive purposes. These arise because to use them in this manner it is necessary first to predict the future values of the explanatory variables themselves. This is not at all easy to do. Complex functional relationships may be needed in turn to explain these variables or strong assumptions about future developments may have to be made or both. In some cases, highly sophisticated and complex models have been used to predict some of these variables on a medium term basis, but with little success. Third, there are the analytical and statistical difficulties that arise because the availability of food aid itself affects these proportions and relationships, so that it must also be used to explain commercial food imports (and therefore food aid requirements).

There is a more basic difficulty about adopting this approach. These countries have tended to handle their problems in the past in particular but different ways. Under this approach, they are, therefore, required to handle their problems in the same way in the future, irrespective of any effects this may have on their economies. One country may have used a relatively large proportion of additions to its foreign exchange earnings to meet its food import needs in the past even though as a result it has not been able to promote its development at an adequate pace. It will be expected to continue to do so in the future and will be given less food assistance from abroad. Some other country that has used less of its foreign exchange earnings to meet its food needs will be allowed to use less of these earnings for this purpose in the future and will therefore be given more assistance.

The usual justification for using different proportions or functions based on past behavior is that they measure the capacity of countries to import food commercially. However, what any of these rules measures at most is the *willingness* of countries to use their import capacity to finance commercial imports of food. The *capacity* of countries to import food commercially depends on the growth problems they face and the contribution that foreign exchange earnings can make to their development if not required for food imports. These are not taken into account.

To try to establish a better basis for estimating commercial food imports, it is important to recognize that food aid requirements do not exist independently of donor policy and that such policy must be development oriented. In determining the volume of a developing country's commercial imports, therefore, such a development-oriented policy must not look at what that country is likely or willing to do but what, from a development point of view, it would be reasonable to expect it to do. For one country, it may not be reasonable to expect it to import as much food commercially as past experience indicates it may be willing to, while for another country, it may not be reasonable to expect it to import as little food commercially as it may be willing to. It is necessary to develop independent criteria for what quantity of food it would be reasonable to expect a country to import commercially. Such criteria should be uniformly applicable to all countries.

Since food aid is a development resource, the search for such criteria should be conducted in the area of possible links between the volume of the country's future commercial food imports and its growth. Logically, this is a two-way relationship. Commercial cereal imports should be determined with reference to some measure of the anticipated growth of the economy, while at the same time, consideration should be given at least in a qualitative way to the impact that is produced on the economy by the volume of commercial imports that each chosen measure would require.

A suitable basis for estimating future commercial food imports is provided by each country's actual commercial cereal imports in a base period. To avoid the erratic influence of year to year variations in such imports, it would be desirable to use an average of actual imports over a period. A five-year period was used.

Three estimates were made. An initial or high estimate was obtained by keeping net commercial cereal imports, that is both gross imports and exports, constant at the base period level. A second or low estimate was obtained by raising gross commercial imports at the rate of growth of aggregate GNP, while exports were assumed to grow at the rate of growth of domestic food production. A third or basic estimate was obtained using the same method for exports but increasing gross commercial imports at the rate of growth of per capita GNP. Subsequent analysis is based entirely on the results obtained by the basic method.

Changes in Scope and Methodology

The underlying data on food consumption and production used in the present study are drawn from the latest available *Supply Utilization Accounts Tape* of the FAO, which provides fully reconciled data through 1983. The earlier study was based on similar data through 1980.

The earlier study made estimates of food aid requirements for the period 1985 through 1990, that is for a period five to ten years from the last year of the then underlying data series. The present study makes estimates for the period 1990-2000, that is for a period seven to seventeen years from the last year of the new underlying data series.

Two major changes have been made in the methodology used in the projections:

(1) Short-period rather than long-period trends in the underlying variables have been used in making projections;
(2) The minimum and maximum constraints on income growth rates and the minimum constraint on rates of growth of food production have been dropped.

In the previous study, the trends in the underlying consumption and production variables used for making projections were drawn from the entire twenty year period, 1961-80, for which data were available. In the present study, the trends in the underlying variables have been drawn from the twelve year period, 1972-83, that is from the second half of the twenty-three year period, 1961-83, for which data are available. An independent study of the behavior of food consumption and production in developing countries shows that there have been sharp changes in trends between the first and the second halves of this period. The short period trends are, therefore, likely to give a better indication of likely behavior of these variables in the future.

For the same reason, for income, short period rates of growth as given in the *World Bank Atlas, 1986* have been used in the present study instead of the long period rates of growth as given in the *World Development Report, 1984* that had been used in the earlier study.

In the earlier study, the rate of growth of per capita GNP was subject to a constraint on the maximum rate of 6.0% and on the minimum rate of 0.5%. The minimum constraint was particularly important because many countries have lower and even negative rates of growth of per capita GNP. Similarly, the rate of growth of food production was subject to a minimum constraint of nil. Many countries have negative growth rates of food production. These constraints on growth rates of income and food production have not been dropped.

One other important change that has been made in the present study relates to the classification of countries by income. In the earlier study, countries were divided into four classes by their income level in 1983. In this study, countries have been regrouped into five income classes. The first two classes have been retained unchanged. A new third class of income between $500 and $800 has been created. The fourth income class then runs from $800 to $1500, with all other countries having per capita incomes above $1500 falling into the fifth class. When dividing countries into low income and high income countries, a new dividing point has been set at $800 instead of the dividing point of $500 used in the earlier study.

2 TREND ESTIMATES

High and Low Estimates

As in the earlier study, an initial estimate of food aid requirements was made for 85 developing countries on the assumption that net commercial imports are held constant at the average level of the base period. The base period for this purpose was taken at 1979-83, the latest five year period for which the relevant data are available on a uniform basis for all the countries covered. The total estimated food aid requirements of 85 developing countries rise from 45 million tons in 1990 to over 70 million tons in 1995 and almost 99 million tons in 2000 (Table 2.1).

This estimate is the high estimate of program food aid requirements since it makes the extreme assumption that developing countries will not increase their commercial cereal imports at all over the base period. The food aid requirements, therefore, increase with the food import gap. It would be reasonable to expect developing countries to increase commercial imports as their economies grow over time. The issue is what criterion to use for determining this growth. This criterion cannot be found in the growth of the import gap—for example by assuming that commercial imports form a fixed proportion of the import gap—since the import gap is a measure of the problem rather than of the capacity to handle it. If food aid is to be growth related, this criterion should be found in the rate of income growth.

The second method used for estimating program food aid assumed that the gross commercial cereal imports of each developing country increase from their base period level at that country's rate of growth of aggregate GNP. Any cereal exports are assumed to grow from their base period level at the rate of growth of food production, so that the proportion of exports to food production remains constant at the level prevailing during the base period. This yields a low estimate of food aid requirements. The results show the estimated program food aid requirements of 85 developing countries rising from 31 million tons in 1990 to over 42 million tons in 1995 and almost 54 million tons in the year 2000 (Table 2.2).

The Basic Estimate

The rate of growth of aggregate GNP, used in the second method to raise gross commercial cereal imports from their base level, is the sum of the rates of growth of population and per capita GNP. The increase in total food consumption that occurs because of the sharp increase in the rate of growth of population is the principal source of the food problem that food aid tries to meet. While food consumption also rises with increases in per capita income, this latter growth also reflects the increasing capacity of the developing country to handle its problems. By using the rate of growth of aggregate GNP to determine the growth of commercial cereal imports, the second method includes a large component of such growth that really measures the size of the country's food problem rather than its capacity to handle it.

The third method of estimating program food aid requirements, therefore, uses the rate of growth of per capita GNP for increasing commercial cereal imports from their base period level. This method yields food aid requirements that are intermediate between those yielded by the first and second methods. In that sense, this method yields moderate results. It is, however, treated as the basic method in this study not for that reason but because it provides the most appropriate simple method of determining how the capacity of developing countries to import cereals commercially grows over time.

By the third or basic method, the estimated food aid requirements of 85 developing countries increase from 37 million tons in 1990 to 55 million tons in 1995 and to almost 74 million tons in 2000 (Table 2.3). In examining these results obtained by the basic method, two features need to be kept in mind. One, these are estimates of program or demand-based food aid requirements and do not, therefore, measure the growth of project or need-based food aid requirements, which may behave quite differently. Two, in making these estimates,

TABLE 2.1 High Estimate of Food Aid Needs (Method 1)

REGION	1990	1991	1992	1993	1994	1995	2000
	....	....	in million	metric tons	....	....	....
SOUTH ASIA	2.53	2.63	2.73	2.83	2.94	3.06	3.07
EAST ASIA	5.61	6.16	6.73	7.32	7.93	8.56	11.34
ASIA	8.14	8.78	9.46	10.15	10.87	11.61	14.40
WEST ASIA	4.26	4.78	5.33	5.90	6.50	7.14	10.74
NORTH AFRICA	16.32	17.99	19.74	21.58	23.52	25.56	36.73
W. ASIA/N. AFRICA	20.58	22.76	25.06	27.48	30.02	32.70	47.47
WEST AFRICA	3.45	3.83	4.22	4.62	5.04	5.47	7.88
CENTRAL AFRICA	1.54	1.75	1.96	2.18	2.41	2.64	3.97
EAST AFRICA	7.37	8.22	9.09	9.98	10.90	11.84	16.93
SUB-SAHARAN AFRICA	12.36	13.79	15.27	16.78	18.35	19.95	28.78
CENTRAL AMERICA	1.62	1.73	1.85	1.96	2.09	2.21	2.85
SOUTH AMERICA	2.69	2.92	3.14	3.37	3.61	3.88	5.22
LATIN AMERICA	4.31	4.65	4.99	5.34	5.69	6.09	8.07
TOTAL	**45.39**	**49.99**	**54.77**	**59.75**	**64.93**	**70.35**	**98.72**

Note: Net Commercial Imports are held level at the 1979-83 Average.

TABLE 2.2 Low Estimate of Food Aid Needs (Method 2)

REGION	1990	1991	1992	1993	1994	1995	2000
	.... in million metric tons						
SOUTH ASIA	2.36	2.43	2.50	2.57	2.64	2.72	2.52
EAST ASIA	1.22	0.97	0.68	0.47	0.42	0.35	0.03
ASIA	3.58	3.40	3.18	3.04	3.06	3.07	2.55
WEST ASIA	2.11	2.24	2.37	2.51	2.65	2.79	3.35
NORTH AFRICA	10.48	11.06	11.64	12.24	12.84	13.45	15.72
W. ASIA/N. AFRICA	12.58	13.30	14.02	14.75	15.49	16.24	19.07
WEST AFRICA	3.10	3.42	3.75	4.10	4.45	4.82	6.86
CENTRAL AFRICA	1.31	1.48	1.65	1.82	2.00	2.19	3.22
EAST AFRICA	7.00	7.79	8.59	9.42	10.27	11.14	15.87
SUB-SAHARAN AFRICA	11.41	12.69	14.00	15.34	16.73	18.15	25.95
CENTRAL AMERICA	1.39	1.47	1.55	1.64	1.72	1.81	2.26
SOUTH AMERICA	2.13	2.31	2.50	2.69	2.88	3.07	3.99
LATIN AMERICA	3.53	3.79	4.05	4.32	4.60	4.88	6.25
TOTAL	**31.10**	**33.16**	**35.24**	**37.45**	**39.87**	**42.34**	**53.82**

Note: Gross Commercial Imports are assumed to grow at the growth rate of aggregate GNP and Exports are assumed to remain a constant proportion of Production as based on the 1979 83 period.

no distinction is drawn between countries on the basis of the level of their per capita GNP. The developing countries covered include countries with per capita GNP levels of below $250 as well as those with such levels of more than $1500 and these are unevenly distributed over different regions.

Keeping these features of the results in mind, the picture of food aid requirements that emerges is one powerfully dominated by West Asia & North Africa and Sub-Saharan Africa. Within these regions, the sub-regions of North Africa and East Africa are dominant. Both Asia and Latin America have relatively small food aid requirements. Asia's food aid requirements actually fall after 1995, with falls occuring for both the sub-regions. The food aid requirements of all other regions and sub-regions increase over the entire period.

The individual country results (Table 2.4) show that as many as 26 of the 85 countries had no program food aid requirements in 1990. One country with no food aid requirements in 1990 has positive requirements in 2000 (Kampuchea) and one country with positive requirements in 1990 has zero requirements in 2000 (Guinea-Bissau), leaving the number of countries with no food aid requirements unchanged at 26 in 2000. The estimated food aid requirements are, therefore, those for 59 of the 85 countries in both years.

The country with the largest food aid requirements in 1990 is Egypt (5.89 million tons). Other countries with estimated program food aid requirements of more than one million tons each in 1990 are Bangladesh in South Asia, Republic of Korea in East Asia, Iraq in West Asia, Algeria and Morocco in North Africa, Kenya and Uganda in East Africa, and Peru in South America. In 2000, Egypt's requirement rises to almost 12 million tons and four other countries have requirements of over 4 million tons each (Iraq, Algeria, Morocco, and Kenya). Bangladesh, which has a requirement of 1.58 million tons in 1990 and 1.63 million tons in 1995, shows a fall in requirement to 1.12 million tons in 2000.

Food Aid and Commercial Imports

The relationship between food aid and commercial imports of cereals is of special interest. Donors of food aid are interested in increasing their commercial cereal exports. How these grow with increases in food aid under the given assumptions needs examination (Table 2.5).

In the basic method for estimating food aid requirements, commercial cereal imports are assumed to grow from their base period level at the rate of growth of per capita GNP. However, if the estimate of commercial imports obtained in this way is greater than the import gap—which is obtained by adding any exports to the difference between total domestic utilization of the major food crops and the domestic production of those crops—actual imports will to that extent be less than the estimate. Actual imports cannot exceed the import gap and a constraint to that effect is imposed on the estimate of commercial cereal imports. This constraint automatically ensures that the estimated food aid requirement for any country will never be negative at any time. The constraint does come into play for some countries, e.g. Pakistan.

For the 85 developing countries covered in the study, estimated food aid requirements of 37.42 million tons in 1990, 54.96 million tons in 1995 and 73.78 million tons in 2000 compare with gross commercial imports of 41.77 million tons, 48.92 million tons and 57.73 million tons in those years. This shows that though the gross commercial imports of these developing countries increase over the decade by almost 16 million tons, food aid increases much more rapidly—by over 36 million tons. As a result, the proportion of food aid to the total import gap increases from 47.26% in 1990 to 52.91% in 1995 and to 56.10% in 2000.

TABLE 2.9 Basic Estimate of Food Aid Needs (Method 3)

REGION	1990	1991	1992	1993	1994	1995	2000
	.... in million metric tons						
SOUTH ASIA	2.44	2.53	2.62	2.71	2.80	2.90	2.83
EAST ASIA	2.38	2.37	2.35	2.32	2.28	2.22	1.19
ASIA	4.82	4.90	4.97	5.03	5.08	5.12	4.01
WEST ASIA	3.39	3.77	4.17	4.59	5.03	5.50	8.15
NORTH AFRICA	12.77	13.82	14.92	16.08	17.29	18.58	25.28
W. ASIA/N. AFRICA	16.16	17.59	19.09	20.67	22.33	24.08	33.44
WEST AFRICA	3.49	3.87	4.27	4.67	5.10	5.53	7.95
CENTRAL AFRICA	1.46	1.65	1.85	2.05	2.27	2.49	3.72
EAST AFRICA	7.31	8.14	8.99	9.87	10.77	11.69	16.67
SUB-SAHARAN AFRICA	12.25	13.66	15.11	16.60	18.13	19.71	28.34
CENTRAL AMERICA	1.60	1.71	1.82	1.93	2.05	2.17	2.77
SOUTH AMERICA	2.59	2.84	3.09	3.35	3.62	3.89	5.22
LATIN AMERICA	4.19	4.54	4.91	5.29	5.67	6.06	7.99
TOTAL	**37.42**	**40.70**	**44.08**	**47.58**	**51.21**	**54.96**	**73.78**

Note: Gross Commercial Imports are assumed to grow at the growth rate of per capita GNP and Exports are assumed to remain a constant proportion of Production as based on the 1979-83 period.

Food Aid Needs by Country Income Class

As has been noted earlier, the per capita income levels of the developing countries covered in the study are spread over an extremely wide range. It is of considerable interest to know how the food aid needs are distributed among countries at different income levels. For this purpose, developing countries were grouped into five income classes according to their per capita GNP level in 1980:

1. Less than $250,
2. $250-$499,
3. $500-$799,
4. $800-$1499,
5. $1500 or more.

Out of the total estimated food aid requirements of 37.45 million tons in 1990, the eighteen countries in Class I accounted for 3.90 million tons, the eighteen in Class II accounted for 6.57 million tons, the ten in Class III accounted for 8.73 million tons, the twenty-two in Class IV accounted for 8.44 million tons, and the seventeen in Class V accounted for 9.81 million tons. This suggests a development-based method of paring down the estimates of food aid requirements or—what comes to the same thing—of limiting the total amount of food aid provided relative to the estimated aggregate. This would involve the fixing of an eligibility criterion for food aid recipients, with only those whose per capita income is below a certain level being considered eligible for food aid. This method also has the advantage of increasing the volume of commercial imports to the extent that food aid is reduced because it can be assumed that countries with higher per capita incomes are likely to import their full requirements commercially if they are not provided food aid.

For the purpose of this study, the eligibility criterion was set at a per capita GNP of $800. If only countries with a per capita GNP of less than $800 are considered eligible for food aid, 46 countries belonging to classes I, II, and III would receive food aid. The food aid requirements of these 46 countries (Table 2.6) total 19.20 million tons in 1990, 28.62 million tons in 1995 and 39.42 million tons in 2000, that is approximately half the estimated requirements for all 85 countries in those years.

The distribution of countries from different regions and sub-regions between the different income classes is extremely uneven. This is also reflected in the distribution of food aid requirements by area when food aid is subject to the eligibility criterion. The eligibility criterion affects two regions very powerfully. All the countries of West Asia/North Africa (except the two Yemens, Egypt and Sudan) and all the countries of Latin America (except Haiti, Honduras and Guyana) get excluded. The main recipients of food aid after the application of the eligibility criterion are, therefore, to be found in Sub-Saharan Africa and Asia, though some countries from these regions also get excluded under the income criterion.

Although most of the countries of West Asia/North Africa get excluded as a result of the income criterion, the countries in this region that remain eligible for food aid include Egypt and Sudan, both of which have extremely large food aid requirements. The impact of the eligibility criterion on the relative importance of West Asia/North Africa and Sub-Saharan Africa within the total of food aid requirements is, therefore, smaller than might appear to be the case. Nevertheless, the two regions interchange ranks, with the food aid requirements of Sub-Saharan Africa becoming the largest among the four regions.

TABLE 2.4 Basic Estimates, Individual Country Results 1990-1995, 2000

COUNTRY	1990	1991	1992	1993	1994	1995	2000
	....	....	in million	metric tons	....	....	
Bangladesh	1.58	1.59	1.60	1.60	1.61	1.63	1.12
Bhutan	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Nepal	0.85	0.92	1.00	1.08	1.17	1.25	1.69
Pakistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sri Lanka	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOUTH ASIA	2.44	2.53	2.62	2.71	2.80	2.90	2.83
Burma	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiji	0.04	0.04	0.04	0.04	0.05	0.05	0.06
Indonesia	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kampuchea	0.00	0.01	0.01	0.02	0.02	0.03	0.02
Korea DPR	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea Rep	1.41	1.36	1.30	1.23	1.14	1.04	0.00
Laos	0.04	0.04	0.04	0.04	0.04	0.04	0.01
Malaysia	0.88	0.92	0.95	0.99	1.03	1.07	1.10
Philippines	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thailand	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vietnam	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EAST ASIA	2.38	2.37	2.35	2.32	2.28	2.22	1.19
ASIA	**4.82**	**4.90**	**4.97**	**5.03**	**5.08**	**5.12**	**4.01**
Cyprus	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iraq	2.20	2.43	2.67	2.91	3.17	3.43	4.81
Jordan	0.41	0.47	0.54	0.61	0.70	0.80	1.50
Lebanon	0.12	0.13	0.14	0.15	0.17	0.18	0.23
Syria	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yemen AR	0.54	0.61	0.68	0.75	0.82	0.90	1.33
Yemen PDR	0.12	0.13	0.15	0.16	0.18	0.20	0.29
WEST ASIA	3.39	3.77	4.17	4.59	5.03	5.50	8.15
Algeria	2.09	2.30	2.52	2.75	2.99	3.25	4.40
Egypt	5.89	6.34	6.82	7.33	7.88	8.46	11.88
Morocco	2.76	2.98	3.20	3.43	3.66	3.89	4.93
Sudan	1.34	1.47	1.61	1.75	1.90	2.06	2.93
Tunisia	0.69	0.73	0.77	0.82	0.87	0.92	1.14
NORTH AFRICA	12.77	13.82	14.92	16.08	17.29	18.58	25.28
W. ASIA/N. AFRICA	**16.16**	**17.59**	**19.09**	**20.67**	**22.33**	**24.08**	**33.44**

COUNTRY	1990	1991	1992	1993	1994	1995	2000
	....	in million metric tons	....				
Benin	0.20	0.23	0.26	0.30	0.33	0.37	0.58
Burkina Faso	0.23	0.26	0.30	0.34	0.37	0.42	0.67
Chad	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gambia	0.07	0.07	0.08	0.09	0.09	0.10	0.13
Ghana	0.88	0.97	1.07	1.17	1.27	1.37	1.90
Guinea	0.20	0.23	0.26	0.30	0.33	0.36	0.55
Guinea Bissau	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Ivory Coast	0.35	0.37	0.40	0.43	0.46	0.49	0.67
Liberia	0.12	0.13	0.15	0.16	0.17	0.19	0.27
Mali	0.49	0.55	0.61	0.68	0.75	0.82	1.22
Mauritania	0.15	0.16	0.17	0.18	0.19	0.20	0.26
Niger	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Senegal	0.63	0.68	0.74	0.80	0.85	0.91	1.25
Sierra Leone	0.06	0.07	0.08	0.08	0.09	0.10	0.14
Togo	0.11	0.13	0.14	0.16	0.18	0.20	0.30
WEST AFRICA	3.49	3.87	4.27	4.67	5.10	5.53	7.95
Angola	0.63	0.71	0.79	0.88	0.96	1.05	1.54
Burundi	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cameroon	0.72	0.82	0.92	1.03	1.14	1.26	1.91
Centr.Afric.Rep.	0.02	0.03	0.03	0.04	0.04	0.05	0.08
Congo	0.05	0.06	0.07	0.08	0.08	0.09	0.14
Gabon	0.03	0.03	0.03	0.04	0.04	0.04	0.06
Rwanda	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zaire	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CENTRAL AFRICA	1.46	1.65	1.85	2.05	2.27	2.49	3.72
Botswana	0.05	0.05	0.05	0.05	0.06	0.06	0.06
Ethiopia	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kenya	2.09	2.34	2.60	2.87	3.16	3.45	5.03
Lesotho	0.22	0.24	0.26	0.28	0.31	0.33	0.46
Madagascar	0.33	0.36	0.40	0.43	0.47	0.50	0.69
Malawi	0.50	0.57	0.64	0.71	0.78	0.85	1.26
Mauritius	0.04	0.04	0.04	0.04	0.04	0.04	0.03
Mozambique	0.75	0.82	0.91	0.99	1.08	1.17	1.65
Somalia	0.30	0.31	0.31	0.31	0.31	0.32	0.35
Swaziland	0.09	0.10	0.11	0.12	0.13	0.14	0.19
Tanzania	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uganda	1.08	1.24	1.40	1.56	1.72	1.88	2.76
Zambia	0.95	1.04	1.13	1.22	1.32	1.41	1.89
Zimbabwe	0.91	1.03	1.15	1.28	1.41	1.55	2.28
EAST AFRICA	7.31	8.14	8.99	9.87	10.77	11.69	16.67
SUB-SAHARAN AFRICA	**12.25**	**13.66**	**15.11**	**16.60**	**18.13**	**19.71**	**28.34**

COUNTRY	1990	1991	1992	1993	1994	1995	2000
	.... in million metric tons						
Costa Rica	0.10	0.10	0.11	0.11	0.12	0.12	0.14
Dominican Rep.	0.22	0.23	0.23	0.24	0.25	0.25	0.26
El Salvador	0.19	0.19	0.20	0.20	0.20	0.20	0.20
Guatemala	0.18	0.19	0.21	0.22	0.24	0.25	0.33
Haiti	0.38	0.42	0.46	0.50	0.55	0.59	0.85
Honduras	0.29	0.31	0.34	0.36	0.39	0.42	0.59
Jamaica	0.23	0.24	0.25	0.27	0.28	0.30	0.36
Nicaragua	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Panama	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Trinidad & Tobago	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CENTRAL AMERICA	1.60	1.71	1.82	1.93	2.05	2.17	2.77
Bolivia	0.38	0.40	0.43	0.46	0.48	0.51	0.67
Colombia	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecuador	0.52	0.59	0.66	0.74	0.81	0.89	1.31
Guyana	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paraguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Peru	1.13	1.24	1.35	1.47	1.58	1.70	2.25
Surinam	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chile	0.56	0.61	0.65	0.70	0.74	0.79	0.99
Uruguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOUTH AMERICA	2.59	2.84	3.09	3.35	3.62	3.89	5.22
LATIN AMERICA	**4.19**	**4.54**	**4.91**	**5.29**	**5.67**	**6.06**	**7.99**
TOTAL	**37.42**	**40.70**	**44.08**	**47.58**	**51.21**	**54.96**	**73.78**

Note: Gross Commercial Imports are assumed to grow at the growth rate of per capita GNP and Exports are assumed to remain a constant proportion of Production as based on the 1979-83 period.

TABLE 2.5 Food Aid Needs and Import Gaps (millions of metric tons)

	FOOD AID NEEDS			ACTUAL GROSS COMMERCIAL IMPORTS			IMPORT GAP			FOOD AID NEEDS AS % OF IMPORT GAP		
COUNTRY	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
Bangladesh	1.58	1.63	1.12	0.46	0.53	0.61	2.04	2.15	1.72	77.63	75.59	64.83
Bhutan	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.05	43.14	44.59	43.06
Nepal	0.85	1.25	1.69	0.01	0.01	0.01	0.85	1.26	1.70	99.01	99.32	99.49
Pakistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Sri Lanka	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	n.d.	n.d.
SOUTH ASIA	2.44	2.90	2.83	0.51	0.56	0.64	2.95	3.46	3.47	82.79	83.85	81.52
Burma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Fiji	0.04	0.05	0.06	0.10	0.10	0.11	0.14	0.15	0.16	28.78	31.81	33.78
Indonesia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Kampuchea	0.00	0.03	0.02	0.10	0.09	0.08	0.10	0.11	0.10	1.70	23.08	21.80
Korea DPR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Korea Rep	1.41	1.04	0.00	8.15	10.60	13.58	9.57	11.65	13.58	14.77	8.95	0.00
Laos	0.04	0.04	0.01	0.06	0.06	0.07	0.11	0.10	0.08	41.24	37.54	16.68
Malaysia	0.88	1.07	1.10	2.63	3.30	4.13	3.51	4.36	5.22	25.05	24.43	20.98
Philippines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Thailand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Vietnam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
EAST ASIA	2.38	2.22	1.19	11.04	14.16	17.97	13.42	16.38	19.15	17.72	13.56	6.20
ASIA	**4.82**	**5.12**	**4.01**	**11.55**	**14.71**	**18.81**	**18.37**	**19.84**	**22.82**	**29.45**	**25.82**	**17.75**
Cyprus	0.00	0.00	0.00	0.42	0.47	0.52	0.42	0.47	0.52	0.00	0.00	0.00
Iraq	2.20	3.43	4.81	3.10	3.26	3.42	5.29	6.69	8.23	41.47	51.33	58.43
Jordan	0.41	0.80	1.50	0.80	1.11	1.52	1.22	1.90	3.02	33.85	41.85	49.57
Lebanon	0.12	0.18	0.23	0.68	0.72	0.75	0.81	0.89	0.98	15.38	19.82	23.26
Syria	0.00	0.00	0.00	0.60	0.57	0.28	0.60	0.57	0.28	0.00	0.00	0.00
Turkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Yemen AR	0.54	0.90	1.33	0.62	0.77	0.95	1.16	1.66	2.28	46.57	53.84	58.20
Yemen PDR	0.12	0.20	0.29	0.27	0.34	0.44	0.39	0.54	0.73	30.71	36.28	39.71
WEST ASIA	3.39	5.50	8.15	6.49	7.23	7.89	9.88	12.73	16.04	34.31	43.21	50.82

TABLE 2.5 continued (2)

	FOOD AID NEEDS			ACTUAL GROSS COMMERCIAL IMPORTS			IMPORT GAP			FOOD AID NEEDS AS % OF IMPORT GAP		
COUNTRY	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
Algeria	2.09	3.25	4.40	3.87	4.40	5.00	5.96	7.65	9.40	35.06	42.46	46.79
Egypt	5.89	8.46	11.88	6.85	9.35	12.75	12.75	17.81	24.63	46.23	47.52	48.25
Morocco	2.76	3.89	4.93	2.12	2.33	2.56	4.88	6.23	7.50	56.52	62.51	65.79
Sudan	1.34	2.06	2.93	0.12	0.14	0.16	1.46	2.19	3.08	91.68	93.72	94.94
Tunisia	0.69	0.92	1.14	1.06	1.25	1.47	1.75	2.17	2.6[illegible]	39.36	42.45	43.83
NORTH AFRICA	12.77	18.58	25.28	14.03	17.46	21.93	26.80	36.04	47.22	47.65	51.54	53.55
W. ASIA/N. AFRICA	**18.16**	**24.08**	**33.44**	**20.52**	**24.89**	**29.82**	**36.68**	**48.77**	**63.26**	**44.06**	**49.37**	**52.85**
Benin	0.20	0.37	0.58	0.09	0.10	0.11	0.29	0.47	0.69	69.74	78.75	83.90
Burkina Faso	0.23	0.42	0.67	0.04	0.04	0.04	0.26	0.46	0.72	85.79	91.04	93.73
Chad	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Gambia	0.07	0.10	0.13	0.02	0.02	0.02	0.09	0.12	0.15	74.17	81.50	86.15
Ghana	0.88	1.37	1.90	0.12	0.09	0.07	0.99	1.47	1.98	88.04	93.56	96.21
Guinea	0.20	0.36	0.55	0.09	0.09	0.09	0.28	0.45	0.64	69.72	80.75	86.35
Guinea Bissau	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00	65.35	n.d.	n.d.
Ivory Coast	0.35	0.49	0.67	0.54	0.54	0.54	0.88	1.03	1.20	39.20	47.84	55.33
Liberia	0.12	0.19	0.27	0.09	0.08	0.08	0.21	0.27	0.35	58.39	69.34	77.22
Mali	0.49	0.82	1.22	0.07	0.07	0.08	0.55	0.89	1.29	88.16	91.98	94.00
Mauritania	0.15	0.20	0.26	0.11	0.11	0.11	0.26	0.31	0.38	56.75	63.83	69.55
Niger	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Senegal	0.63	0.91	1.25	0.37	0.37	0.36	1.00	1.28	1.60	62.78	71.44	77.65
Sierra Leone	0.06	0.10	0.14	0.08	0.08	0.08	0.15	0.18	0.22	42.44	54.04	63.41
Togo	0.11	0.20	0.30	0.06	0.06	0.06	0.17	0.26	0.36	65.33	77.50	84.34
WEST AFRICA	3.49	5.53	7.95	1.68	1.66	1.65	5.16	7.18	9.59	67.53	76.97	82.85
Angola	0.63	1.05	1.54	0.36	0.40	0.44	1.00	1.45	1.99	63.55	72.33	77.65
Burundi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Cameroon	0.72	1.26	1.91	0.23	0.27	0.33	0.95	1.53	2.23	75.80	82.10	85.36
Central Afr. Rep	0.02	0.05	0.08	0.01	0.01	0.01	0.04	0.06	0.09	62.56	78.42	86.52
Congo	0.05	0.09	0.14	0.06	0.06	0.06	0.12	0.15	0.20	46.64	59.68	68.86

COUNTRY	FOOD AID NEEDS			ACTUAL GROSS COMMERCIAL IMPORTS			IMPORT GAP			FOOD AID NEEDS AS % OF IMPORT GAP		
	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
Gabon	0.03	0.04	0.06	0.03	0.03	0.02	0.06	0.07	0.08	42.66	60.05	74.00
Rwanda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Zaire	0.00	0.00	0.00	0.18	0.07	0.00	0.18	0.07	0.00	0.00	0.00	n.d.
CENTRAL AFRICA	1.46	2.49	3.72	0.89	0.85	0.87	2.35	3.34	4.59	62.16	74.46	81.13
Botswana	0.05	0.06	0.06	0.18	0.24	0.32	0.23	0.30	0.38	20.39	19.31	16.22
Ethiopia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Kenya	2.09	3.45	5.03	0.09	0.09	0.09	2.17	3.54	5.13	95.92	97.42	98.16
Lesotho	0.22	0.33	0.46	0.17	0.21	0.25	0.39	0.54	0.72	56.01	61.27	64.88
Madagascar	0.33	0.50	0.69	0.16	0.14	0.13	0.49	0.65	0.82	66.95	77.78	84.54
Malawi	0.50	0.85	1.26	0.03	0.03	0.04	0.54	0.89	1.29	93.82	96.08	97.17
Mauritius	0.04	0.04	0.03	0.17	0.19	0.21	0.21	0.23	0.24	18.74	17.10	13.82
Mozambique	0.75	1.17	1.65	0.20	0.21	0.21	0.95	1.37	1.86	78.84	85.03	88.71
Somalia	0.30	0.32	0.35	0.08	0.08	0.08	0.39	0.40	0.43	78.53	79.48	81.34
Swaziland	0.09	0.14	0.19	0.07	0.07	0.07	0.16	0.21	0.26	57.17	67.25	73.93
Tanzania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Uganda	1.08	1.88	2.76	0.01	0.01	0.01	1.09	1.89	2.77	99.15	99.61	99.79
Zambia	0.95	1.41	1.89	0.16	0.14	0.13	1.11	1.55	2.02	85.39	90.76	93.74
Zimbabwe	0.91	1.55	2.28	0.05	0.05	0.05	0.96	1.60	2.34	94.59	96.69	97.70
EAST AFRICA	7.31	11.69	16.67	1.38	1.46	1.58	8.69	13.15	18.25	84.08	88.87	91.35
SUB-SAHARAN AFRICA	**12.25**	**19.71**	**28.34**	**3.95**	**3.98**	**4.10**	**16.20**	**23.68**	**32.43**	**75.83**	**83.23**	**87.39**
Costa Rica	0.10	0.12	0.14	0.14	0.14	0.14	0.24	0.27	0.28	40.11	46.14	49.97
Dominican Rep.	0.22	0.25	0.26	0.25	0.23	0.21	0.48	0.48	0.48	46.71	51.98	55.17
El Salvador	0.19	0.20	0.20	0.09	0.08	0.07	0.28	0.28	0.27	68.27	72.58	75.63
Guatemala	0.18	0.25	0.33	0.18	0.19	0.19	0.36	0.44	0.52	50.29	57.73	63.10
Haiti	0.38	0.59	0.85	0.13	0.14	0.15	0.51	0.73	1.00	74.01	80.85	85.13
Honduras	0.29	0.42	0.59	0.07	0.07	0.07	0.36	0.49	0.66	80.60	85.66	89.16

COUNTRY	FOOD AID NEEDS			ACTUAL GROSS COMMERCIAL IMPORTS			IMPORT GAP			FOOD AID NEEDS AS % OF IMPORT GAP		
	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
Jamaica	0.23	0.30	0.36	0.21	0.18	0.15	0.44	0.47	0.51	51.41	62.36	70.87
Nicaragua	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	n.d.	n.d.
Panama	0.02	0.03	0.03	0.12	0.14	0.16	0.14	0.16	0.18	12.39	16.75	14.91
Trinidad & Tobago	0.00	0.00	0.00	0.38	0.44	0.50	0.38	0.44	0.50	0.00	0.00	0.00
CENTRAL AMERICA	1.60	2.17	2.77	1.61	1.60	1.64	3.20	3.77	4.41	49.88	57.45	62.78
Bolivia	0.38	0.51	0.67	0.18	0.16	0.14	0.55	0.67	0.8.	68.21	76.56	82.66
Colombia	0.00	0.00	0.00	0.98	0.82	0.49	0.98	0.82	0.49	0.00	0.00	0.00
Ecuador	0.52	0.89	1.31	0.40	0.45	0.50	0.92	1.34	1.81	56.36	66.62	72.30
Guyana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Paraguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
Peru	1.13	1.70	2.25	1.15	1.09	1.03	2.28	2.78	3.28	49.62	60.93	68.58
Surinam	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.00	n.d.	n.d.
Chile	0.56	0.79	0.99	1.33	1.37	1.40	1.90	2.16	2.39	29.63	36.54	41.41
Uruguay	0.00	0.00	0.00	0.08	0.05	0.01	0.08	0.05	0.0.	0.00	0.00	0.00
SOUTH AMERICA	2.59	3.89	5.22	4.15	3.93	3.57	6.73	7.82	8.79	38.43	49.75	59.38
LATIN AMERICA	4.19	8.08	7.99	5.75	5.54	5.21	9.94	11.59	13.20	42.12	52.28	60.52
TOTAL	37.42	54.98	73.78	41.77	48.92	57.74	79.19	103.88	131.51	47.28	52.91	56.10

Note: Import Gap = Total Domestic Use - Production + Exports, thus the Import Gap - Actual Gross Commercial Imports = Food Aid Needs

n.d. -- not defined

TABLE 2.6 Classification of Food Aid Requirements by Country/Region and by Income Class

	Less than $250			$250-$500			$500-$800			Total of Less than $800			$800-$1,500			$1,500 or More			Total All Income Groups		
COUNTRY	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
	(1,000,000 Metric Tons)																				
BANGLADESH	1.58	1.63	1.12							1.58	1.63	1.12							1.58	1.63	1.12
BHUTAN	0.02	0.02	0.02							0.02	0.02	0.02							0.02	0.02	0.02
NEPAL	0.85	1.25	1.69							0.85	1.25	1.69							0.85	1.25	1.69
PAKISTAN				0.00	0.00	0.00				0.00	0.00	0.00							0.00	0.00	0.00
SRI LANKA	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
SOUTH ASIA	2.45	2.90	2.83	0.00	0.00	0.00				2.45	2.90	2.83							2.45	2.90	2.83
BURMA	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
FIJI																0.04	0.05	0.06	0.04	0.05	0.06
INDONESIA				0.00	0.00	0.00				0.00	0.00	0.00							0.00	0.00	0.00
KAMPUCHEA	0.00	0.03	0.02							0.00	0.03	0.02							0.00	0.03	0.02
KOREA DPR													0.00	0.00	0.00				0.00	0.00	0.00
KOREA REP																1.41	1.04	0.00	1.41	1.04	0.00
LAOS	0.04	0.04	0.01							0.04	0.04	0.01							0.04	0.04	0.01
MALAYSIA																0.88	1.07	1.10	0.98	1.07	1.10
PHILIPPINES							0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
THAILAND							0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
VIETNAM	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
EAST ASIA	0.04	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.03	0.00	0.00	0.00	2.33	2.16	1.16	2.37	2.23	1.19
ASIA	**2.49**	**2.97**	**2.86**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.49**	**2.97**	**2.86**	**0.00**	**0.00**	**0.00**	**2.33**	**2.16**	**1.16**	**4.82**	**5.13**	**4.02**
CYPRUS																0.00	0.00	0.00	0.00	0.00	0.00
IRAQ																2.20	3.43	4.81	2.20	3.43	4.81
JORDAN													0.41	0.80	1.50				0.41	0.80	1.50
LEBANON													0.12	0.18	0.23				0.12	0.18	0.23
SYRIA													0.00	0.00	0.00				0.00	0.00	0.00
TURKEY																0.00	0.00	0.00	0.00	0.00	0.00
YEMEN AR							0.54	0.90	1.33	0.54	0.90	1.33							0.54	0.90	1.33
YEMEN PDR				0.12	0.20	0.29				0.12	0.20	0.29							0.12	0.20	0.29
WEST ASIA				0.12	0.20	0.29	0.54	0.90	1.33	0.66	1.10	1.62	0.53	0.98	1.73	2.20	3.43	4.81	3.39	5.51	8.16

COUNTRY	Less than $250 1990	1995	2000	$250-$500 1990	1995	2000	$500-$800 1990	1995	2000	Total of Less than $800 1990	1995	2000	$800-$1,500 1990	1995	2000	$1,500 or More 1990	1995	2000	Total All Income Groups 1990	1995	2000
	(1,000,000 Metric Tons)																				
ALGERIA																2.09	3.25	4.40	2.09	3.25	4.40
EGYPT							5.89	8.46	11.88	5.89	8.46	11.88							5.89	8.46	11.88
MOROCCO													2.76	3.89	4.93				2.76	3.89	4.93
SUDAN				1.34	2.06	2.93				1.34	2.06	2.93							1.34	2.06	2.93
TUNISIA													0.69	0.92	1.14				0.69	0.92	1.14
NORTH AFRICA				1.34	2.06	2.93	5.89	8.46	11.88	7.23	10.52	14.81	3.45	4.81	6.07	2.09	3.25	4.40	12.77	18.58	25.28
W.ASIA/N.AFRICA				**1.46**	**2.26**	**3.22**	**6.43**	**9.36**	**13.21**	**7.89**	**11.62**	**16.43**	**3.98**	**5.79**	**7.80**	**4.29**	**6.88**	**9.21**	**16.16**	**24.09**	**33.44**
BENIN				0.20	0.37	0.58				0.20	0.37	0.58							0.20	0.37	0.58
BURKINA FAS	0.23	0.42	0.67							0.23	0.42	0.67							0.23	0.42	0.67
CHAD	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
GAMBIA				0.07	0.10	0.13				0.07	0.10	0.13							0.07	0.10	0.13
GHANA																0.88	1.37	1.90	0.88	1.37	1.90
GUINEA				0.20	0.36	0.55				0.20	0.36	0.55							0.20	0.36	0.55
GUINEA-BISS	0.01	0.00	0.00							0.01	0.00	0.00							0.01	0.00	0.00
IVORY COAST													0.35	0.49	0.67				0.35	0.49	0.67
LIBERIA							0.12	0.19	0.27	0.12	0.19	0.27							0.12	0.19	0.27
MALI	0.49	0.83	1.22							0.49	0.83	1.22							0.49	0.83	1.22
MAURITANIA				0.15	0.20	0.26				0.15	0.20	0.26							0.15	0.20	0.26
NIGER				0.00	0.00	0.00				0.00	0.00	0.00							0.00	0.00	0.00
SENEGAL				0.63	0.91	1.25				0.63	0.91	1.25							0.63	0.91	1.25
SIERRA LEONE				0.06	0.10	0.14				0.06	0.10	0.14							0.06	0.10	0.14
TOGO				0.11	0.20	0.30				0.11	0.20	0.30							0.11	0.20	0.30
WEST AFRICA	0.73	1.25	1.89	1.42	2.24	3.21	0.12	0.19	0.27	2.27	3.68	5.37	0.35	0.49	0.67	0.88	1.37	1.90	3.50	5.54	7.94

COUNTRY	Less than $250 1990	1995	2000	$250-$500 1990	1995	2000	$500-$800 1990	1995	2000	Total of Less than $800 1990	1995	2000	$800-$1,500 1990	1995	2000	$1,500 or More 1990	1995	2000	Total All Income Groups 1990	1995	2000
	(1,000,000 Metric Tons)																				
ANGOLA													0.63	1.05	1.54				0.63	1.05	1.54
BURUNDI	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
CAMEROON							0.72	1.26	1.91	0.72	1.26	1.91							0.72	1.26	1.91
CENT AFR REP				0.02	0.05	0.08				0.02	0.05	0.08							0.02	0.05	0.08
CONGO													0.05	0.09	0.14				0.05	0.09	0.14
GABON																0.03	0.04	0.06	0.03	0.04	0.06
RWANDA	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
ZAIRE	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
CENTRAL AFR	0.00	0.00	0.00	0.02	0.05	0.08	0.72	1.26	1.91	0.74	1.31	1.99	0.68	1.14	1.68	0.03	0.04	0.06	1.45	2.49	3.73
BOTSWANA													0.06	0.06	0.06				0.06	0.06	0.06
ETHIOPIA	0.00	0.00	0.00							0.00	0.00	0.00							0.00	0.00	0.00
KENYA				2.09	3.45	5.03				2.09	3.45	5.03							2.09	3.45	5.03
LESOTHO							0.22	0.33	0.46	0.22	0.33	0.46							0.22	0.33	0.46
MADAGASCAR				0.33	0.50	0.69				0.33	0.50	0.69							0.33	0.50	0.69
MALAWI				0.50	0.85	1.26				0.50	0.85	1.26							0.50	0.85	1.26
MAURITIUS													0.04	0.04	0.03				0.04	0.04	0.03
MOZAMBIQUE				0.75	1.17	1.65				0.75	1.17	1.65							0.75	1.17	1.65
SOMALIA	0.30	0.32	0.35							0.30	0.32	0.35							0.30	0.32	0.35
SWAZILAND													0.09	0.14	0.19				0.09	0.14	0.19
TANZANIA				0.00	0.00	0.00				0.00	0.00	0.00							0.00	0.00	0.00
UGANDA																1.08	1.88	2.76	1.08	1.88	2.76
ZAMBIA							0.96	1.41	1.89	0.96	1.41	1.89							0.76	1.41	1.89
ZIMBABWE													0.91	1.55	2.28				0.91	1.55	2.28
EAST AFRICA	0.30	0.32	0.35	3.67	5.97	8.63	1.17	1.74	2.35	5.14	8.03	11.33	1.10	1.79	2.56	1.08	1.88	2.76	7.32	11.70	16.65
S.S. AFRICA	1.03	1.57	2.24	5.11	8.26	11.92	2.01	3.19	4.53	8.15	13.02	18.69	2.13	3.42	4.91	1.99	3.29	4.72	12.27	19.73	28.32

	Less than $250			$250-$500			$500-$800			Total of Less than $800			$800-$1,500			$1,500 or More			Total All Income Groups		
COUNTRY	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
	(1,000,000 Metric Tons)																				
COSTA RICA																0.1	0.12	0.14	0.10	0.12	0.14
DOMINICAN REP													0.22	0.25	0.26				0.27	0.25	0.26
EL SALVADOR													0.19	0.20	0.20				0.19	0.20	0.20
GUATEMALA													0.18	0.25	0.33				0.18	0.25	0.33
HAITI	0.38	0.59	0.85							0.38	0.59	0.85							0.38	0.59	0.85
HONDURAS							0.29	0.42	0.59	0.29	0.42	0.59							0.29	0.42	0.59
JAMAICA													0.23	0.30	0.36				0.23	0.30	0.36
NICARAGUA													0.00	0.00	0.00				0.00	0.00	0.00
PANAMA																0.02	0.03	0.03	0.02	0.03	0.03
TRINID & TOB																0.00	0.00	0.00	0.00	0.00	0.00
CENTRAL AME	0.38	0.59	0.85				0.29	0.42	0.59	0.67	1.01	1.44	0.82	1.00	1.15	0.12	0.15	0.17	1.61	2.16	2.76
BOLIVIA													0.38	0.51	0.67				0.38	0.51	0.67
COLOMBIA													0.00	0.00	0.00				0.00	0.00	0.00
ECUADOR																0.52	0.89	1.31	0.52	0.89	1.31
GUYANA							0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
PARAGUAY													0.00	0.00	0.00				0.00	0.00	0.00
PERU													1.13	1.70	2.25				1.13	1.70	2.25
SURINAM																0.00	0.00	0.00	0.00	0.00	0.00
CHILE																0.56	0.79	0.99	0.56	0.79	0.99
URUGUAY																0.00	0.00	0.00	0.00	0.00	0.00
SOUTH AMERICA							0.00	0.00	0.00	0.00	0.00	0.00	1.51	2.21	2.92	1.08	1.68	2.30	2.59	3.89	5.22
LATIN AMERI	0.38	0.59	0.85				0.29	0.42	0.59	0.67	1.01	1.44	2.33	3.21	4.07	1.20	1.83	2.47	4.20	6.05	7.98
TOTAL	3.90	5.13	5.95	6.57	10.52	15.14	8.73	12.97	18.33	19.20	28.62	39.42	8.44	12.42	16.78	9.81	13.98	17.56	37.45	55.00	73.78
Number	18	18	18	18	18	18	10	10	10	46	46	46	22	22	22	17	17	17	85	85	85

Note: 1980 trend value of per capita GNP is used, based on 1961-80 period.

In Asia, the food aid requirements of eligible countries are almost halved but rise proportionately to the full regional total over time. However, the entire fall occurs in East Asia, where the countries remaining eligible have extremely small requirements. All the countries in South Asia remain eligible. The food aid requirements of Latin America fall dramatically with the application of the eligibility criterion and also fall proportionally to the full regional requirement over time.

Food Aid for Low Income Countries and Commercial Imports

The full implications of imposing the income constraint on food aid recipients can only be understood by examining the relationship of estimated food aid requirements to commercial cereal imports and the food import gap. While the estimated food aid requirements of low income countries rise rapidly from 19.19 million tons in 1990 to 39.43 million tons in 2000, the gross commercial imports of the same countries rise much more slowly from 11.08 million tons in 1990 to 17.60 million tons in 2000 (Table 2.7). These movements are reflected in a rise in the proportion of food aid received by the low income countries to their food import gaps from 63.40% in 1990 to 69.14% in 2000.

There are of course wide differences in these proportions between different regions and sub-regions. Amongst the regions, the proportion in 1990 varies from a high of 78.90% in Asia to a low of 50.09% in West Asia/North Africa. Amongst sub-regions, the variation is from a high of 85.04% in East Africa to a low of 22.46% in East Asia.

In the aggregate, these proportions are very high. However, the comparison should correctly be made not with the commercial imports of only the low income countries but with those of all developing countries. Before such a comparison is made, it should be recognized that the estimated commercial imports of the high income countries cannot remain unchanged with the imposition of the income criterion for the provision of food aid. To deny food aid to these countries on the ground that their income is high enough is to assert that this income is sufficient for them to be able to import all their food requirements commercially. This means that the commercial food imports of these countries must increase by the amount of their estimated food aid requirements when such food aid is not provided to them because they do not satisfy the eligibility criterion. In any case, it is only when the estimated food aid requirements of these countries are added back to their estimated commercial imports that the sum of their food aid requirements and gross commercial imports will add up to their total food import gap.

The estimated food aid requirements of low income developing countries of 19.19 million tons in 1990, 28.58 million tons in 1995 and 39.43 million tons in 2000 can then be compared with total gross commercial imports of all developing countries of 60.00 million tons in 1990, 75.30 million tons in 1995 and 92.09 million tons in 2000 (Table 2.8). The estimates of food aid requirements for the medium term future can now be seen in perspective. While total food aid requirements of the low income countries increase by 20.24 million tons between 1990 and 2000, commercial food imports of all developing countries increase by 32.09 million tons. As a result, the proportion that food aid to low income developing countries forms to the food import gaps of all developing countries now rises much more slowly from the much lower level of 24.24% in 1990 to 27.52% in 1995 and 29.98% in 2000. These proportions are substantially lower than those obtained when the food aid needs of the low income countries are compared with their own food import gaps.

TABLE 2.7 Food Aid Needs of Low Income Countries by Region and Import Gap (millions of metric tons)

	FOOD AID NEEDS			ACTUAL GROSS COMMERCIAL IMPORTS			IMPORT GAP			FOOD AID NEEDS AS % OF IMPORT GAP		
REGION	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
SOUTH ASIA	2.44	2.90	2.83	0.51	0.56	0.64	2.95	3.46	3.47	82.79	83.85	81.52
EAST ASIA	0.05	0.07	0.04	0.16	0.15	0.15	0.20	0.22	0.18	22.46	29.93	19.59
ASIA	2.49	2.97	2.86	0.67	0.71	0.79	3.16	3.68	3.65	78.90	80.66	78.41
WEST ASIA	0.66	1.09	1.61	0.89	1.11	1.39	1.55	2.20	3.00	42.59	49.54	53.73
NORTH AFRICA	7.23	10.52	14.81	6.98	9.48	12.90	14.21	20.00	27.71	50.91	52.59	53.44
W. ASIA/N. AFRICA	7.89	11.61	16.42	7.86	10.59	14.29	15.76	22.20	30.71	50.09	52.29	53.47
WEST AFRICA	2.27	3.66	5.38	1.02	1.02	1.03	3.29	4.69	6.4[illegible]	68.95	78.19	83.89
CENTRAL AFRICA	0.74	1.30	1.98	0.43	0.36	0.34	1.17	1.67	2.32	63.55	78.28	85.41
EAST AFRICA	5.14	8.03	11.34	0.90	0.91	0.93	6.04	8.94	12.27	85.04	89.83	92.45
SUB-SAHARAN AFRICA	8.15	12.99	18.70	2.35	2.29	2.30	10.50	15.29	21.00	77.61	85.00	89.06
CENTRAL AMERICA	0.66	1.01	1.44	0.20	0.21	0.22	0.86	1.22	1.66	76.72	82.78	86.73
SOUTH AMERICA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
LATIN AMERICA	0.66	1.01	1.44	0.20	0.21	0.22	0.86	1.22	1.66	76.72	82.78	86.73
TOTAL	**19.19**	**28.58**	**39.43**	**11.08**	**13.81**	**17.60**	**30.27**	**42.39**	**57.03**	**63.40**	**67.42**	**69.14**

Note: Import Gap = Total Domestic Use - Production + Exports, thus
the Import Gap - Actual Gross Commercial Imports = Food Aid Needs

n.d. -- not defined

3 VARIABILITY OF FOOD AID REQUIREMENTS

Variability in Individual Countries

The estimates of food aid requirements presented in Chapter II are derived from trends in the underlying variables and are, therefore, trend-based in nature. It follows that actual food aid requirements may differ from the trend-based estimates even if all the assumptions made are fully satisfied. This is because of year to year variations around trend in variables like food production. In this study, it is assumed that the correct policy would be for food aid to vary (a) only with variations in food production, and (b) to the full extent of such variations. This assumption has been made after considering other sources of possible variation in domestic supply as well as other means of handling the effects of production.

To estimate the variability of food aid requirements on these assumptions, it is necessary first to estimate the past variability of food production around trend for each country. This past variability is measured as the coefficient of variation, which is the percentage of the standard deviation to the geometric mean of past trend values. This is then applied to the projected trend values of food production estimated for future years on the assumption that variability in production in future years will be proportionally the same as in the past. The quantities of variation thus obtained are added to and deducted from trend food production to give the upper and lower limits of expected production around the trend. Corresponding quantities of food exports are estimated by applying the proportion of such exports to production in the base period to these new upper and lower values of possible production in each year.

Upper and lower limits for food aid requirements around the basic estimates are then obtained by deducting estimated commercial cereal imports and the lower and upper estimates of production from the estimated consumption and then adding back the lower and higher estimates of cereal exports. Given our assumptions, the lower limit of food aid requirements for any country, like the trend estimate itself, can never be negative. Any negative result obtained from the computation is treated as nil. It follows from this that the absolute difference of the lower limit for any country from the trend level cannot exceed the trend estimate itself so that the percentage lower difference can never be more than one hundred percent. This contrasts with the position regarding upward variations in food aid needs, where no artificial constraint is imposed. As a result, the upper limit can reach any level, the absolute upper difference can be much larger than the trend estimate itself and the percentage upper difference can be substantially above a hundred percent.

The results showing the variability of food aid requirements on this basis are presented in Table 3.1. This shows the likely upper and lower limits of food aid requirements for each country relative to the trend food aid requirements. It also shows the absolute amount of variation from trend in both positive and negative directions. These are described as absolute positive and negative differences. The proportion formed by these differences to the trend values are also presented in the table. This clearly depends on the coefficient of variation of production, the trend value of production and the trend value of the food aid requirements. The first two determine the absolute differences and these in relation to the size of the trend requirement determines the percentage difference.

TABLE 2.8 Comparison of Food Aid Needs of Low Income Countries with the Import Gap of All Countries

REGION	FOOD AID NEEDS LOW INCOME COUNTRIES			ACTUAL GROSS COMMERCIAL IMPORTS ALL COUNTRIES WHEN FOOD AID RESTRICTED TO LOW INCOME COUNTRIES a/			IMPORT GAP ALL COUNTRIES			FOOD AID NEEDS OF LOW INCOME COUNTRIES AS PERCENTAGE OF IMPORT GAP OF ALL COUNTRIES		
	1990	1995	2000	1990	1995	2000	1990	1995	2000	1990	1995	2000
SOUTH ASIA	2.44	2.90	2.83	0.51	0.56	0.64	2.95	3.46	3.47	82.79	83.85	81.52
EAST ASIA	0.05	0.07	0.04	13.37	16.31	19.12	13.42	16.38	19.15	0.34	0.40	0.19
ASIA	2.49	2.97	2.86	13.88	16.87	19.76	16.37	19.84	22.62	15.21	14.95	12.66
WEST ASIA	0.66	1.09	1.61	9.22	11.64	14.43	9.88	12.73	16.04	6.66	8.57	10.06
NORTH AFRICA	7.23	10.52	14.81	19.57	25.52	32.41	26.80	36.04	47.22	26.99	29.19	31.36
W. ASIA/N. AFRICA	7.89	11.61	16.42	28.79	37.16	46.84	36.68	48.77	63.26	21.51	23.81	25.96
WEST AFRICA	2.27	3.66	5.38	2.91	3.52	4.22	5.16	7.18	9.59	43.87	51.00	56.04
CENTRAL AFRICA	0.74	1.30	1.98	1.60	2.04	2.61	2.35	3.34	4.59	31.66	39.02	43.21
EAST AFRICA	5.14	8.03	11.34	3.55	5.13	6.91	8.69	13.15	18.25	59.13	61.01	62.14
SUB-SAHARAN AFRICA	8.15	12.99	18.70	8.06	10.69	13.74	16.20	23.68	32.43	50.29	54.87	57.66
CENTRAL AMERICA	0.66	1.01	1.44	2.54	2.76	2.97	3.20	3.77	4.41	20.70	26.87	32.72
SOUTH AMERICA	0.00	0.00	0.00	6.73	7.82	8.79	6.73	7.82	8.79	0.00	0.00	0.00
LATIN AMERICA	0.66	1.01	1.44	9.27	10.58	11.76	9.94	11.59	13.20	6.67	8.74	10.93
TOTAL	**19.19**	**28.58**	**39.43**	**80.00**	**75.30**	**92.09**	**79.19**	**103.88**	**131.51**	**24.24**	**27.52**	**29.98**

a/ Actual Gross Commercial Imports of all countries plus Food Aid Needs of high income countries.

Variability in Country Groups

The variation in the aggregate food aid needs of each group of countries (including the group of all countries) is of course *not* equal to the sum of the variations in the food aid needs of the countries in that group since the variations in production in different countries need not coincide in direction and magnitude. For each such group of countries, therefore, the likely variation in food aid needs has to be directly estimated from the variability in the aggregate production (and exports) of that group of countries. A serious problem arises in doing this because of the treatment that is accorded to any negative estimates of individual country food aid needs and that must also be accorded to any negative upper or lower estimates of food aid needs. Such estimates, wherever they occur, are treated as nil on the ground that negative food aid needs of one country cannot offset the positive food aid needs of another. However, if such countries are included in any group whose aggregate production is examined for variations as a basis for estimating variations in food aid needs, their negative food aid requirements do in fact enter into the ultimate measure of the food aid needs of that group. There is no way in which these can then be disentangled to obtain a more acceptable estimate of the variations in the food aid needs of that group of countries. On the other hand, it is not possible to simply exclude countries that show some possible negative food aid needs from the relevant group. It is possible that they may have some positive food aid needs in some years that ought not to be excluded.

The search for a solution to this problem, that would make it possible to obtain reasonable upper and lower estimates of food aid needs for various groups of countries (including the group of all countries), is assisted by classifying countries according to the positive or negative character of all three estimates of their individual food aid needs—the upper limit, the trend or average, and the lower limit.

Table 3.2 shows how such a classification would work. Countries for which all three estimates of food aid needs are positive would form one class—A. Those for which the upper and trend estimates are positive but the lower are negative would form a second class—B. Those for which only the upper estimate is positive, while both trend and lower estimates are negative would form a third class—C. Countries for which all three estimates are negative would then fall into the fourth class—D.

An examination of the nature of these classes suggests that the best estimate of both upper and lower limits for any group consisting of all classes of countries (including the group of all countries) is the highest estimate for that group obtained by taking class A alone or either of the combinations—classes A and B or classes A, B and C —discussed above. Most of these results come from the combination of classes A and B, but there are some that are obtained by taking class A countries only and others that are obtained by taking classes A, B and C. These selected results are considered to be the best estimates of the results for any group and at the same time possibly to be underestimates of some degree because of the influence of negative values that would remain for the estimates of some countries.

The variability of food aid requirements for the world and for regional and sub-regional groups of countries when no income constraint is imposed on recipients of food aid is presented in Table 3.3. This shows that food aid requirement for all developing countries varies in 1990 between 42.29 million tons and 33.57 million tons around the trend estimate of 37.42.

The positive percentage difference is 13% and the negative percentage difference is 10.3%. The region with the highest positive percentage difference (27.24%) is Asia and

TABLE 3.1 Variability of Food Aid Needs for Individual Countries: Trend, Upper and Lower Estimates

Row 1: Upper Estimate, based on (Prod - 1 S.D.)
Row 2: Basic Estimates of FANs
Row 3: Lower Estimate, based on (Prod + 1 S.D.)

n.d. not defined

	Row 1: Upper Estimate, based on (Prod - 1 S.D.); Row 2: Basic Estimates of FANs; Row 3: Lower Estimate, based on (Prod + 1 S.D.)							Difference from Basic Estimates (row 2)							Percentage Difference from Basic Estimates						
	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Bangladesh	2.46	2.49	2.53	2.57	2.61	2.65	2.31	0.88	0.91	0.93	0.96	0.99	1.02	1.19	55.54	57.05	58.55	60.04	61.51	62.95	106.88
	1.58	1.59	1.60	1.60	1.61	1.63	1.12														
	0.70	0.68	0.66	0.64	0.62	0.60	0.00	0.88	0.91	0.93	0.96	0.99	1.02	1.12	55.54	57.05	58.55	60.04	61.51	62.95	100.00
Bhutan	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.87	6.88	6.89	6.90	6.91	6.92	7.88
	0.02	0.02	0.02	0.02	0.02	0.02	0.02														
	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.87	6.88	6.89	6.90	6.91	6.92	7.88
Nepal	1.16	1.24	1.32	1.40	1.49	1.58	2.02	0.31	0.31	0.32	0.32	0.32	0.32	0.33	36.86	34.02	31.54	29.37	27.45	25.73	19.79
	0.85	0.92	1.00	1.08	1.17	1.25	1.69														
	0.53	0.61	0.69	0.77	0.85	0.93	1.36	0.31	0.31	0.32	0.32	0.32	0.32	0.33	36.86	34.02	31.54	29.37	27.45	25.73	19.79
Pakistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sri Lanka	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Burma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Fiji	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.14	8.83	8.54	8.26	8.00	7.75	6.95
	0.04	0.04	0.04	0.04	0.05	0.05	0.06														
	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.14	8.83	8.54	8.26	8.00	7.75	6.95
Indonesia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Kampuchea	0.39	0.40	0.41	0.42	0.43	0.44	0.45	0.39	0.39	0.40	0.40	0.40	0.41	0.43	23681.72	6486.47	3693.11	2551.91	1933.28	1546.11	1886.60
	0.00	0.01	0.01	0.02	0.02	0.03	0.02														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.02	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Korea DPR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Korea Rep	2.35	2.30	2.25	2.17	2.09	1.99	0.74	0.94	0.94	0.94	0.94	0.94	0.94	0.74	66.39	68.82	72.10	76.49	82.42	90.61	n.d.
	1.41	1.36	1.30	1.23	1.14	1.04	0.00														
	0.47	0.43	0.36	0.29	0.20	0.10	0.00	0.94	0.94	0.94	0.94	0.94	0.94	0.00	66.39	68.82	72.10	76.49	82.42	90.61	n.d.
Laos	0.18	0.18	0.19	0.19	0.19	0.19	0.19	0.14	0.14	0.14	0.15	0.15	0.16	0.18	307.25	322.07	338.56	357.00	377.74	401.24	1347.01
	0.04	0.04	0.04	0.04	0.04	0.04	0.01														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.01	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Malaysia	1.03	1.06	1.10	1.14	1.17	1.21	1.24	0.15	0.15	0.15	0.15	0.14	0.14	0.14	16.72	15.98	15.29	14.65	14.05	13.49	12.82
	0.88	0.92	0.95	0.99	1.03	1.07	1.10														
	0.73	0.77	0.81	0.85	0.88	0.92	0.96	0.15	0.15	0.15	0.15	0.14	0.14	0.14	16.72	15.98	15.29	14.65	14.05	13.49	12.82
Philippine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Thailand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Vietnam	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cyprus	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Iraq	2.72	2.94	3.17	3.41	3.66	3.92	5.25	0.52	0.52	0.51	0.50	0.49	0.48	0.44	23.89	21.24	19.01	17.10	15.45	14.01	9.18
	2.20	2.43	2.67	2.91	3.17	3.43	4.81														
	1.67	1.91	2.16	2.42	2.68	2.95	4.37	0.52	0.52	0.51	0.50	0.49	0.48	0.44	23.89	21.24	19.01	17.10	15.45	14.01	9.18
Jordan	0.47	0.53	0.59	0.67	0.75	0.85	1.54	0.06	0.06	0.06	0.05	0.05	0.05	0.04	14.58	12.34	10.44	8.83	7.47	6.33	2.83
	0.41	0.47	0.54	0.61	0.70	0.80	1.50														
	0.35	0.41	0.48	0.56	0.65	0.75	1.46	0.06	0.06	0.06	0.05	0.05	0.05	0.04	14.58	12.34	10.44	8.83	7.47	6.33	2.83
Lebanon	0.13	0.14	0.15	0.16	0.17	0.18	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	4.25	3.71	3.24	2.84	2.50	2.20	1.26
	0.12	0.13	0.14	0.15	0.17	0.18	0.23														
	0.12	0.13	0.14	0.15	0.16	0.17	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	4.25	3.71	3.24	2.84	2.50	2.20	1.26
Syria	1.19	1.22	1.26	1.29	1.33	1.38	1.38	1.19	1.22	1.26	1.29	1.33	1.38	1.38	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Turkey	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Yemen AR	0.65	0.72	0.78	0.85	0.92	0.99	1.41	0.11	0.11	0.11	0.10	0.10	0.10	0.09	21.12	18.26	15.93	14.00	12.39	11.02	6.44
	0.54	0.61	0.68	0.75	0.82	0.90	1.33														
	0.43	0.50	0.57	0.64	0.72	0.80	1.24	0.11	0.11	0.11	0.10	0.10	0.10	0.09	21.12	18.26	15.93	14.00	12.39	11.02	6.44
Yemen PDR	0.13	0.14	0.16	0.17	0.19	0.20	0.30	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6.71	6.07	5.52	5.03	4.61	4.23	2.96
	0.12	0.13	0.15	0.16	0.18	0.20	0.29														
	0.11	0.12	0.14	0.15	0.17	0.19	0.28	0.01	0.01	0.01	0.01	0.01	0.01	0.01	6.71	6.07	5.52	5.03	4.61	4.23	2.96
Algeria	2.51	2.72	2.93	3.15	3.39	3.63	4.75	0.42	0.41	0.41	0.40	0.39	0.39	0.35	20.19	18.00	16.14	14.52	13.12	11.89	8.02
	2.09	2.30	2.52	2.75	2.99	3.25	4.40														
	1.67	1.89	2.12	2.35	2.60	2.86	4.05	0.42	0.41	0.41	0.40	0.39	0.39	0.35	20.19	18.00	16.14	14.52	13.12	11.89	8.02
Egypt	6.15	6.60	7.08	7.60	8.15	8.74	12.18	0.26	0.26	0.27	0.27	0.27	0.28	0.29	4.45	4.18	3.93	3.70	3.48	3.28	2.47
	5.89	6.34	6.82	7.33	7.88	8.46	11.88														
	5.63	6.07	6.55	7.06	7.60	8.19	11.59	0.26	0.26	0.27	0.27	0.27	0.28	0.29	4.45	4.18	3.93	3.70	3.48	3.28	2.47

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Morocco	3.64	3.84	4.04	4.25	4.46	4.68	5.64	0.88	0.86	0.84	0.82	0.80	0.79	0.71	31.70	28.75	26.18	23.94	21.97	20.22	14.35
	2.76	2.98	3.20	3.43	3.66	3.89	4.93														
	1.89	2.12	2.36	2.61	2.85	3.10	4.22	0.88	0.86	0.84	0.82	0.80	0.79	0.71	31.70	28.75	26.18	23.94	21.97	20.22	14.35
Sudan	2.22	2.37	2.52	2.68	2.85	3.02	3.98	0.88	0.90	0.92	0.93	0.95	0.97	1.06	65.81	61.12	56.97	53.28	49.97	46.99	36.13
	1.34	1.47	1.61	1.75	1.90	2.06	2.93														
	0.46	0.57	0.69	0.82	0.95	1.09	1.87	0.88	0.90	0.92	0.93	0.95	0.97	1.06	65.81	61.12	56.97	53.28	49.97	46.99	36.13
Tunisia	0.88	0.92	0.96	1.01	1.06	1.11	1.33	0.19	0.19	0.19	0.19	0.19	0.19	0.19	27.27	25.71	24.26	22.89	21.61	20.41	16.41
	0.69	0.73	0.77	0.82	0.87	0.92	1.14														
	0.50	0.54	0.59	0.63	0.68	0.73	0.96	0.19	0.19	0.19	0.19	0.19	0.19	0.19	27.27	25.71	24.26	22.89	21.61	20.41	16.41
Benin	0.29	0.33	0.36	0.39	0.43	0.47	0.69	0.09	0.09	0.09	0.10	0.10	0.10	0.11	45.21	40.10	35.93	32.47	29.55	27.06	18.51
	0.20	0.23	0.26	0.30	0.33	0.37	0.58														
	0.11	0.14	0.17	0.20	0.23	0.27	0.47	0.09	0.09	0.09	0.10	0.10	0.10	0.11	45.21	40.10	35.93	32.47	29.55	27.06	18.51
Burkina Fa	0.39	0.43	0.47	0.51	0.56	0.60	0.87	0.17	0.17	0.17	0.18	0.18	0.18	0.20	73.83	65.31	58.45	52.82	48.10	44.10	30.10
	0.23	0.26	0.30	0.34	0.37	0.42	0.67														
	0.06	0.09	0.12	0.16	0.19	0.23	0.47	0.17	0.17	0.17	0.18	0.18	0.18	0.20	73.83	65.31	58.45	52.82	48.10	44.10	30.10
Chad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Gambia	0.10	0.11	0.11	0.12	0.12	0.13	0.16	0.03	0.03	0.03	0.03	0.03	0.03	0.03	47.92	43.08	38.97	35.43	32.36	29.67	19.96
	0.07	0.07	0.08	0.09	0.09	0.10	0.13														
	0.04	0.04	0.05	0.06	0.06	0.07	0.10	0.03	0.03	0.03	0.03	0.03	0.03	0.03	47.92	43.08	38.97	35.43	32.36	29.67	19.96
Ghana	0.99	1.09	1.18	1.28	1.38	1.47	1.99	0.12	0.11	0.11	0.11	0.10	0.10	0.09	13.20	11.57	10.24	9.13	8.20	7.40	4.69
	0.88	0.97	1.07	1.17	1.27	1.37	1.90														
	0.76	0.86	0.96	1.06	1.17	1.27	1.82	0.12	0.11	0.11	0.11	0.10	0.10	0.09	13.20	11.57	10.24	9.13	8.20	7.40	4.69
Guinea	0.25	0.28	0.31	0.35	0.38	0.41	0.60	0.05	0.05	0.05	0.05	0.05	0.05	0.05	25.37	21.83	19.09	16.91	15.13	13.65	8.87
	0.20	0.23	0.26	0.30	0.33	0.36	0.55														
	0.15	0.18	0.21	0.25	0.28	0.31	0.51	0.05	0.05	0.05	0.05	0.05	0.05	0.05	25.37	21.83	19.09	16.91	15.13	13.65	8.87

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Guinea Bis	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.03	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.01	0.01	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ivory Coas	0.46	0.50	0.53	0.56	0.60	0.63	0.83	0.12	0.12	0.13	0.13	0.13	0.14	0.16	33.96	32.49	31.18	30.02	28.97	28.03	24.38
	0.36	0.37	0.40	0.43	0.46	0.49	0.67														
	0.23	0.25	0.28	0.30	0.33	0.36	0.50	0.12	0.12	0.13	0.13	0.13	0.14	0.16	33.96	32.49	31.18	30.02	28.97	28.03	24.38
Liberia	0.13	0.14	0.16	0.17	0.18	0.20	0.28	0.01	0.01	0.01	0.01	0.01	0.01	0.01	9.26	8.54	7.92	7.38	6.91	6.49	4.89
	0.12	0.13	0.15	0.16	0.17	0.19	0.27														
	0.11	0.12	0.13	0.15	0.16	0.18	0.26	0.01	0.01	0.01	0.01	0.01	0.01	0.01	9.26	8.54	7.92	7.38	6.91	6.49	4.89
Mali	0.71	0.77	0.83	0.90	0.97	1.04	1.43	0.22	0.22	0.22	0.22	0.22	0.22	0.22	44.56	39.53	35.38	31.91	28.97	26.44	17.72
	0.49	0.55	0.61	0.68	0.75	0.82	1.22														
	0.27	0.33	0.40	0.46	0.53	0.60	1.00	0.22	0.22	0.22	0.22	0.22	0.22	0.22	44.56	39.53	35.38	31.91	28.97	26.44	17.72
Mauritania	0.17	0.18	0.19	0.20	0.21	0.22	0.28	0.02	0.02	0.02	0.02	0.02	0.02	0.02	13.92	13.03	12.21	11.47	10.80	10.17	7.73
	0.15	0.16	0.17	0.18	0.19	0.20	0.26														
	0.13	0.14	0.15	0.16	0.17	0.18	0.24	0.02	0.02	0.02	0.02	0.02	0.02	0.02	13.92	13.03	12.21	11.47	10.80	10.17	7.73
Niger	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Senegal	1.10	1.16	1.21	1.27	1.33	1.39	1.71	0.47	0.47	0.47	0.47	0.47	0.47	0.47	75.38	69.30	63.98	59.31	55.16	51.46	37.53
	0.63	0.68	0.74	0.80	0.85	0.91	1.25														
	0.15	0.21	0.27	0.32	0.38	0.44	0.78	0.47	0.47	0.47	0.47	0.47	0.47	0.47	75.38	69.30	63.98	59.31	55.16	51.46	37.53
Sierra Leo	0.11	0.12	0.13	0.13	0.14	0.15	0.20	0.05	0.05	0.05	0.05	0.05	0.05	0.06	80.77	74.01	68.31	63.42	59.18	55.48	41.22
	0.06	0.07	0.08	0.08	0.09	0.10	0.14														
	0.01	0.02	0.02	0.03	0.04	0.04	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.06	80.77	74.01	68.31	63.42	59.18	55.48	41.22
Togo	0.15	0.17	0.18	0.20	0.22	0.24	0.35	0.04	0.04	0.04	0.04	0.04	0.04	0.04	34.78	30.72	27.47	24.81	22.59	20.70	14.41
	0.11	0.13	0.14	0.16	0.18	0.20	0.30														
	0.07	0.09	0.10	0.12	0.14	0.16	0.26	0.04	0.04	0.04	0.04	0.04	0.04	0.04	34.78	30.72	27.47	24.81	22.59	20.70	14.41

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Angola	0.68	0.76	0.84	0.92	1.00	1.09	1.58	0.04	0.04	0.04	0.04	0.04	0.04	0.04	6.74	5.92	5.25	4.70	4.22	3.82	2.44
	0.63	0.71	0.79	0.88	0.96	1.05	1.54														
	0.59	0.67	0.75	0.84	0.92	1.01	1.50	0.04	0.04	0.04	0.04	0.04	0.04	0.04	6.74	5.92	5.25	4.70	4.22	3.82	2.44
Burundi	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0,00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cameroon	0.87	0.97	1.08	1.18	1.29	1.41	2.06	0.15	0.15	0.15	0.15	0.15	0.15	0.15	21.45	18.79	16.64	14.87	13.38	12.12	7.88
	0.72	0.82	0.92	1.03	1.14	1.26	1.91														
	0.56	0.66	0.77	0.88	0.99	1.10	1.76	0.15	0.15	0.15	0.15	0.15	0.15	0.15	21.45	18.79	16.64	14.87	13.38	12.12	7.88
C A R	0.04	0.05	0.05	0.06	0.06	0.07	0.10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	72.90	62.06	54.00	47.79	42.84	38.81	25.43
	0.02	0.03	0.03	0.04	0.04	0.05	0.08														
	0.01	0.01	0.01	0.02	0.02	0.03	0.06	0.02	0.02	0.02	0.02	0.02	0.02	0.02	72.90	62.06	54.00	47.79	42.84	38.81	25.43
Congo	0.06	0.07	0.08	0.08	0.09	0.10	0.15	0.01	0.01	0.01	0.01	0.01	0.01	0.01	13.36	12.03	10.93	10.01	9.22	8.55	6.20
	0.05	0.06	0.07	0.08	0.08	0.09	0.14														
	0.05	0.05	0.06	0.07	0.08	0.08	0.13	0.01	0.01	0.01	0.01	0.01	0.01	0.01	13.36	12.03	10.93	10.01	9.22	8.55	6.20
Gabon	0.03	0.04	0.04	0.04	0.05	0.05	0.07	0.01	0.01	0.01	0.01	0.01	0.01	0.01	35.03	31.67	29.00	26.84	25.05	23.54	16.88
	0.03	0.03	0.03	0.04	0.04	0.04	0.06														
	0.02	0.02	0.02	0.03	0.03	0.03	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	35.03	31.67	29.00	26.84	25.05	23.54	16.88
Rwanda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Zaire	0.17	0.17	0.16	0.15	0.14	0.13	0.09	0.17	0.17	0.16	0.15	0.14	0.13	0.09	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Botswana	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.01	0.01	0.01	0.01	0.01	0.01	0.00	22.41	19.43	16.97	14.91	13.17	11.69	7.04
	0.05	0.05	0.05	0.05	0.06	0.06	0.06														
	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.00	22.41	19.43	16.97	14.91	13.17	11.69	7.04

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Ethiopia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Kenya	2.39	2.64	2.90	3.17	3.44	3.73	5.30	0.30	0.30	0.30	0.29	0.29	0.28	0.26	14.60	12.84	11.38	10.16	9.12	8.23	5.25
	2.09	2.34	2.60	2.87	3.16	3.45	5.03														
	1.78	2.04	2.31	2.58	2.87	3.16	4.77	0.30	0.30	0.30	0.29	0.29	0.28	0.26	14.60	12.84	11.38	10.16	9.12	8.23	5.25
Lesotho	0.27	0.29	0.31	0.33	0.36	0.38	0.51	0.05	0.05	0.05	0.05	0.05	0.05	0.04	23.63	21.34	19.35	17.59	16.04	14.66	9.67
	0.22	0.24	0.26	0.28	0.31	0.33	0.46														
	0.17	0.19	0.21	0.23	0.26	0.28	0.42	0.05	0.05	0.05	0.05	0.05	0.05	0.04	23.63	21.34	19.35	17.59	16.04	14.66	9.67
Madagascar	0.43	0.46	0.49	0.53	0.57	0.60	0.80	0.09	0.10	0.10	0.10	0.10	0.10	0.11	28.47	26.25	24.35	22.70	21.26	20.00	15.55
	0.33	0.36	0.40	0.43	0.47	0.50	0.69														
	0.24	0.27	0.30	0.33	0.37	0.40	0.59	0.09	0.10	0.10	0.10	0.10	0.10	0.11	28.47	26.25	24.35	22.70	21.26	20.00	15.55
Malawi	0.68	0.75	0.82	0.89	0.96	1.04	1.45	0.18	0.18	0.18	0.18	0.18	0.18	0.19	35.10	31.38	28.30	25.71	23.51	21.62	15.35
	0.50	0.57	0.64	0.71	0.78	0.85	1.26														
	0.33	0.39	0.46	0.52	0.60	0.67	1.06	0.18	0.18	0.18	0.18	0.18	0.18	0.19	35.10	31.38	28.30	25.71	23.51	21.62	15.35
Mauritius	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	2.52	2.53	2.54	2.56	2.57	3.04
	0.04	0.04	0.04	0.04	0.04	0.04	0.03														
	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	2.52	2.53	2.54	2.56	2.57	3.04
Mozambique	0.84	0.92	1.00	1.09	1.17	1.26	1.75	0.10	0.10	0.10	0.10	0.10	0.10	0.10	12.95	11.68	10.62	9.70	8.91	8.22	5.75
	0.75	0.82	0.91	0.99	1.08	1.17	1.65														
	0.65	0.73	0.81	0.89	0.98	1.07	1.56	0.10	0.10	0.10	0.10	0.10	0.10	0.10	12.95	11.68	10.62	9.70	8.91	8.22	5.75
Somalia	0.38	0.39	0.40	0.40	0.41	0.41	0.47	0.08	0.09	0.09	0.09	0.10	0.10	0.12	27.69	28.37	29.08	29.83	30.61	31.43	33.55
	0.30	0.31	0.31	0.31	0.31	0.32	0.35														
	0.22	0.22	0.22	0.22	0.22	0.22	0.23	0.08	0.09	0.09	0.09	0.10	0.10	0.12	27.69	28.37	29.08	29.83	30.61	31.43	33.55
Swaziland	0.10	0.11	0.12	0.13	0.14	0.15	0.19	0.01	0.01	0.01	0.01	0.01	0.01	0.00	9.46	8.10	7.00	6.09	5.32	4.68	2.58
	0.09	0.10	0.11	0.12	0.13	0.14	0.19														
	0.08	0.09	0.10	0.11	0.12	0.13	0.19	0.01	0.01	0.01	0.01	0.01	0.01	0.00	9.46	8.10	7.00	6.09	5.32	4.68	2.58

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Tanzania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Uganda	1.62	1.77	1.92	2.07	2.23	2.38	3.22	0.54	0.53	0.52	0.51	0.51	0.50	0.46	49.98	42.90	37.40	33.00	29.41	26.43	16.63
	1.08	1.24	1.40	1.56	1.72	1.88	2.76														
	0.54	0.71	0.87	1.04	1.21	1.39	2.30	0.54	0.53	0.52	0.51	0.51	0.50	0.46	49.98	42.90	37.40	33.00	29.41	26.43	16.63
Zambia	1.13	1.21	1.30	1.38	1.47	1.55	2.01	0.18	0.17	0.17	0.16	0.15	0.14	0.12	18.97	16.57	14.59	12.92	11.50	10.29	6.16
	0.95	1.04	1.13	1.22	1.32	1.41	1.89														
	0.77	0.87	0.97	1.07	1.17	1.26	1.77	0.18	0.17	0.17	0.16	0.15	0.14	0.12	18.97	16.57	14.59	12.92	11.50	10.29	6.16
Zimbabwe	1.57	1.68	1.80	1.92	2.05	2.18	2.89	0.66	0.65	0.65	0.64	0.64	0.63	0.61	71.90	63.15	56.02	50.11	45.13	40.89	26.65
	0.91	1.03	1.15	1.28	1.41	1.55	2.28														
	0.26	0.38	0.51	0.64	0.77	0.91	1.67	0.66	0.65	0.65	0.64	0.64	0.63	0.61	71.90	63.15	56.02	50.11	45.13	40.89	26.65
Costa Rica	0.14	0.14	0.15	0.16	0.16	0.17	0.19	0.04	0.04	0.04	0.04	0.04	0.05	0.05	42.29	41.10	40.01	39.00	38.06	37.18	35.89
	0.10	0.10	0.11	0.11	0.12	0.12	0.14														
	0.06	0.06	0.06	0.07	0.07	0.08	0.09	0.04	0.04	0.04	0.04	0.04	0.05	0.05	42.29	41.10	40.01	39.00	38.06	37.18	35.89
Dom Rep	0.27	0.28	0.29	0.29	0.30	0.31	0.32	0.05	0.05	0.05	0.05	0.05	0.05	0.06	22.12	21.93	21.76	21.62	21.50	21.40	22.48
	0.22	0.23	0.23	0.24	0.25	0.25	0.26														
	0.17	0.18	0.18	0.19	0.19	0.20	0.20	0.05	0.05	0.05	0.05	0.05	0.05	0.06	22.12	21.93	21.76	21.62	21.50	21.40	22.48
El Salv	0.32	0.32	0.33	0.33	0.34	0.34	0.36	0.12	0.13	0.13	0.13	0.14	0.14	0.16	64.73	65.54	66.43	67.40	68.47	69.62	78.63
	0.19	0.19	0.20	0.20	0.20	0.20	0.20														
	0.07	0.07	0.07	0.06	0.06	0.06	0.04	0.12	0.13	0.13	0.13	0.14	0.14	0.16	64.73	65.54	66.43	67.40	68.47	69.62	78.63
Guatemala	0.26	0.28	0.29	0.31	0.33	0.35	0.44	0.08	0.08	0.09	0.09	0.09	0.09	0.11	44.54	42.68	40.98	39.42	37.98	36.65	32.51
	0.18	0.19	0.21	0.22	0.24	0.25	0.33														
	0.10	0.11	0.12	0.13	0.15	0.16	0.22	0.08	0.08	0.09	0.09	0.09	0.09	0.11	44.54	42.68	40.98	39.42	37.98	36.65	32.51
Haiti	0.42	0.46	0.50	0.54	0.59	0.63	0.89	0.04	0.04	0.04	0.04	0.04	0.04	0.04	10.55	9.55	8.69	7.95	7.31	6.75	4.72
	0.38	0.42	0.46	0.50	0.55	0.59	0.85														
	0.34	0.38	0.42	0.46	0.51	0.55	0.81	0.04	0.04	0.04	0.04	0.04	0.04	0.04	10.55	9.55	8.69	7.95	7.31	6.75	4.72

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Honduras	0.35	0.38	0.41	0.43	0.46	0.49	0.67	0.07	0.07	0.07	0.07	0.07	0.07	0.08	23.44	21.86	20.46	19.21	18.09	17.07	12.99
	0.29	0.31	0.34	0.36	0.39	0.42	0.59														
	0.22	0.24	0.27	0.29	0.32	0.35	0.51	0.07	0.07	0.07	0.07	0.07	0.07	0.08	23.44	21.86	20.46	19.21	18.09	17.07	12.99
Jamaica	0.24	0.25	0.26	0.28	0.29	0.30	0.37	0.01	0.01	0.01	0.01	0.01	0.01	0.01	3.90	3.65	3.44	3.25	3.08	2.92	2.34
	0.23	0.24	0.25	0.27	0.28	0.30	0.36														
	0.22	0.23	0.25	0.26	0.27	0.29	0.35	0.01	0.01	0.01	0.01	0.01	0.01	0.01	3.90	3.65	3.44	3.25	3.08	2.92	2.34
Nicaragua	0.04	0.03	0.01	0.00	0.00	0.00	0.00	0.04	0.03	0.01	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Panama	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.03	136.96	124.71	114.23	105.16	97.23	90.25	97.15
	0.02	0.02	0.02	0.02	0.03	0.03	0.03														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.03	100.00	100.00	100.00	100.00	97.23	90.25	97.15
Tri Tob	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Bolivia	0.50	0.53	0.56	0.59	0.62	0.65	0.81	0.13	0.13	0.13	0.13	0.13	0.13	0.14	34.04	32.06	30.28	28.68	27.23	25.91	20.57
	0.38	0.40	0.43	0.46	0.48	0.51	0.67														
	0.25	0.27	0.30	0.33	0.35	0.38	0.53	0.13	0.13	0.13	0.13	0.13	0.13	0.14	34.04	32.06	30.28	28.68	27.23	25.91	20.57
Colombia	0.36	0.33	0.29	0.25	0.21	0.16	0.00	0.36	0.33	0.29	0.25	0.21	0.16	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ecuador	0.63	0.70	0.77	0.84	0.92	1.00	1.41	0.11	0.11	0.11	0.11	0.11	0.10	0.10	21.78	18.87	16.55	14.64	13.06	11.72	7.46
	0.52	0.59	0.66	0.74	0.81	0.89	1.31														
	0.40	0.48	0.55	0.63	0.71	0.79	1.21	0.11	0.11	0.11	0.11	0.11	0.10	0.10	21.78	18.87	16.55	14.64	13.06	11.72	7.46
Guyana	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.03	0.03	0.02	0.02	0.01	0.01	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000	1990	1991	1992	1993	1994	1995	2000
	.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)							.... (1,000,000 Metric Tons)						
Paraguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Peru	1.28	1.39	1.50	1.61	1.72	1.84	2.38	0.14	0.14	0.14	0.14	0.14	0.14	0.14	12.69	11.50	10.49	9.62	8.87	8.21	6.01
	1.13	1.24	1.35	1.47	1.58	1.70	2.25														
	0.99	1.10	1.21	1.33	1.44	1.56	2.11	0.14	0.14	0.14	0.14	0.14	0.14	0.14	12.69	11.50	10.49	9.62	8.87	8.21	6.01
Surinam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Chile	0.82	0.86	0.90	0.95	0.99	1.04	1.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	45.09	41.84	38.99	36.47	34.21	32.20	25.61
	0.56	0.61	0.65	0.70	0.74	0.79	0.99														
	0.31	0.35	0.40	0.44	0.49	0.53	0.74	0.25	0.25	0.25	0.25	0.25	0.25	0.25	45.09	41.84	38.99	36.47	34.21	32.20	25.61
Uruguay	0.18	0.17	0.17	0.17	0.16	0.16	0.13	0.18	0.17	0.17	0.17	0.16	0.16	0.13	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

that with the lowest (16.2%) is Latin America. Among sub-regions, the highest positive percentage difference (49.3%) is for West Asia and the lowest (9%) is for Central America.

TABLE 3.2 Basis of Classification of Countries According to the Positive or Negative Character of their Food Aid Requirements (Before Application of the Constraint on Negative Values)

	Estimate		
Class	Upper Limit	Average	Lower Limit
A	+	+	+
B	+	+	-
C	+	-	-
D	-	-	-

For reasons set out in Chapter II, there is considerable justification for imposing an income constraint on recipients of food aid. An upper limit on per capita GNP of $800 was suggested. Low-income countries, that is those with a lower per capita GNP than $800 in 1980, need to be examined for the variability of food aid requirements for the world and for the regions and sub-regions into which they fall. The results are presented in Table 3.4. This table shows that total food aid requirement for all low-income countries varies in 1990 from 23.3 million tons to 16.32 million tons around the trend requirement of 19.2 million tons. The positive percentage difference is 16.14% and the negative percentage difference is 15%. The percentage differences are not defined for South America because its trend requirement is nil. Similarly, these differences are extremely high for East Asia because the trend requirement is extremely small (particularly so, relative to the volume of domestic production). Amongst the other sub-regions, the highest positive percentage difference is 43.31% for South Asia and the lowest is 11.1% for North Africa. Figure 3.1 shows the percentage variability of different regions and sub-regions for 1990, 1995 and 2000.

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TABLE 3.3 Variability of Food Aid Needs for Regions and Sub-Regions: Trend, Upper and Lower Estimates

Row 1: Upper Estimate, based on (Production - 1 S.D.)
Row 2: Basic Estimates of FANs
Row 3: Lower Estimate, based on (Production + 1 S.D.)

n.d. not defined

	Estimates			Difference from Basic Estimates (row 2)			Percentage Difference from Basic Estimates		
	1990	1995	2000	1990	1995	2000	1990	1995	2000
	(1,000,000 Metric Tons)								
SOUTH ASIA	3.50	4.12	4.23	1.06	1.22	1.41	43.26	42.00	49.72
	2.44	2.90	2.83						
	1.38	1.68	1.43	1.07	1.22	1.40	43.58	42.07	49.55
EAST ASIA	3.34	3.21	2.19	0.96	0.99	1.01	40.58	44.36	84.92
	2.38	2.22	1.19						
	1.45	1.29	0.26	0.93	0.93	0.93	39.01	41.83	78.41
ASIA	6.13	6.58	5.64	1.31	1.46	1.63	27.24	28.49	40.55
	4.82	5.12	4.01						
	3.54	3.69	2.42	1.29	1.43	1.60	26.67	27.92	39.80
WEST ASIA	5.06	7.45	10.48	1.67	1.95	2.33	49.33	35.43	28.55
	3.39	5.50	8.15						
	2.90	5.05	7.75	0.49	0.45	0.40	14.51	8.10	4.96
NORTH AFRICA	14.35	20.19	26.95	1.57	1.61	1.66	12.33	8.69	6.58
	12.77	18.58	25.28						
	11.20	16.96	23.62	1.57	1.61	1.66	12.33	8.69	6.58
W. ASIA/N. AFRICA	18.95	27.04	36.63	2.79	2.97	3.20	17.28	12.32	9.56
	16.16	24.08	33.44						
	14.28	22.17	31.50	1.88	1.90	1.94	11.62	7.90	5.79
WEST AFRICA	4.58	6.68	9.17	1.10	1.15	1.22	31.43	20.87	15.41
	3.49	5.53	7.95						
	2.41	4.39	6.75	1.08	1.14	1.20	30.99	20.53	15.12

	1990	1995	2000	1990	1995	2000	1990	1995	2000
	(1,000,000 Metric Tons)								
CENTRAL AFRICA	1.79	2.84	4.11	0.33	0.36	0.39	22.65	14.36	10.42
	1.46	2.49	3.72						
	1.27	2.30	3.53	0.19	0.19	0.19	13.05	7.63	5.10
EAST AFRICA	8.49	12.85	17.82	1.19	1.16	1.14	16.26	9.94	6.86
	7.31	11.69	16.67						
	6.12	10.53	15.53	1.19	1.16	1.14	16.26	9.94	6.86
SUB-SAHARAN AFRICA	14.38	21.90	30.62	2.13	2.19	2.27	17.36	11.12	8.02
	12.25	19.71	28.34						
	10.29	17.73	26.33	1.97	1.98	2.01	16.05	10.05	7.09
CENTRAL AMERICA	1.74	2.33	2.94	0.14	0.16	0.18	9.03	7.35	6.35
	1.60	2.17	2.77						
	1.46	2.01	2.60	0.14	0.16	0.17	8.95	7.26	6.26
SOUTH AMERICA	3.28	4.65	6.05	0.69	0.75	0.83	26.75	19.39	15.89
	2.59	3.89	5.22						
	2.20	3.51	4.85	0.38	0.38	0.37	14.85	9.71	7.12
LATIN AMERICA	4.86	6.80	8.80	0.68	0.74	0.81	16.18	12.22	10.20
	4.19	6.06	7.99						
	3.79	5.65	7.56	0.40	0.41	0.43	9.45	6.81	5.42
TOTAL	42.29	60.18	79.42	4.86	5.21	5.64	13.00	9.49	7.64
	37.42	54.96	73.78						
	33.57	50.92	69.51	3.85	4.04	4.27	10.29	7.35	5.79

TABLE 3.4 Low Income Countries: Variability of Food Aid Needs for Regions and Sub-Regions: Trend, Upper and Lower Estimates

	Row 1: Upper Estimate, based on (Production - 1 S.D.) Row 2: Basic Estimates of FANs Row 3: Lower Estimate, based on (Production + 1 S.D.)			Difference from Basic Estimates (row 2)			Percentage Difference from Basic Estimates n.d. not defined		
	1990	1995	2000	1990	1995	2000	1990	1995	2000
	(1,000,000 Metric Tons)								
SOUTH ASIA	3.51	4.12	4.23	1.06	1.22	1.40	43.31	42.05	49.59
	2.45	2.90	2.63						
	1.39	1.68	1.43	1.06	1.22	1.40	43.31	42.05	49.59
EAST ASIA	0.44	0.50	0.50	0.40	0.43	0.47	989.92	618.82	1582.56
	0.04	0.07	0.03						
	0.00	0.00	0.00	0.04	0.07	0.03	100.00	100.00	100.00
ASIA	3.67	4.32	4.40	1.18	1.35	1.54	47.25	45.34	53.99
	2.49	2.97	2.86						
	1.43	1.75	1.46	1.06	1.22	1.40	42.61	41.06	49.07
WEST ASIA	0.78	1.21	1.72	0.12	0.11	0.10	18.49	9.94	6.08
	0.66	1.10	1.62						
	0.54	0.99	1.52	0.12	0.11	0.10	18.48	9.94	6.08
NORTH AFRICA	8.03	11.38	15.73	0.80	0.86	0.92	11.10	8.16	6.21
	7.23	10.52	14.81						
	6.43	9.66	13.89	0.80	0.86	0.92	11.10	8.16	6.21
W. ASIA/N. AFRICA	8.80	12.58	17.45	0.91	0.96	1.02	11.47	8.27	6.22
	7.89	11.62	16.43						
	6.98	10.66	15.41	0.91	0.96	1.02	11.47	8.27	6.22
WEST AFRICA	3.21	4.66	6.40	0.94	0.98	1.03	41.35	26.62	19.10
	2.27	3.68	5.37						
	1.35	2.72	4.37	0.92	0.96	1.00	40.62	26.05	18.61
CENTRAL AFRICA	1.05	1.65	2.36	0.31	0.34	0.37	41.29	25.58	18.51
	0.74	1.31	1.99						
	0.57	1.14	1.82	0.17	0.17	0.17	22.64	12.88	8.55
EAST AFRICA	6.26	9.13	12.42	1.12	1.10	1.09	21.81	13.70	9.59
	5.14	8.03	11.33						
	4.02	6.93	10.24	1.12	1.10	1.09	21.81	13.70	9.59
SUB-SAHARAN AFRICA	10.09	15.02	20.76	1.94	2.00	2.07	23.76	15.34	11.10
	8.15	13.02	18.69						
	6.39	11.26	16.91	1.76	1.76	1.78	21.55	13.53	9.50
CENTRAL AMERICA	0.75	1.10	1.53	0.08	0.09	0.09	12.22	8.43	6.15
	0.67	1.01	1.44						
	0.60	0.93	1.36	0.07	0.08	0.08	10.84	7.51	5.51
SOUTH AMERICA	0.03	0.01	0.00	0.03	0.01	0.00	n.d.	n.d.	n.d.
	0.00	0.00	0.00						
	0.00	0.00	0.00	0.00	0.00	0.00	n.d.	n.d.	n.d.
LATIN AMERICA	0.75	1.09	1.53	0.08	0.08	0.09	11.92	8.38	6.25
	0.67	1.01	1.44						
	0.60	0.93	1.36	0.07	0.08	0.08	10.84	7.51	5.51
TOTAL	22.30	31.97	43.06	3.10	3.35	3.64	16.14	11.70	9.23
	19.20	28.62	39.42						
	16.32	25.53	36.08	2.88	3.09	3.34	14.99	10.80	8.48

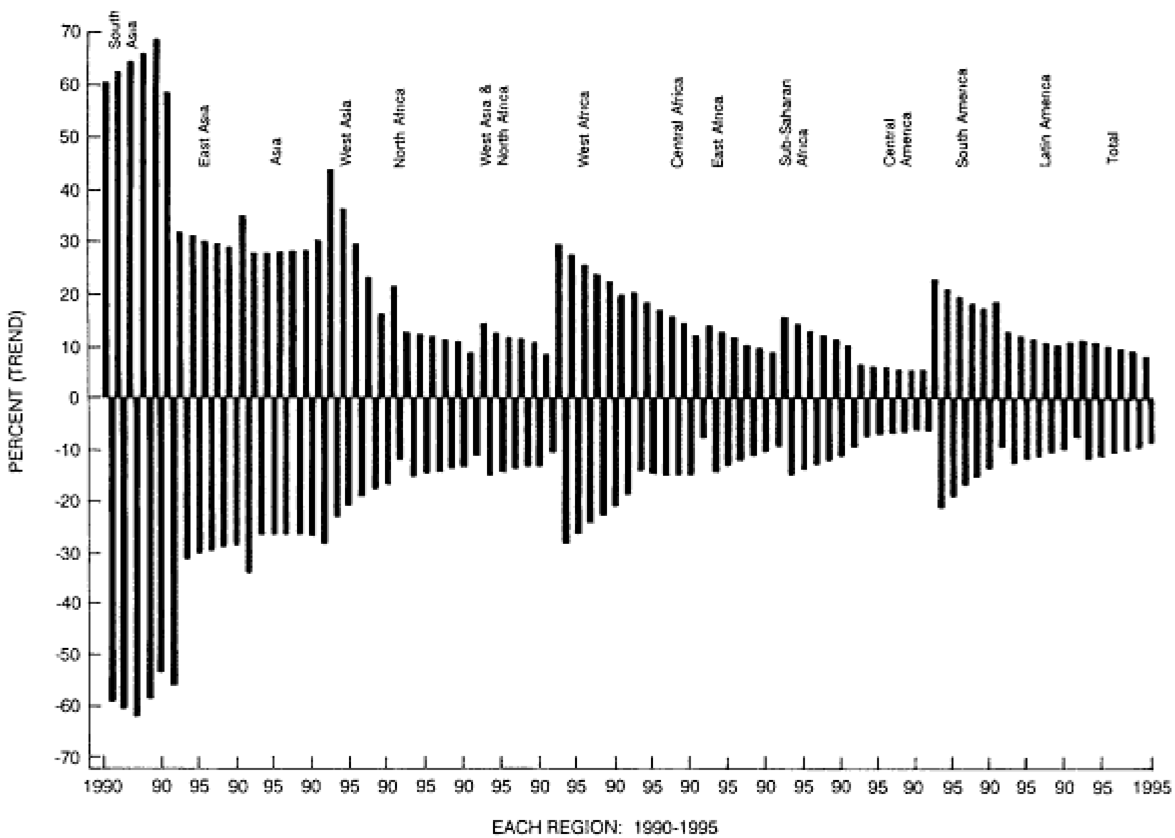

Figure 3.1
Percentage Difference of Upper and Lower Estimates of Food Aid Requirements from Basic Trend Estimates for Regions and Sub-regions

Appendix B

Food Aid Requirements of Developing Countries

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This paper summarizes results obtained with the Basic Linked System (BLS) on food aid requirements in developing countries (LDCs). The simulations of the scenarios for which results are described in this paper were carried out at the Food and Agriculture Program (FAP) of the International Institute for Applied Systems Analysis (IIASA) where the BLS was developed. They are published by Parikh et al. (1988) and, as an executive report, by Parikh and Tims (1986).

The BLS is a tool for analyzing agricultural policies in an international setting. It consists of 18 national models: 2 models comprising economically integrated regions, the European Community (EC) and the Countries for Mutual Economic Assistance (CMEA); and 14 regional models including all other countries. The national models and both the EC and the CMEA models are detailed in their representation of the behavior of producers, consumers and governments. The regional models have a somewhat less detailed specification. They all are of the general equilibrium type, are recursively dynamic and run in annual time increments.

Since the BLS is used mainly for analyzing agricultural policies, the representation of the agricultural sector is more detailed relative to the non-agricultural sectors which are summarized in one aggregate. Agricultural commodities are aggregated to nine subsectors which are the following: wheat, rice, coarse grains, ovine and bovine meat, dairy products, other animal products (pork, poultry, eggs and fish), protein feed (both of crops and animal origin), other food (oils and fats, sugar, vegetables, fruits, nonalcoholic beverages such as coffee, tea and cocoa), and nonfood agriculture (fibre, industrial commodities originating from agriculture). For each of these aggregates, production, disappearance (human consumption, feed, intermediate consumption), storage, net trade, and prices are calculated both at the national and international level.

The BLS ensures consistency among quantities traded and the countries' trade balances at the international level and, at the national level among supply, disappearance and net trade as well as expenditure and income. These consistencies are an important element of

* The view expressed in this paper is not necessarily that of the OECD.

the BLS—as of any general equilibrium-type model—and are missing in partial equilibrium models.

Relevant for the topic of this paper is an explanation of how the nutritional status of the population is assessed in the BLS. Two indicators are calculated for this purpose with the BLS; nutritional intake and number of hungry people. A third indicator, food requirement is taken from calculations jointly established by FAO, the World Bank and the World Health Organization. The nutritional intake is calculated in form of calories and protein intake and based on the per capita consumption of food in a given country. Consumption, in turn, is arrived at by assuming that consumers maximize their utility given prices and income. The nutritional content of the various food items was calculated from FAO data simultaneously with the aggregation of the products to subsectors. It may vary from country to country for the same item.

The number of people hungry is another indicator which is calculated based on the results obtained with the BLS. It should be pointed out that only chronic hunger is dealt with in this analysis. Famines are not considered since the BLS is basically a deterministic system. The Fourth World Food Survey (FAO 1977) provides estimates of this indicator for each country. These FAO estimates are based on country-specific data and on cross-country comparisons. FAO did not formalize the method completely. The same procedure has been adopted for the BLS by estimating the following regression (Parikh et al., 1988):

$$\text{Hungry} = \begin{cases} 0.01338\ (138.6 - \text{CALAR})^2 & \text{if CALAR} \leq 138.6 \\ 0 & \text{if CALAR} > 138.6 \end{cases}$$

where

HUNGRY = percentage of population with calorie intake 1.2 times less than the required norm (basal metabolic rate)

CALAR = calories available as a percentage of requirement.

This cross-country regression provides a good fit of the FAO procedure ($R^2 = 0.87$). However, the good fit could be expected since the independent variable was used in generating the dependent variable, among others and, obviously, had a strong impact. The unexplained variation of the dependent variables is influenced by country-specific variables like income distribution and genetic and climatic characteristics.

Several scenarios have been analyzed with the help of the BLS. They can be grouped into two categories; scenarios dealing with issues of trade liberalization in agriculture and scenarios designed to analyze the efficacy of aid. All scenarios were simulated for the period 1980-2000. The discussions of the results provided in the two references cited above are focusing on the outcomes obtained for the year 2000. This will be followed in the current report as well.

The assessment of the various policies is done by comparing the scenario results of a specific year with those obtained for the same year in a reference run. The outcome of the latter with regard to the nutritional status of the population and the number of people suffering from hunger will be discussed before an assessment of the scenario results is provided.

Results of the Reference Run

The underlying assumption in generating the reference run has been a continuation of policy responses as in the past. With this assumption, it is hoped to have a base for

TABLE 1 GDP Per Capita, Calorie Intake, and People Hungry in Some Developing Countries

	GDP/capita (US$ 1970)		Calorie intake (kCal/capita/day)		People hungry (10)	
	1980	2000	1980	2000	1980	2000
Argentina	1,350	1,795	3,653	3,656	1	1
Brazil	822	1,818	2,860	3,283	12	3
Mexico	798	1,157	2,487	2,588	3	3
Egypt	266	448	2,799	3,134	1	0
Kenya	166	200	2,495	2,802	6	7
Nigeria	181	390	2,254	3,168	25	2
India	104	181	2,141	2,533	219	156
Indonesia	83	151	1,840	2,374	21	0
Pakistan	182	224	2,460	2,718	9	6
Thailand	219	423	2,856	3,235	8	4
Turkey	580	1,231	3,137	3,219	1	1

Source: Parikh et al., 1988, Table 4.16, p. 84.

comparison of the scenario runs which is as neutral as possible in the sense that it "does not accentuate the impact of some policies while muting that of others" (Parikh et al., 1988, p. 39). It is not to be seen as a forecast because the BLS is not a forecasting tool but an analytical device to explore and better understand the impact of alternative policy scenarios.

The reference run very strongly points to the persistence of hunger. If no drastic policy changes are introduced—as assumed for the reference run—hunger is not eliminated by the end of the century. Results obtained with the BLS indicate that a large part of the population in LDCs still suffers from undernutrition; 17 percent or 470 million people in 1990 and 11 percent or 400 million in 2000. To put this into perspective, 660 million hungry people is the estimate by FAO to have prevailed in 1970. The BLS results indicate the number of hungry people to have peaked in the early 1980s and a steady decline from then on.

Although the number of hungry persons remains disappointingly high, only relatively small quantities of additional food are required to raise the level of the nutritional status of all people to the accepted minimum. It amounts to about 50 million tons of grain or 3 per cent of the world cereal output.

The reason why hunger is not eliminated during this century if past policies are extended into the future is, in general, the lack of marketable resources and skills of the poor which constrains their purchasing power. Obviously, BLS results indicate progress in terms of eliminating hunger. Income increases in LDCs, but not to the necessary extent (see Table 1). Also, increases in some food prices reduce purchasing power.

The calorie intake reported in Table 1 refers to an average person and does not indicate the situation of the undernourished people. The change over time (from 1980 to 2000), however, provides some information as to how the nutritional status of these people might also evolve as long as their income situation does rot worsen relative to the average person, and as long as price changes are not detrimental for them.

The last two columns in Table 1 give estimates of hungry people in LDCs based on BLS results. "Success" can be claimed only by Egypt and Indonesia, the two countries which are able to eliminate hunger by the year 2000, according to BLS results. Brazil, Nigeria, India, Pakistan and Thailand reduce the occurrence of hunger in their countries, while in Argentina, Kenya and Turkey no improvement seems to be possible with a continuation of past policies.

What generates the "success" of Egypt and especially Indonesia? The latter has a very strong per-capita income growth, averaging 3.0 percent per annum. But other countries have an even changes growth rate and still have problems with regard to feeding all people adequately (e.g., Turkey). Indonesia's prices of staple food decline or remain relatively constant. The same holds for Egypt which has a slightly lower growth rate of per-capita income.

The countries with no progress in solving the food problem are suffering either from low income growth (Kenya, 0.9 percent per annum per capita; Argentina, 1.4 per cent) and/or have less favorable staple food prices. Of course, one cannot rule out the possibility that a worsening of income distribution occurs simultaneously with the other changes. This explains why the number of hungry people increases in Turkey. * Usually, for a country as a whole the FAP study found a relatively low income elasticity of aggregate food demand expressed in calorie intake. In many of the LDCs, the figure is about 0.2 for the average population and nearly 1.0 for the very low income groups. This also indicates the importance of assuring income growth across the various income classes.

Impact of Trade Liberalization on Hunger

Several scenarios regarding trade liberalization in agriculture have been analyzed with the BLS. Their impact on the nutritional status of many people in the DCs depends strongly on which countries participate in the trade liberalization and how the world market prices are affected (Table 2).

Three scenarios of agricultural trade liberalization will be briefly discussed here; liberalization by OECD countries, except Turkey; by LDCs and by all market economies. Relative world market prices of agricultural commodities increase in all three scenarios, in comparison to the reference run. The strongest price rise is estimated to be for dairy products and for bovine and ovine meat followed by grains. Between the three liberalization scenarios, the price increases are more pronounced when OECD countries participate, i.e. in the liberalizing countries alone than when LDCs are the only liberalizing countries. This is a reflection of the strong protection agriculture gets in OECD countries.

These increases in relative world market prices of agricultural commodities are transmitted onto the domestic markets. That stimulates agricultural output in LDCs but not necessarily the income of the entire economy, to an extent to offset the reduction in purchasing power due to higher food prices. Therefore, both indicators—calorie intake and the number of people hungry—worsen in many LDCs. That might be accentuated under a

* The reader is reminded that for all countries but India income distribution is not explicitly included in the model.

scenario of trade liberalization by LDCs in those countries in which agriculture is taxed. In those cases, food price increases are even stronger.

TABLE 2 Percentage Change Relative to the Reference Run in Calorie Intake and Number of People Hungry in the Year 2000 in Three Trade Liberalization Scenarios: By All Market Economies (ALLME), by OECD Countries excluding Turkey, and by D C Market Economies

	ALLME		OECD Countries		LDC Countries	
Countries	Calorie intake	Number hungry	Calorie intake	Number hungry	Calorie intake	Number hungry
Argentina	-1.5	31.0	-0.3	6.7	-1.2	24.1
Brazil	-2.0	49.8	-0.5	12.3	1.4	34.1
Mexico	0.2	-2.8	-0.5	8.8	0.3	-5.5
Egypt	-0.4	0	-0.5	0	0.6	0
Kenya	3.1	-14.2	1.8	-8.8	1.3	-6.3
Nigeria	1.1	-56.9	0.4	-47.4	1.3	-59.6
India	-0.4	2.2	-0.9	5.6	1.5	-9.1
Indonesia	1.8	0	0	0	0.3	0
Pakistan	1.4	-16.9	-0.6	8.1	2.7	-31.9
Thailand	-0.3	3.3	-0.1	1.0	-0.4	4.0
Turkey	0.2	-5.7	-0.1	1.7	0.1	-2.1

SOURCE: Various tables in Parikh et al., 1988.

Maybe a discussion of the impact of trade liberalization on Argentina and Nigeria brings out this point more strongly. In Argentina, value added increases in all these scenarios. But so do food prices. The income increase is not strong enough to offset the rise in food prices and hence the decline in food consumption.

In Nigeria, total value added goes up only when OECD countries alone liberalize, but not when the country itself participates. In the former case, food prices also go up slightly and in the latter two scenarios they go down. The offsetting mechanism is not strong enough in all three scenarios to allow the Nigerian population a higher food consumption and a reduction of the number of hungry people.

Impact of Aid on Hunger

The scenarios of trade liberalization in agriculture do not show any significant progress on the hunger issues. Can aid given to LDCs by the rich countries help? Several scenarios were analyzed with the BLS which address this issue.

Aid is a much more effective means for eradicating hunger than is free trade in agriculture. Yet, the most promising one is a combination of the two. Table 3 lists the impact of two aid scenarios on the number of hungry people in LDCs by 2000. Both scenarios assume the same amount of aid given; 0.5 percent of the GDP of the rich countries in addition to the 0.35 percent aid given currently. This additional aid is distributed to the LDCs in inverse relation to their per-capita incomes. In one scenario, aid is tied to be spent as capital investment (A-Cap). The other scenario assumes that aid is given as a balance-of-payment support (A-Bop). The A-Cap scenario has a direct impact on the growth of the economy and indirect then on food consumption. The A-Bop scenario affects food consumption immediately since the marginal expenditure propensities of the recipient countries apply to balance of payments changes in the same way as to domestically-generated income.

TABLE 3 Impact of Aid of 0.5 Percent of GDP by the Rich Countries to the LDCs in Addition to the 0.35 Percent Presently Given--Results in 2000

Country Groups	Hungry Persons Reference Scenario (10^6)	Percent Change over Reference Scenario A-Cap[a]	A-Bop[b]
All Developing Countries	400	-32	-32
Middle Income	30	0	+4
Low-Middle Income	60	-13	-8
Low Income[a]	310	-40	-40
of which India	155	-54	-56

[a] Aid given to LDCs is added to investment.
[b] Aid given to LDCs as support of balance of payments.

SOURCE: Parikh and Tims, 1986.

As can be seen from Table 3, the two scenarios provide a much stronger reduction of hunger in LDCs than the free trade scenarios discussed earlier. This impact is more pronounced in low-income LDCs because they receive a relatively high share of the aid given.

Donating countries might be hesitating in providing this additional aid, as one currently can observe, by the fact that the aid given is far below the amount the rich countries promised. If one compares free trade with aid the donating countries can recapture more than they give to the LDCs. Trade liberalization by all market economics and 0.5 percent of GDP as aid to the LDCs results in a significant reduction in the number of hungry people. The impact, however, is slightly less than in a pure aid-giving scenario because of a food price increase. The donating countries can recover all the aid given and even have a 0.25 percent growth in income.

The scenario described last is one of the more "sweetened" ones in terms of making it easier for the rich countries to donate aid and, at the same time, have a considerable effect on the developing countries and their hunger problem. The disappointing aspect is that it will not eradicate hunger entirely. The developing countries still can, in addition, introduce some of their own measures to accelerate this process. If they use some redistribution schemes, like food for work, hunger might not be a problem any more. Analyses with the model for India, which is part of the BLS and very detailed in terms of income distribution, indicate that this is the best of all scenarios. Trade liberalization coupled with aid to LDCs and income redistribution schemes in LDCs is a feasible solution for eradicating hunger and minimizing the negative impact of aid on developed countries.

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Appendix C

Commodity Market Outlook and Trade Implications Indicated by the FAPRI Analysis

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INTRODUCTION

In this evaluation we use a multinational and multi-commodity trade model to project grain production, consumption, trade, and prices for selected countries and regions for the period 1987/88 to 1996/97. The projections are compared to historical data and are used to assess the grain needs of the importing countries.

In evaluating the food requirements, factors such as supply and demand conditions in other countries, world market price for agricultural commodities, economic growth and purchasing power of the importing countries are often ignored. It is important to take these factors into account in assessing the food needs of the importing countries. The trade model used in this study incorporates these factors. The trade models are econometric models consisting of behavioral components of supply and demand for wheat, coarse grains, soybeans, soymeal, and soyoil for major exporters and importers.

Before presenting the results, we briefly explain the structure and components of the model and assumptions used in the projection. The projections are first presented in general terms for wheat, coarse grains, and soybeans. Then a regional analysis is conducted for wheat and coarse grains.

MODEL DESCRIPTION

The CARD/FAPRI agricultural trade models are dynamic, nonspatial, partial equilibrium econometric models for wheat, coarse grains (corn, barley, and oats), sorghum and the soybean complex. All four trade models are used in the analysis; however the detailed results are presented only for wheat and coarse grains. The models are non-spatial in that they do not identify trade flows between regions; the major concern is to identify net quantities traded by each country or region.

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While the individual commodity components may be run independently, they are integrated into a larger system with other commodity components through price linkages permitting cross-commodity and cross-country interactions to take place. These linkages between countries and commodities are designed to reflect the simultaneity of the price determination process in the agricultural sector. A simultaneous solution can be obtained to arrive at a consistent market clearing equilibrium for the four commodities. In regions where internal prices are not insulated from the world market, domestic prices are linked to their respective U.S. commodity prices—corn, sorghum, barley, wheat, soybean, soymeal and soyoil.

A descriptive econometric approach is employed in the structural specification which imposes few constraints on the parameter estimation. While the functional form of the models is generally linear, fundamental identities and other basic variables, such as relative prices, render the models nonlinear. The models include domestic supply and demand functions for major trading and producing countries and regions. Equilibrium prices, quantities and net trade are determined by equating excess demands and supplies across regions and explicitly linking prices in each region to a world price. Except where they are set by governments, domestic prices are linked to world prices via price linkage equations including bilateral exchange ranges and transfer service margins. Where some degree of insulation of domestic prices from external market conditions exists. the free adjustment of trade flows is restricted. The price linkage equation defines the degree of price transmission of external market conditions into the internal system. Trade occurs whether price transmission is allowed or not. If there is no price transmission, the quantity traded merely adjusts to internal conditions.

Figure 1 illustrates the linkages between the four commodity trade models and the regional and country details of each model. The coarse grains model includes corn, barley and oats, while sorghum is modeled separately. Within this group of coarse grain crops (corn, barley and oats) supply and demand of the one or two most important crops in each country or region have been modeled. Net import demand (export supply) of the endogenous commodities are added (with a weight equal to one) to the exogenous net trade of the minor commodities to find the net imports (exports) for all coarse grains. The market equilibrium identity is defined in terms of the aggregate commodity, coarse grains.

Coarse grains and sorghum are mainly used as feed and therefore this derived demand is of primary importance. While the portion of coarse grains directly consumed for food compared to total usage is small, the proportion of coarse grains utilized for nonfeed uses is large in Africa, and significant and rising in the EC-12 and in the United States. In these areas, coarse grain used as food is determined endogenously in the model.

The coarse grain model includes 20 countries and regions. In all of them, the demand component is endogenous. In countries or regions where production is important, supply has been endogenized, but in countries with very little domestic production, such as Japan, domestic supply is exogenous.

The wheat model is composed of 22 countries and regions. In 16 countries and regions both production and demand functions are estimated.

In the Soviet Union, Eastern Europe and Japan, production is exogenous and domestic demand is endogenized. Other Western Europe and High Income East Asian regions each consist of a net import function. Wheat demand equations are usually specified either as total demand (feed plus food) or as food demand only. However, in those countries or regions where wheat feed use is a significant proportion of total domestic use, such as in the United States, Canada and the EC-12, wheat feed demand is estimated separately.

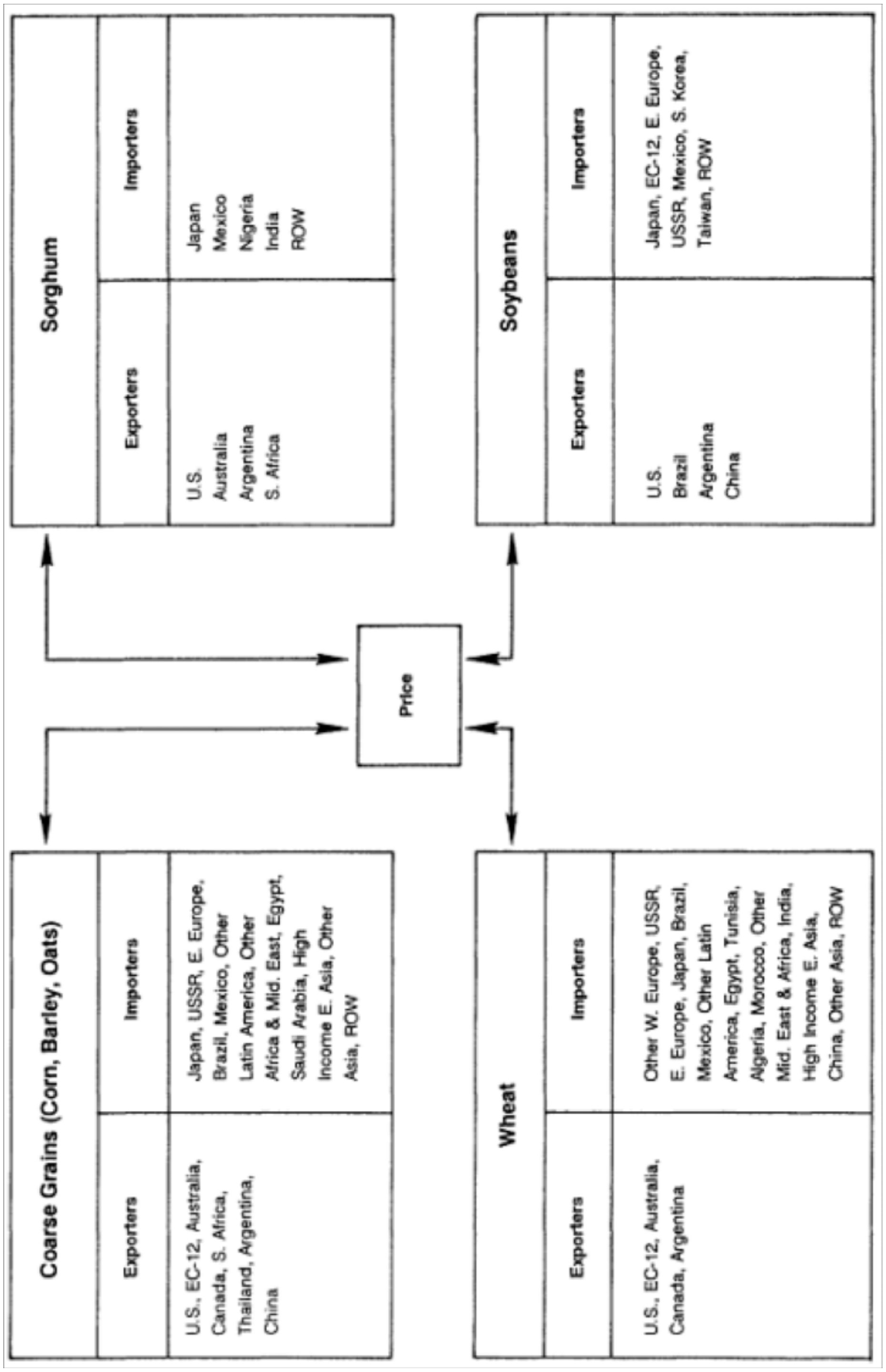

Figure 1
CARD/FAPRI World Agricultural Trade Models (Annual Econometric System)

ASSUMPTIONS

The macroeconomic, policy, and yield growth assumptions used in the projections are external to the models.

Macroeconomic Assumptions

The macroeconomic assumptions for the projection were provided by the WEFA Group (1987). The macroeconomic environment for the next 10-year period (1987/88 to 1996/97) contrasts sharply with that of the early 1980s. Then, low or negative real GDP growth was experienced by many countries. Although still sluggish, the recovery of the world economies from the performance in the early 1980s has a significant impact on the level of demand and trade over the next decade. The growth patterns in the developing market economies are diverse, with some struggling under heavy external debt, and others, like the Asians NICs (Newly Industrialized Countries) experiencing sustained growth.

The projection for world economic growth averages 2.8 percent per annum from 1988 to 1992. Significant price declines, lower interest rates, a cheaper dollar, and lower oil and commodity prices signify ongoing adjustments in the world economy. The debt crisis and high unemployment in individual developing countries remain as potential problems. The outlook is influenced by assumptions about oil and non-oil commodity prices, international debt, exchange rates, and fiscal and monetary policies. The baseline implicitly assumes that the GATT negotiations result in few changes and that protectionist forces are held in check at their historical level of influence.

The projected pattern of economic growth activity in developing market economies is much more fragmented compared to developed economies. Several oil-exporting debtor countries, e.g., Mexico, Venezuela, Nigeria, and Indonesia, continue to stagger under the growing weight of external debt. A reduction in external assets would cushion some of the impact of lower oil prices for the oil exporting countries in the Middle East and Africa, but the bulk of the adjustment is expected to be accomplished through a decline in domestic demand and imports. For the oil importing developing countries, such as the Asian NICs, prospects are good. Lower oil prices, lower global interest rates, and continued expansion of the developed economies combine to boost projected growth above the average for the developing world as a whole.

The debt crisis may worsen somewhat in light of a weaker U.S. and world economic outlook. The renewed debt crisis in Brazil could dampen Latin American growth this year. Continuing structural adjustments in most debtor economies and restrained growth are expected. These economies will reduce investment to repay past debts, making new financial transfers to developed countries.

Pacific Basin. Countries in the Pacific Basin region are expected to have higher economic growth rates in the projection period compared to those of other regions. Projected real GDP growth rate of the Pacific Basin countries is 5.5 percent in 1988 and increases to 6.0 percent in 1992. The higher economic growth rate of Pacific Basin countries is partly due to their expanding export markets. Since this region is a growth market for U.S. exports, higher economic growth rates in this region should have a positive effect on the U.S. exports.

Other Asia and Middle East. The projected real GDP growth rate for this region is around 4 percent in the projection period. Since countries in this region are net importers of food products, their imports heavily depend on their economic growth. In recent years, some parts of this region, e.g., India, were profoundly affected by a severe drought. This year, Bangladesh was hit by severe flooding.

Latin America. The projected real GDP growth rate in Latin America averages 2.5 percent over the projection period. Economic growth in these countries is plagued by the debt crisis. Other debtors may now follow Brazil's example of interest moratoria, delayed reschedulings, reduced flows of bank credits, postponed implementation of structural reforms, and more import and capital controls. This continued adjustment to accommodate the foreign debt is likely to restrain economic growth.

Africa. The projected real GDP growth rate of 2.5 percent in African countries, is the lowest compared to those of other regions in the world. This lower growth rate would limit their purchasing power to import agricultural commodities in the world market.

Farm Policy Assumptions

The Food Security Act of 1985 has reduced world commodity prices and increased trade shares for the United States. The increase in exports were achieved by allowing target prices to decline slowly while lowering loan rates substantially, adopting marketing loan programs for rice and cotton, and conducting aggressive export enhancement programs. It is assumed in this analysis that current programs will prevail and future legislation will continue with the objective of reducing stocks, and remaining competitive in world markets. This implies reductions in support prices and continued use of programs to control production and encourage the utilization of commodities currently in excess supply.

Target prices, for most major commodities, were allowed to decline slowly. For example, in the case of wheat, the target price in 1988/89 was set at $4.23 and was reduced to $3.54 by 1996/97. Similarly, the corn target price was allowed to decline from $2.93 in 1988/89 to $2.44 in 1996/97. The baseline assumes a target price reduction of 2 percent per year during the five years following the end of the current farm legislation.

For all program commodities, we assume that loan rates will be reduced in 1989/90. In 1990/91, however, cotton, rice, and soybean loan rates will not be reduced, because they will have reached the minimum levels permitted by the FSA85. For feed grains and wheat, however, loan rates are set equal to 75 percent of the average market price for the previous 5 marketing years. excluding the years with the highest and lowest prices. A further qualification is that loan rates may not fall more than 5 percent in a given year. Beginning in 1990/92, the 75 percent rule begins to take effect for wheat, barley, and oats. and loan rates for these commodities increase from 1989/1990 levels.

The conservation reserve program is assumed to reach its maximum of 45 million acres by 1990/91. The annual acreage reduction program is gradually reduced over time and the paid diversion is eliminated as CRP expands and market prices begin to increase.

A large proportion of U.S. grain exports is under one or more of a variety of government programs, including PL-480, various loan programs, and the Export Enhancement Program (EEP). The EEP is a new program created by the FSA85 that has played a major role in expanding U.S. wheat and barley exports. Under the EEP, exporters receive generic certificates equal in value to the difference between export prices and the accepted bid prices of countries qualified to buy EEP grain. We assume that the EEP and other export programs will be phased out by 1990. As market prices increase and government stocks decline, there is less incentive to utilize export subsidies.

It is assumed that the European Community will increase its intervention price only slightly over the next decade due to a strain on the European Agricultural Guidance and Guarantee fund. The initial prices paid by the Canadian Wheat Board to Canadian farmers are assumed to decline because of the lower world market prices.

Yield Assumptions

Production in the forecast period depends on acreage projections and yield assumptions. In most of the countries acreage is endogenously projected; however, yield growth is assumed to be exogenous. More specifically, when yield is not endogenously estimated a trend growth rate is assumed.

COMMODITY MARKET PROJECTIONS

The baseline projection (Table 1) was prepared before the onset of the 1988 U.S. drought. The drought will reduce 1988 crop production and increase market prices above baseline levels. Stocks will be reduced more quickly and 1989 planted area will be higher in response to higher prices and reduced U.S. government acreage reduction programs. Most impacts of the drought will have played themselves out by the early 1990s. This study focuses primarily on the 1990-1996 period. That is, most results of this analysis are not substantially affected by the drought (Westhoff et al. 1988).

Real prices of wheat, maize, and soybeans are expected to remain constant or decline over the period 1989/90-1995/96 (Table 1 and Figure 2). In particular, the real price of maize remains nearly constant, wheat prices decline by 5 percent and soybean prices by more than 8 percent over the period. Thus, the historical pattern of declining real prices for these commodities continues, but at a somewhat slower rate than during the last decade.

From 1989 to 1995 world wheat production increases by 12.5 percent, feed grain production by 13.7 percent, and soybean production by 12.5 percent. Consumption is projected to grow at a slightly lower pace except for soybeans, and ending stocks are projected to remain stable or increase. The increase in carryover stocks from 1989 to 1995 still leaves inventories well below the high levels that existed in 1986/87. In fact, the stock-to-use ratios for wheat, coarse grains, and soybeans are projected to be 0.25, 0.24, and 0.15 in 1995/96 compared to 0.34, 0.33, and 0.20 in 1986/87, respectively (Table 1 and Figure 3).

Trade for grains and soybeans increases more rapidly than production and consumption. The patterns of change in net imports and net exports indicate that demand growth continues to outpace supply growth in developing and centrally planned economies and that production growth continues to exceed demand growth in the industrial countries (Table 1 and Figures 4 and 5). This pattern has been evident for more than a decade and raises concerns about the foreign exchange costs of the projected imports of developing countries. Using U.S. Gulf port prices, the import cost of wheat, coarse grains, and soybeans to developing countries in 1988 dollars is projected to increase from $9 billion in 1986/87 to $15 billion in 1995/96. The trade picture for soymeal is different. Argentina and Brazil are projected to export an increased quantity and value of soybean meal to the industrial and centrally planned economies.

The supply, demand and prices in the evaluation period indicate a return to more stable commodity market conditions after the extraordinary market boom that occurred in the mid-1970s and the equally traumatic decline of the first half of the 1980s. Much of the explanation for this boom and bust cycle lies in the macroeconomic factors external to agriculture. However, the explanation also rests with agricultural policies and productivity changes. Johnson, et al. (1988) recently evaluated the sensitivity of these projections to alternatives for the macroeconomy, productivity growth, and potential policy changes that could occur over the next decade.

TABLE 1 Baseline Projections of Wheat and Coarse Grains and Soybean Supply, Use, Trade, and Prices

	Actual		Projected					
	1986/87	1989/90	90/91	91/92	92/93	93/94	94/95	95/96
Nominal Prices ($/mt)								
Wheat [1]	109	134	137	138	138	139	144	150
Maize [2]	74	90	91	94	99	98	100	105
Soybeans [3]	193	211	204	233	215	232	224	228
Real Prices (1988$/mt)								
Wheat [1]	117	131	129	128	124	122	123	124
Maize [2]	79	87	87	87	89	86	85	87
Soybeans [3]	207	205	194	215	194	204	191	188
Wheat (mil. mt.)								
World Production	529	535	548	560	572	583	591	602
World Consumption	521	536	549	561	572	582	592	602
World Ending Stocks	176	150	149	149	149	149	149	149
Net Exports								
Industrial	72	79	81	83	85	86	87	89
Developing	-53	-61	-62	-64	-66	-68	-70	-71
CPE (excl. China)	-18	-18	-19	-19	-19	-18	-17	-17
Coarse Grains (mil. mt.)[4]								
World Production	752	748	767	792	805	825	838	851
World Consumption	724	764	776	791	802	817	831	845
World Ending Stocks	236	182	173	174	177	186	193	199
Net Exports								
Industrial	41	46	48	51	53	56	59	62
Developing	-27	-31	-32	-34	-37	-38	-42	-43
CPE (excl. China)	-14	-15	-16	-17	-17	-18	-18	-19
Soybeans (mil. mt.)								
World Production	98	112	113	114	119	120	124	126
World Consumption	101	110	112	115	118	120	123	126
World Ending Stocks	20	18	19	18	19	19	19	19
Net Exports								
Industrial	1.6	2.6	2.9	3.4	3.6	4.1	4.5	5.0
Developing	0.3	0.3	0.1	-0.4	-0.6	-1.1	-1.4	-1.9
CPE (excl. China)	-1.9	-2.9	-3.0	-3.0	-3.0	-3.1	-3.1	-3.1
Soymeal Net Exports (mil. mt.)								
Industrial	-2.1	-3.4	-3.6	-3.7	-3.7	-3.8	-3.9	-3.9
Developing	8.6	10.6	11.1	11.4	11.7	12.2	12.5	12.8
CPE (excl. China)	-6.5	-7.2	-7.5	-7.7	-8.0	-8.4	-8.6	-8.9

[1] Wheat - FOB Gulf #2 H.W. 13%
[2] Corn - FOB Gulf #3 Yellow
[3] Soybeans - FOB Gulf #2 Yellow
[4] Maize, Sorghum, Barley and Oats

DETAILED REGIONAL IMPLICATIONS

In this section, we discuss the results of projecting grain production, consumption, and import requirements of four major regions from 1987/88 to 1996/97. These regions include Africa and Middle East, Latin America, Asia, and Centrally Planned Economies.

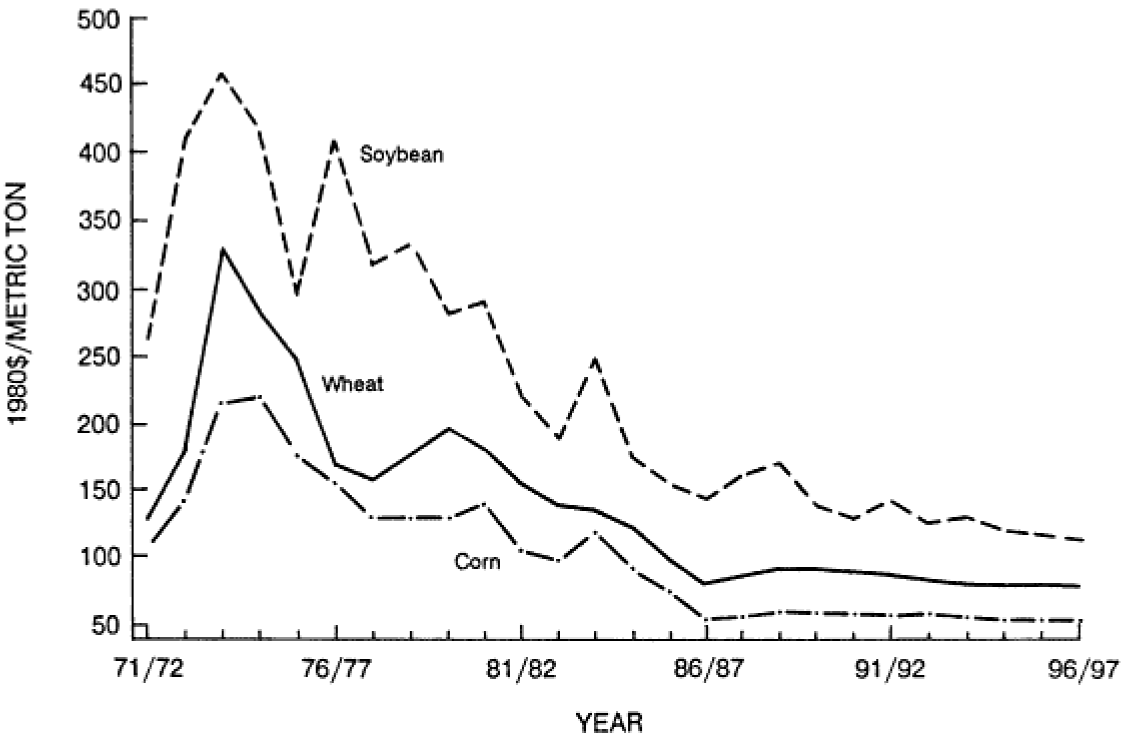

Figure 2
Real U.S. Gulf Port Prices

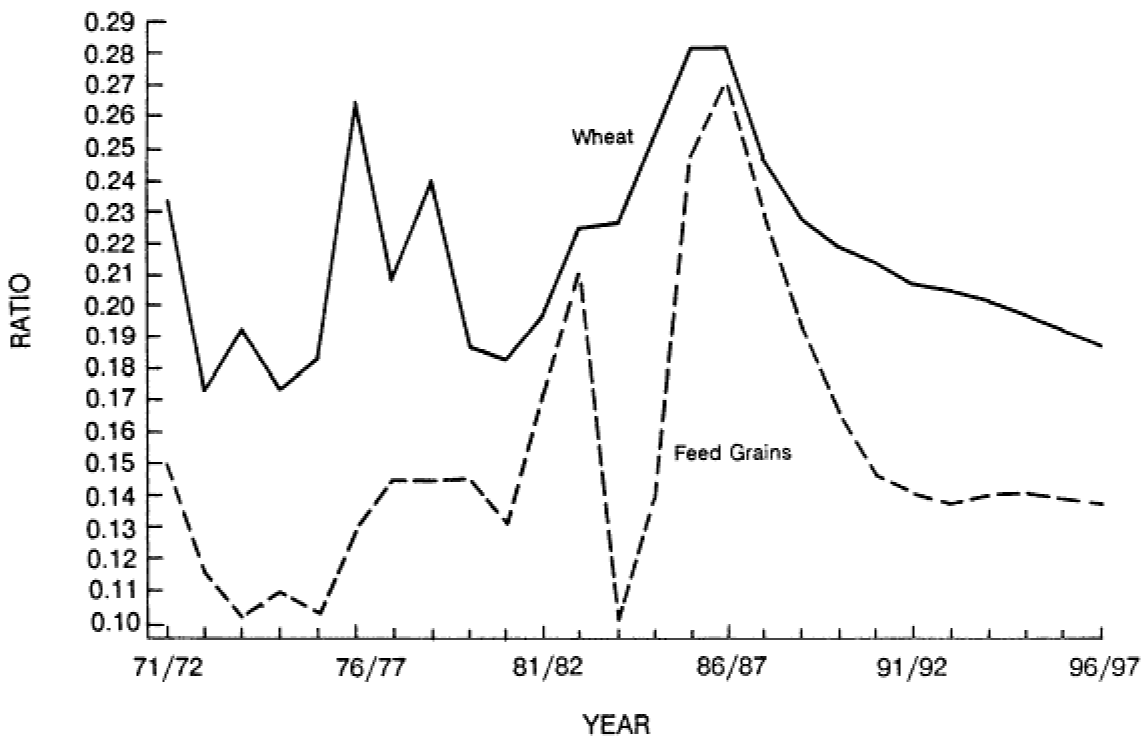

Figure 3
World Stocks to Use Ratio

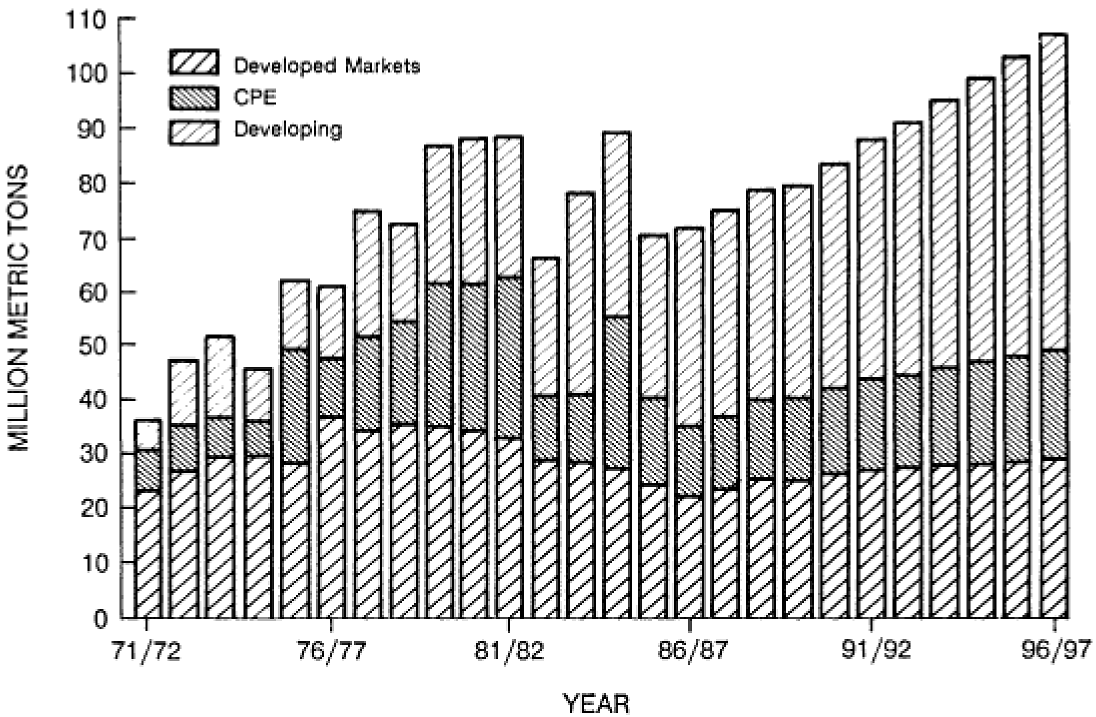

Figure 4
Net Importers: Coarse Grain Imports

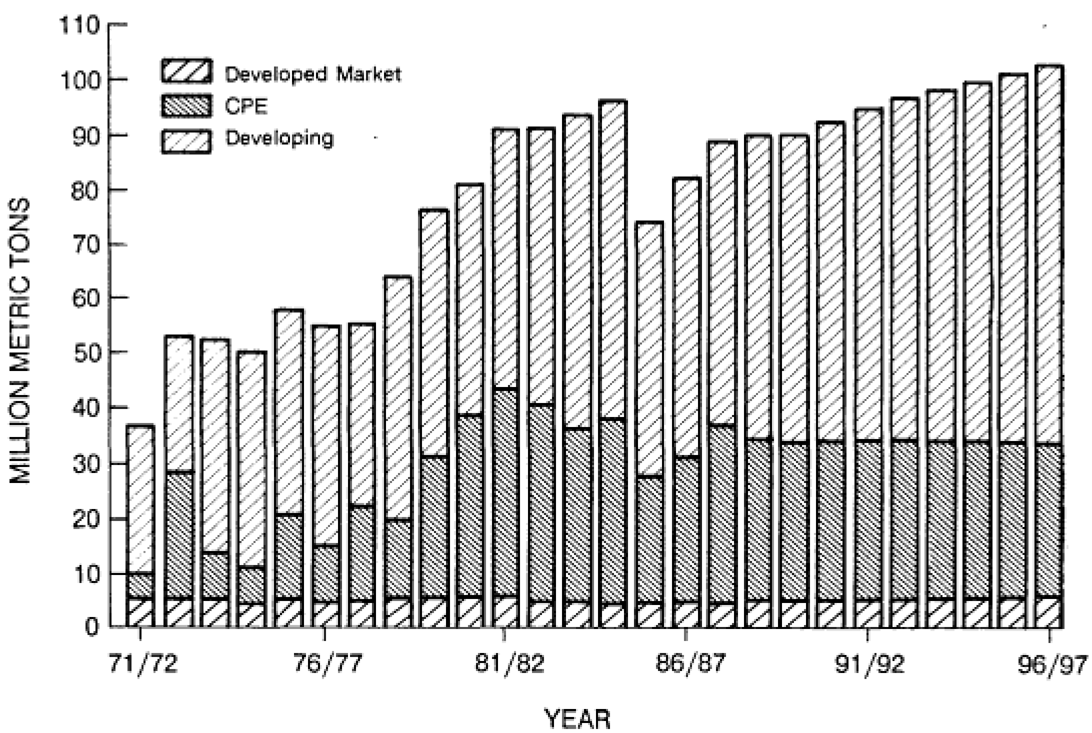

Figure 5
Net Importers: Wheat Imports

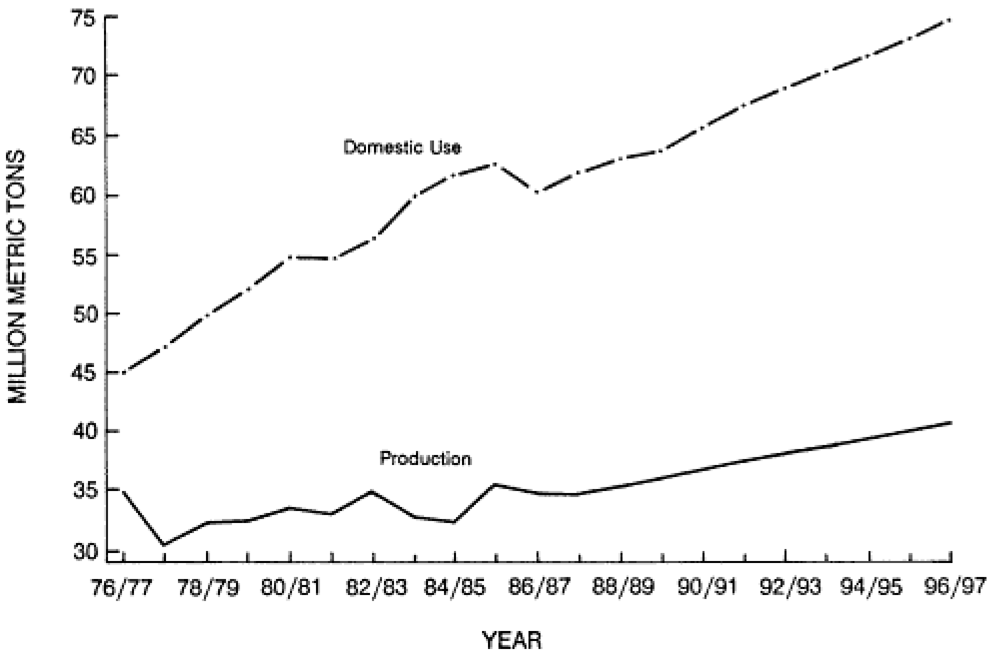

Figure 6
Africa and Middle East Wheat

Africa and Middle East

African and Middle Eastern countries' imports of wheat are projected to increase from 27.7 million metric tons in 1987/88 to 34.5 million metric tons in 1996/97. This increasing trend is due to the widening gap between domestic use and production levels over the projection period (Figure 6). Production grows only at an average annual rate of 1.5 percent, whereas the domestic use grows at a much faster rate of 1.9 percent, resulting in increased import needs in the next decade by the countries in this region. A similar projection for coarse grains shows that imports increase from 11.5 million metric tons in 1987/88 to 17.1 million metric tons in 1996/97 (Figure 7). As in the case of wheat, the domestic use growth rate is projected to increase at a faster pace than that of production. The increase in domestic use of wheat and coarse grains can be attributed to the projected rise in population throughout the region and income growth rates in certain countries. The projected real GDP growth rate of 3.0 percent over the next decade is significantly higher than the -0.06 percent over the previous decade.

In most of the countries in this region, domestic production does not meet the growing demand. For example, countries in the Middle East do not have suitable agronomic conditions to produce enough food to meet the increased demand generated by population and income growth. In many Middle Eastern countries the contribution of the agricultural sector to GNP is very small.

In most of the African countries, however, agriculture contributes at least 50 percent of the GNP. Governments in many of these countries tend to subsidize consumption but tax the agriculture sector and food production. Moreover, projected population growth rates in this region exceed food production growth rates. Also, the economies in many of these countries are plagued by foreign debt problems. Agriculture is generally characterized by declining per capita income, slow or no increase in per capita food production, recurrent droughts, and unmanageable debt. Therefore, most of the African countries are likely to rely on foreign food aid and development assistance in the near future.

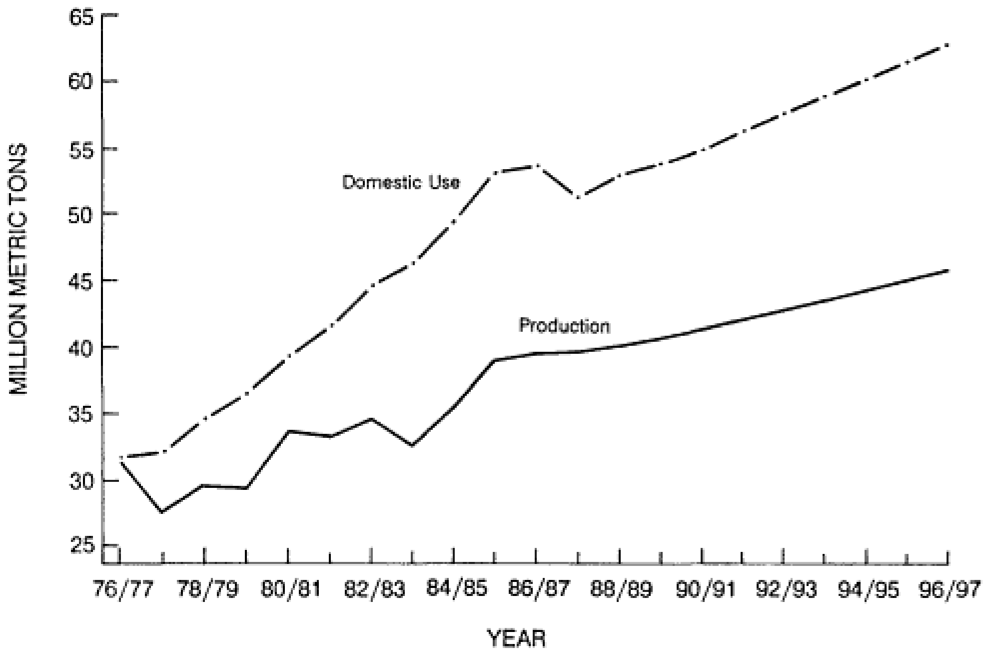

Figure 7
Africa and Middle East Coarse Grains

One of the countries studied more closely in this region is Egypt. because of its growing import demand. For two decades, Egypt has not been self-sufficient in food production and currently imports about half of the food requirement to meet the growing demand of its rapidly rising population of more than 50 million people. As shown in Figures 8 and 9, wheat and corn production is virtually stagnant, whereas the combined domestic use of these commodities increases from 14.0 million metric tons to 15.4 million metric tons from 1987/88 to 1996/98, resulting in an increase of 2.1 million metric tons of imports over the same period.

Countries like Algeria and Morocco are expected to make little progress in their grain production, but face significant demand growth, which would make them more dependent on the world market for their imports. As indicated in Figure 10, four North African countries (Egypt, Algeria, Tunisia, and Morocco) are expected to expand their wheat imports by an additional 2 million metric tons by 1996/97.

Expansion of the livestock industry coupled with import subsidies have made Saudi Arabia one of the world's largest importers of barley. Saudi Arabia increased its barley imports from less than 0.1 million metric tons in 1976/77 to 8.6 million metric tons in 1986/87 (Figure 11). Future imports are expected to remain high with relatively little growth.

Latin America

Production and domestic use of wheat and coarse grains of Latin American countries, excluding Argentina, are shown in Figures 12 and 13. Since Argentina is a net exporter of wheat and coarse grains, inclusion of Argentina would mislead one to conclude that countries in this region do not rely heavily on imports of these commodities. It is evident

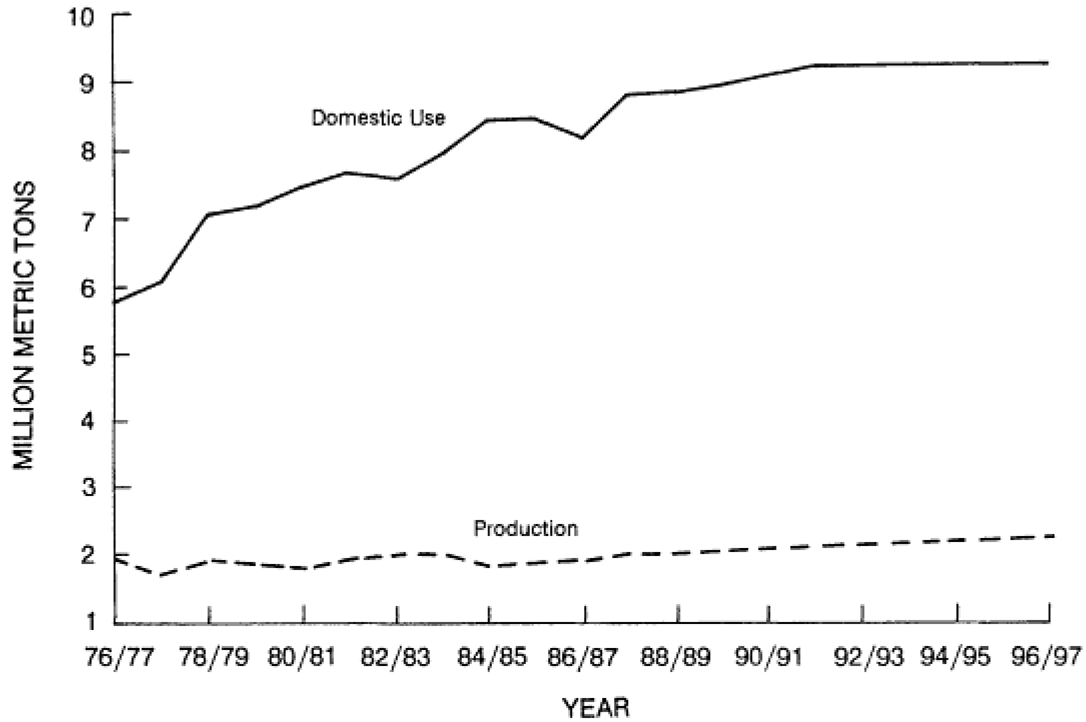

Figure 8
Egypt Wheat

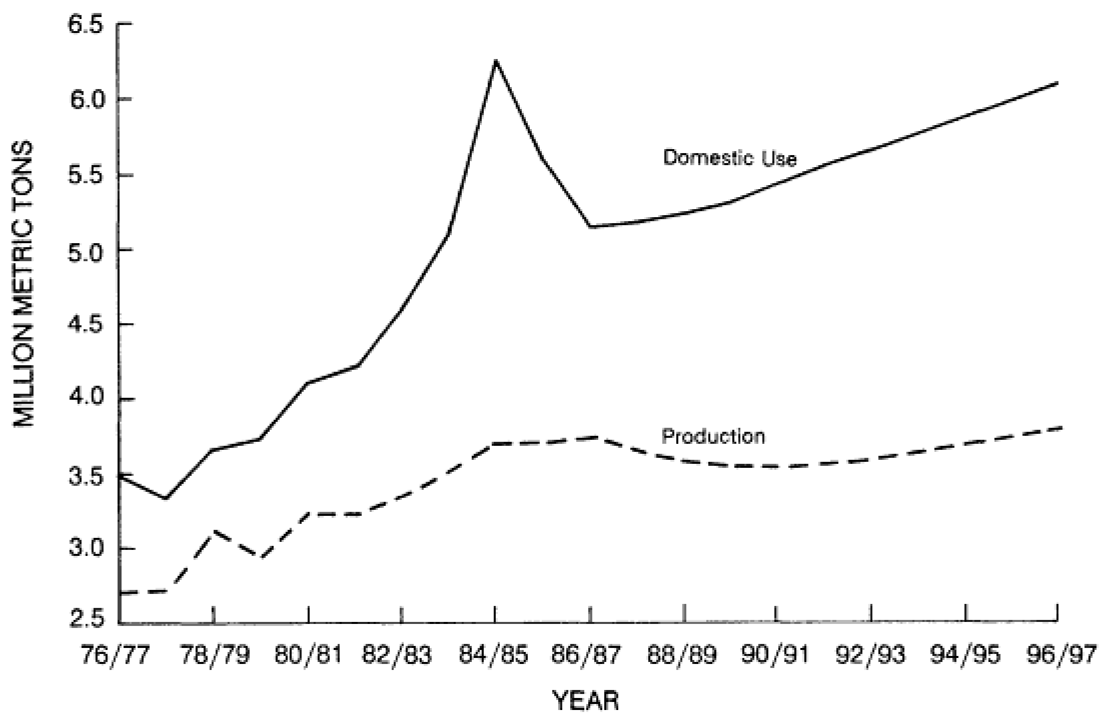

Figure 9
Egypt Corn

that an increasing need for imports by countries in this region is expected. Net imports of wheat in 1987/88 were 8.4 million metric tons and are projected to increase to 11.2 million metric tons by 1996/97, an increase of 2.8 million metric tons. Coarse grains imports over the same period are expected to go up by 2.9 million metric tons. In both wheat and coarse grains, growth in domestic use exceeds production growth.

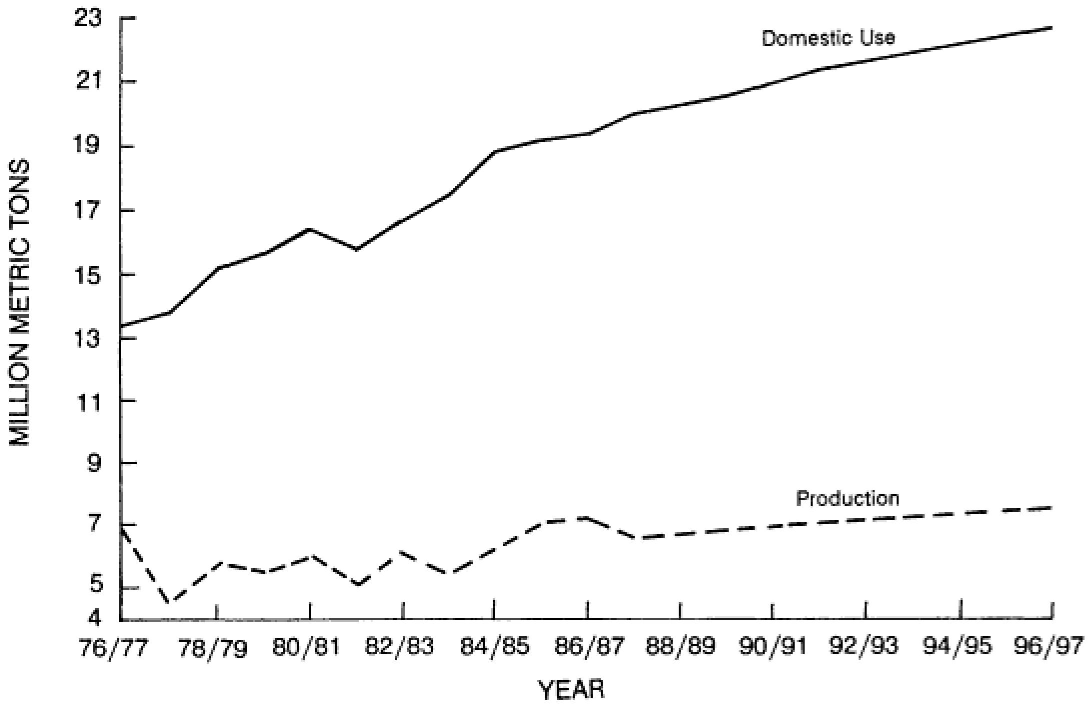

Figure 10
Egypt, Algeria, Tunisia and Morocco Wheat

Even though the projected average income of $1997 per capita for the countries in this region is higher than in many developing countries, economic growth in many of the countries in this region is slowed by high inflation rates, large foreign debt, foreign exchange shortages and unstable economic and political conditions. Foreign exchange deficits could severely restrict imports of agricultural commodities.

Brazil's production and domestic use of wheat and coarse grains are presented in Figures 14 and 15, respectively. In 1987/88 Brazil imported only 2.2 million metric tons of wheat and 2 million metric tons of coarse grains. However, its imports over the next decade are projected to grow significantly, reaching 4.5 million metric tons of wheat and 4.7 million metric tons of coarse grains in 1996/97. Brazil's economic growth has increased in recent years, but foreign debt remains a major obstacle to its continued economic growth. Brazil owes $108 billion in foreign debt, about half of its GDP. Brazil is an exporter of agricultural products and relies heavily on its agricultural export revenues for its foreign exchange.

Mexico's production and domestic use of wheat and coarse grains are presented in Figures 16 and 17. Mexico is only a small importer of wheat as it is expected to produce enough wheat to keep pace with demand growth. However, Mexico is a moderate importer of coarse grains. It is projected that Mexico will import an average of 1.8 million metric tons per year over the next decade. Mexico like many other Latin American countries is plagued by foreign debt problems, unstable economic conditions, and an uneven income

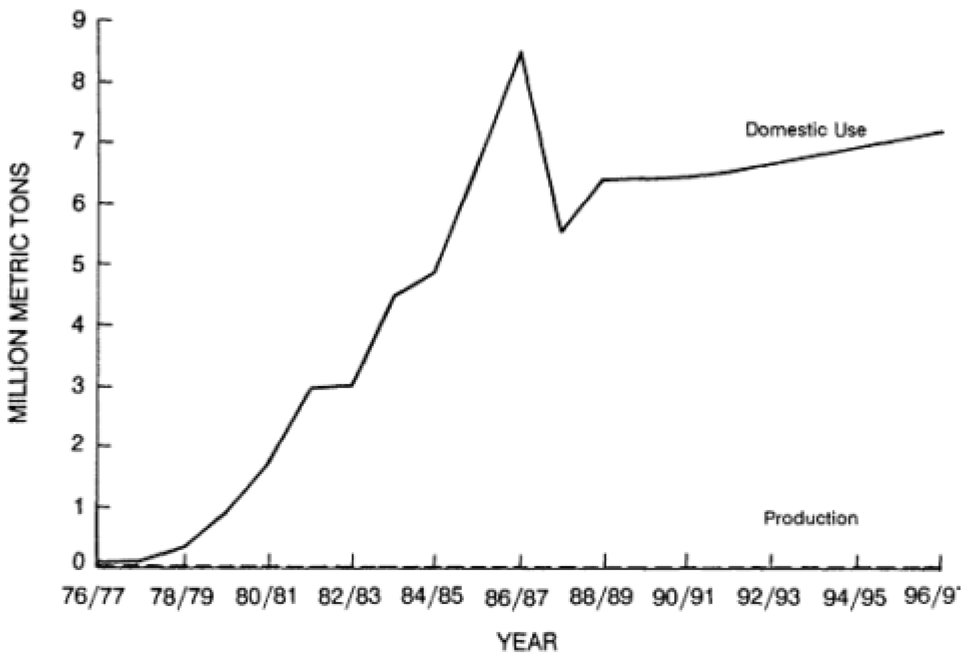

Figure 11
Saudi Arabia Barley

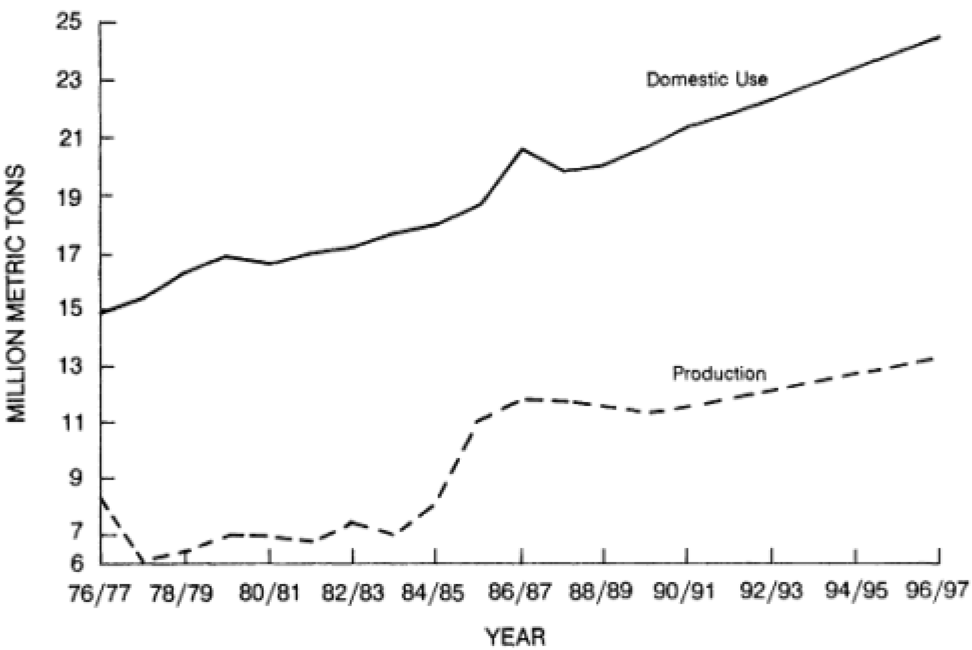

Figure 12
Latin America Excluding Argentina Wheat

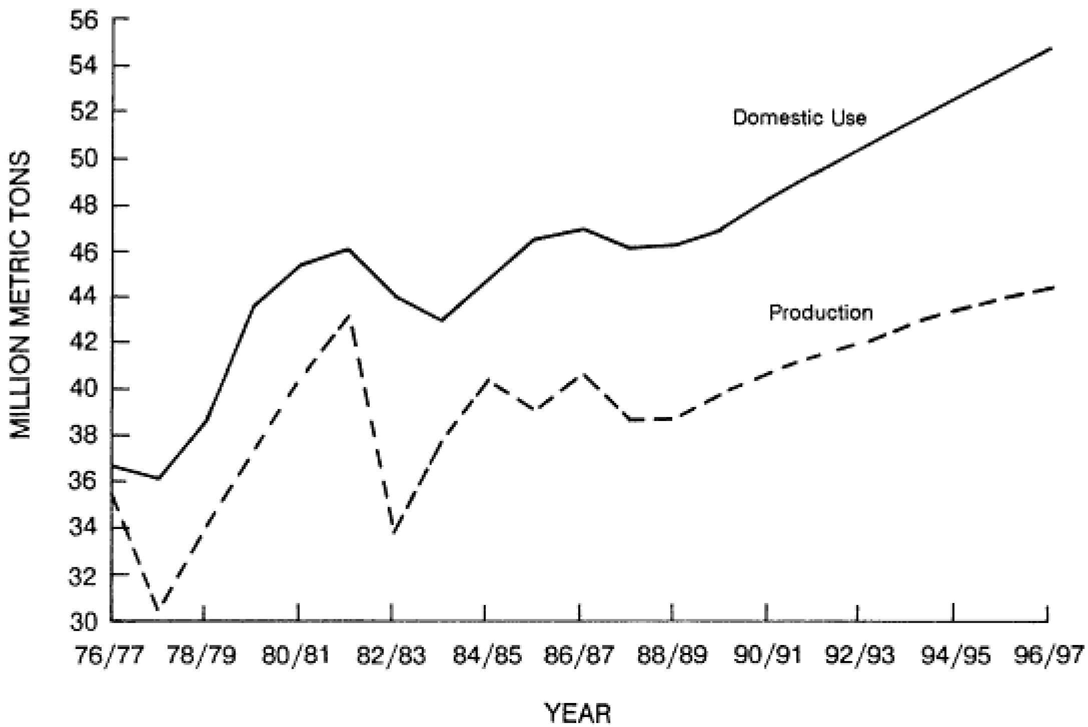

Figure 13
Latin America Excluding Argentina Coarse Grains

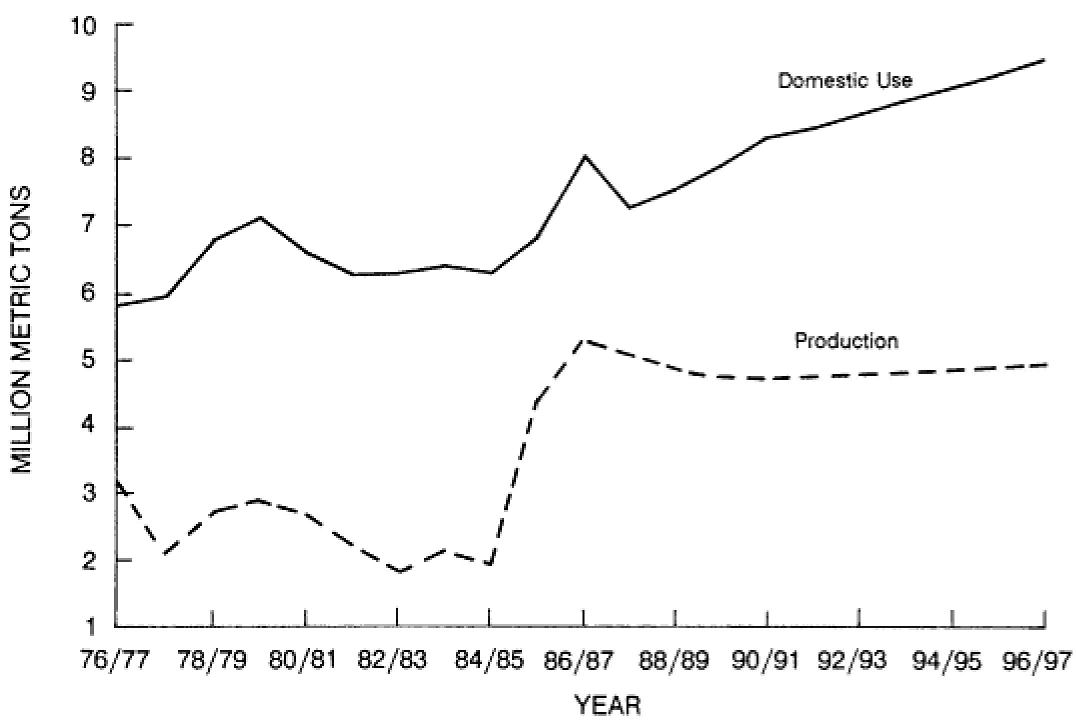

Figure 14
Brazil Wheat

distribution. Furthermore, its economic growth is closely tied to oil prices, since Mexico is a oil exporter. Mexico's imports are likely to vary because its foreign exchange earnings depend heavily on the oil price and its repayment of the foreign debt.

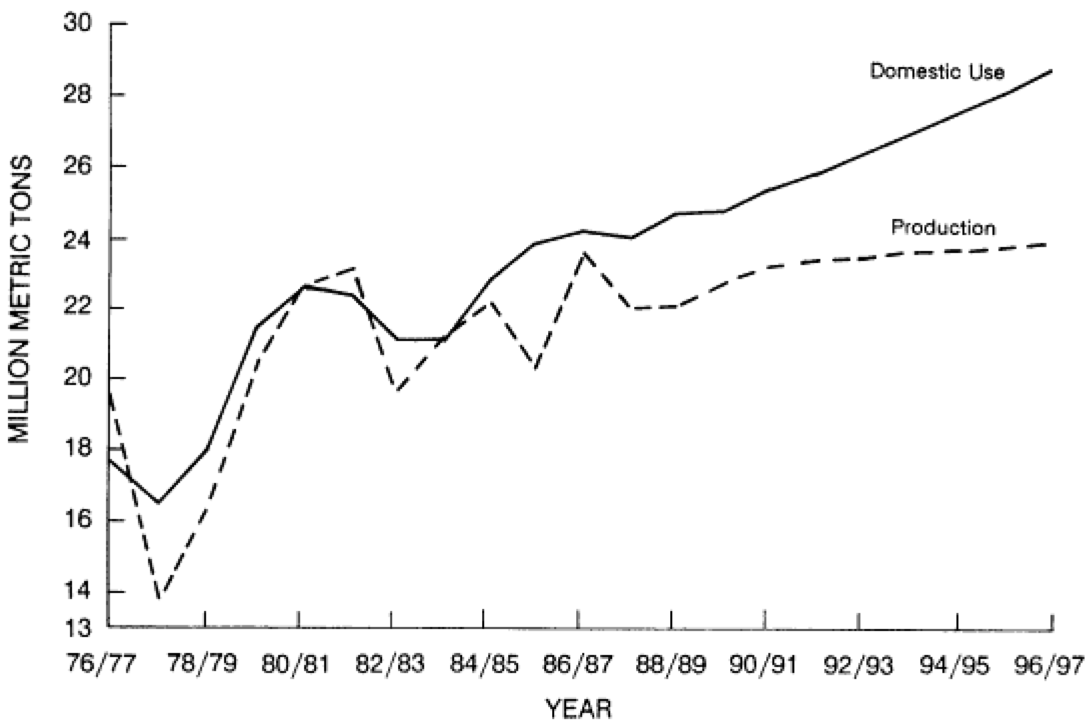

Figure 15
Brazil Coarse Grains

Asia

The production and domestic use of coarse grains and wheat of all Asian countries are shown in Figures 18 and 19. The coarse grain imports of this region in the last decade averaged 5 million metric tons per year, but are projected to increase to an average of 12.2 million metric tons per year over the next decade. The average wheat imports corresponding to these two periods are 21.5 and 27.5 million metric tons, respectively. Clearly, the projected increase in imports by the countries in this region is due to faster growth in consumption than in production. The faster consumption growth is attributed to the projected increases in population in countries such as India, Pakistan, and Bangladesh, and rising per capita income in East Asian countries such as South Korea, Taiwan, and Hong Kong.

For both wheat and coarse grains, countries in High Income East Asia (South Korea, Taiwan, Hong Kong, and Singapore) show strong import demand (Figures 20 and 21). Countries in this region made a significant advancement in the manufacturing sector and experienced high economic growth over the last decade. They are able to earn foreign exchange by exporting industrial goods. It is assumed that these countries will continue their economic progress in the next decade. Recently, these countries have also expanded their livestock sectors, which made them more dependent on imports of coarse grains. Thus, countries in this region are increasingly becoming high growth markets for these grains.

China and Thailand are both expected to continue to export corn. Therefore, the production and domestic use projection for this region, excluding China and Thailand, is a better indicator of the growing need for coarse grains imports (Figure 22). Furthermore, the High Income East Asian (HIEA) countries would not have significant foreign exchange constraints, so they are excluded. The average annual imports of coarse grains by the remaining Asian countries over the last three years were nearly 2.0 million metric tons, and are projected to more than double over the next ten years.

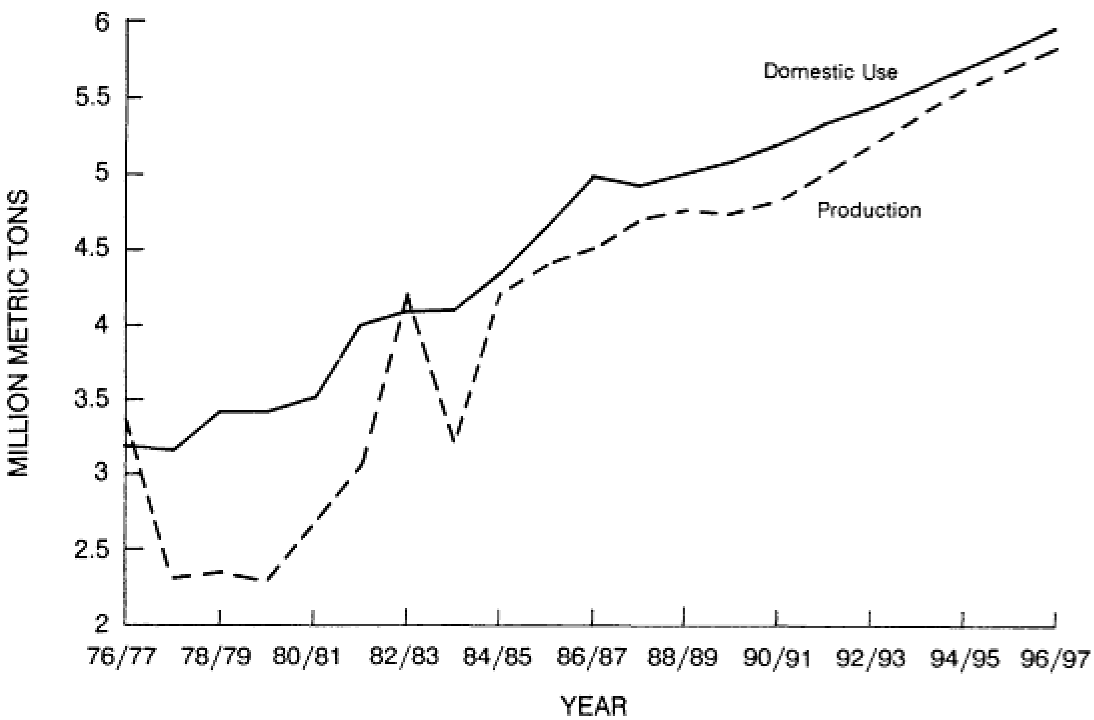

Figure 16
Mexico Wheat

In the case of wheat, India is expected to remain approximately self-sufficient and the HIEA countries will not have difficulty paying for imports. As shown in Figure 23, wheat imports by other countries in this region, excluding India and HIEA are projected to increase slowly.

Centrally Planned Economies

This region includes the Soviet Union and Eastern Europe. Imports by these countries over the last ten years show a high degree of fluctuation because they are primarily determined by centralized political decisions and production variability.

Countries in this region are expected to continue to be major importers of wheat and coarse grains (Figures 24 and 25). Unfavorable climatic conditions, inefficient input use, and little technological innovation in the past have made these countries more dependent on the world market. Moreover, these countries' economic policies have favored development in the industrial sector over the agricultural sector. However, both production and domestic use of wheat and coarse grains are projected to increase over the next ten years with annual imports averaging 20.2 million metric tons of wheat and 18.7 million metric tons of coarse grains.

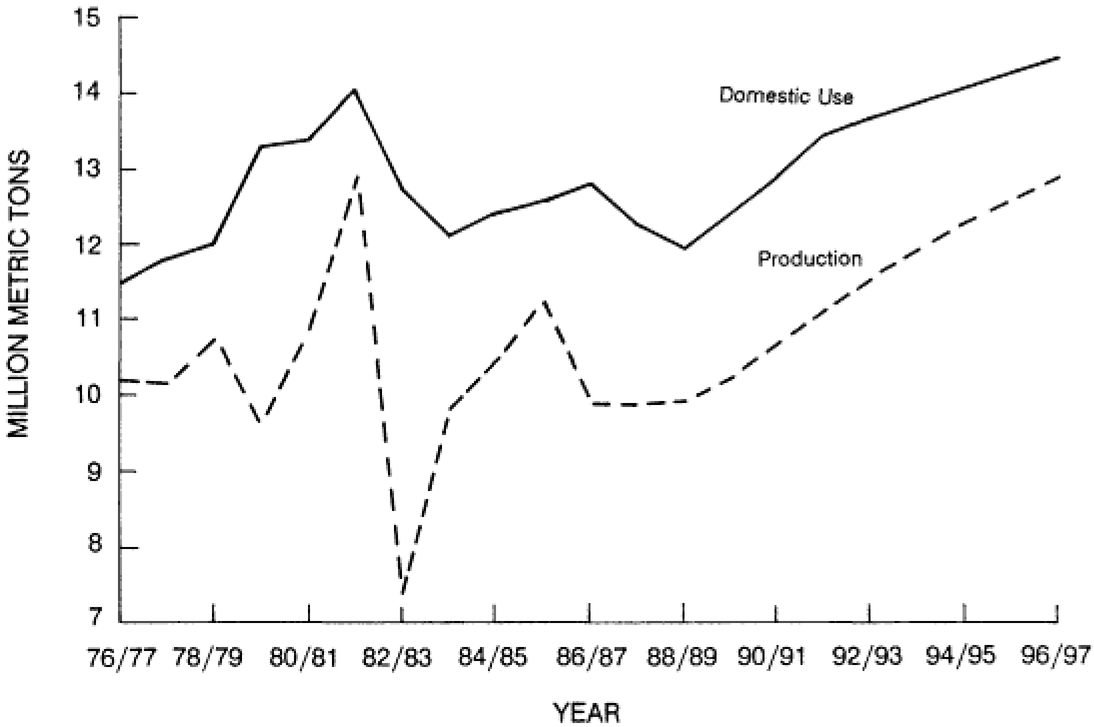

Figure 17
Mexico Coarse Grains

CONCLUSIONS AND IMPLICATIONS

The implications of these projections are summarized by looking at per capita income, production, consumption, and net imports of the major developing regions of the world. Per capita income growth rates for the Latin American and Asian regions are slightly lower than those experienced in the last decade. In Africa and the Middle East per capita income is still projected to decline but at a much slower rate than occurred during the last decade. Overall, the general economic picture for the world is projected to be significantly more favorable than the past five years but not as robust as in the 1970s. Thus, the ten year historical averages mask the sharp economic downturn that occurred in the early 1980s and the more recent improvement in economic performance that occurred in the mid-1980s.

While the improved economic conditions are encouraging, the fact remains that in many developing countries production growth cannot keep pace with the growth in demand resulting from both population and income increases. This leads to increased import demand for both wheat and coarse grains in most developing regions. Some of the strong growth markets, such as High Income East Asia, can cover the increasing cost of grain imports with increasing revenues from export sales. However, many other countries and regions in the developing world have heavy debt service problems and foreign exchange constraints that inhibit their ability to substantially increase the imports of grains. Thus, the rate of production and import growth in these projections is not sufficient to maintain current per capita consumption levels.

While grain prices are stable or declining in real U.S. dollars, the cost to the importers will also depend heavily on whether local currencies appreciate or depreciate relative to the U.S. dollar. The same countries which have a shortage of foreign exchange and heavy

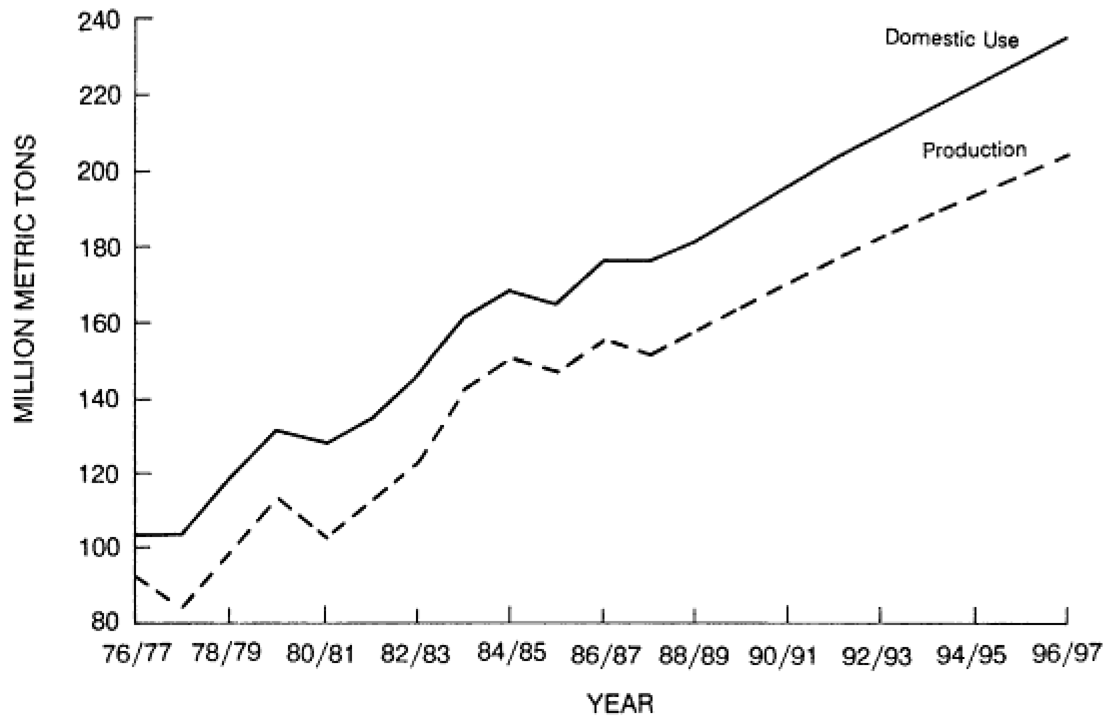

Figure 18
Asia Wheat

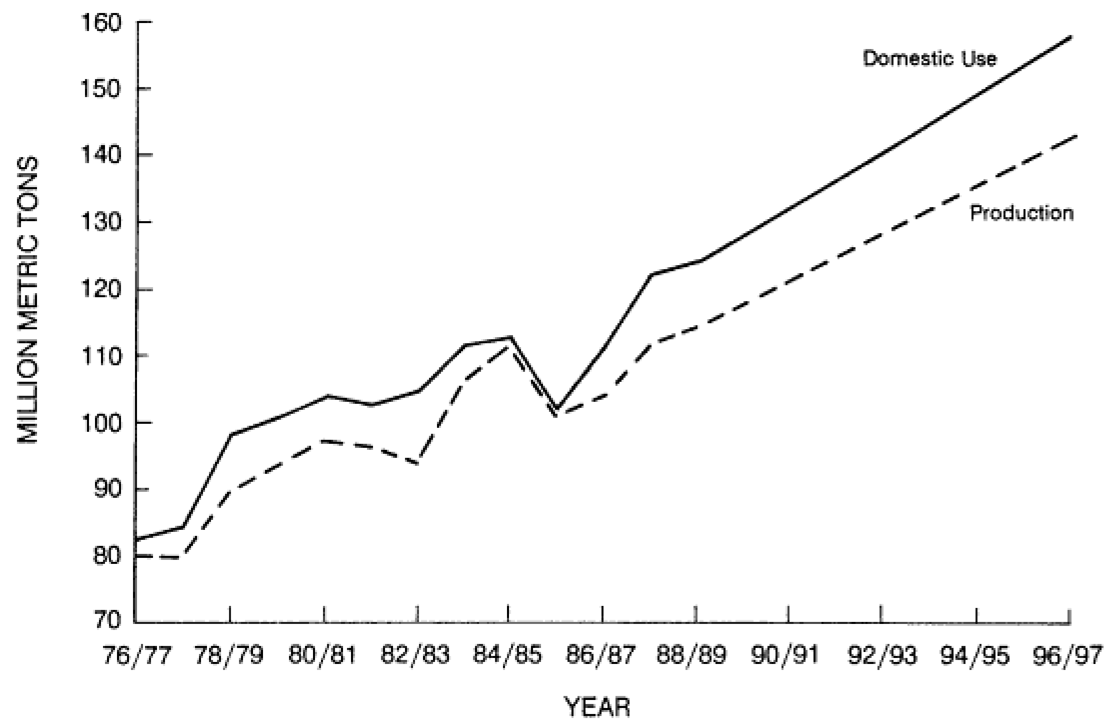

Figure 19
Asia Coarse Grains

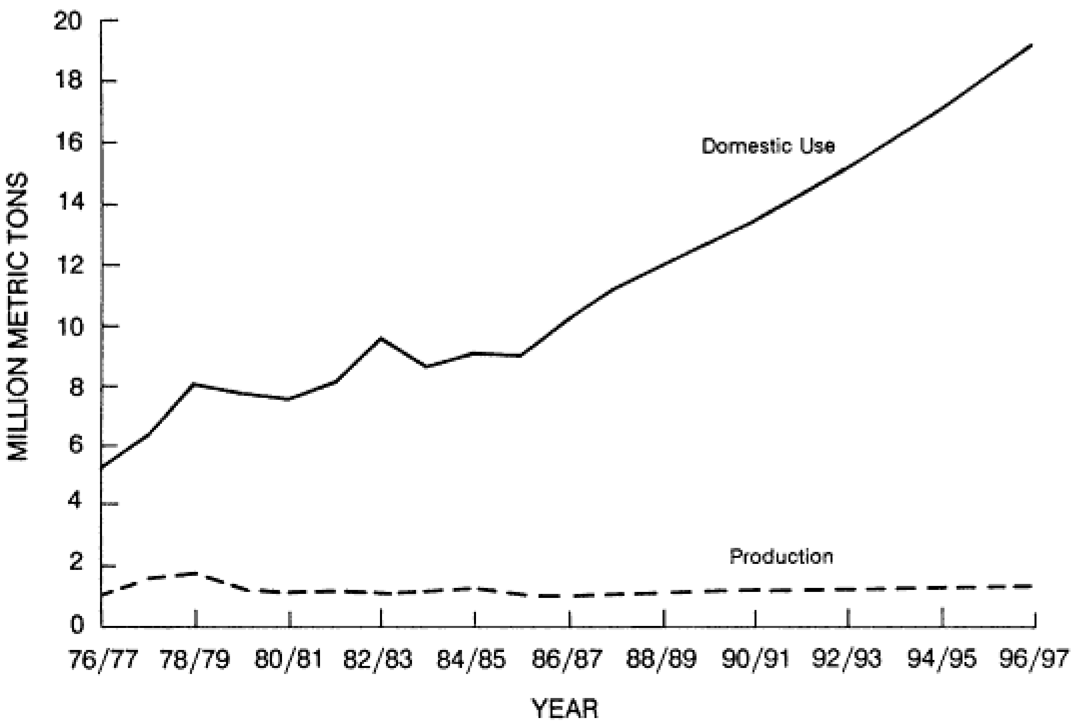

Figure 20
High Income East Asia Coarse Grains

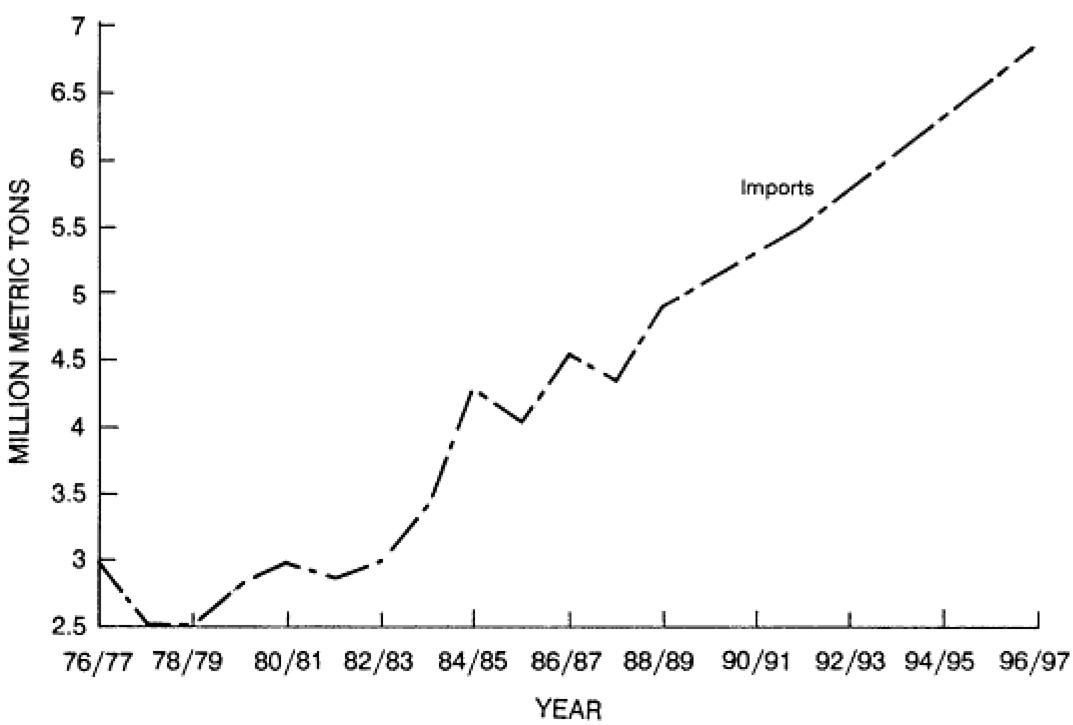

Figure 21
High Income East Asia Wheat

debt service obligations are the ones whose currencies are likely to depreciate relative to the dollar, causing the import costs of these commodities to increase.

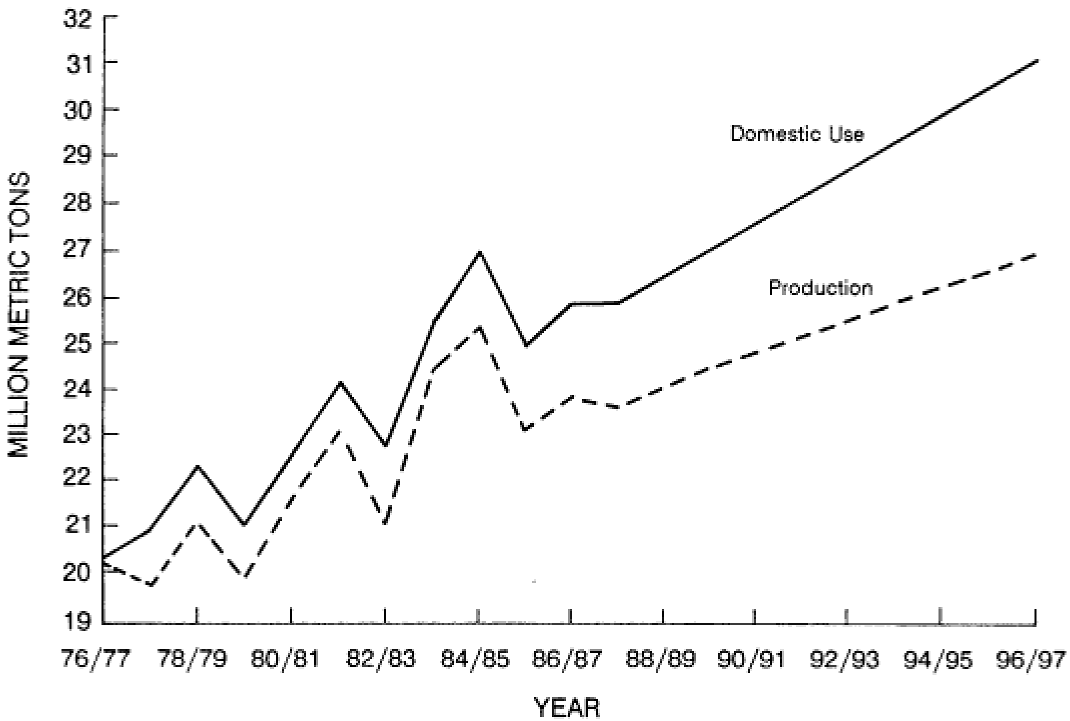

Figure 22
Asia less China, Thailand, and HIEA Coarse Grains

Our analysis suggests that the region under the greatest pressure in terms of potential reductions in per capita consumption is Africa and the Middle East. Second to this region is the Latin American region excluding Argentina. The Asian region is expected to perform better, because production growth is expected to keep pace with or be slightly ahead of the population growth rate. A major reason for the declining per capita consumption in the other regions is that per capita production is declining. Although imports are increasing in all developing regions, these increases are not sufficient to offset the slower rates of growth in production.

Measures to improve productivity growth in these regions would be the most desirable solution to these problems. A recent analysis by Johnson, et al. (1988) indicated that improved rates of yield growth globally would benefit the developing regions by reducing world market prices, increasing developing country production and reducing their net imports.

Another important measure is the resolution of the Third World debt problem. The debt service burden is one of the constraints to import demand in developing countries. A resolution of the debt problem or other measures that would increase the rate of economic growth in developing countries would be expected to stimulate more import demand for grains and lead to higher levels of trade.

Food assistance programs are recognized as being a short term or stop gap measure rather than a solution to stagnant or declining per capita consumption levels. Targeted export subsidies can have a similar effect, provided that the targeting is based on human need rather than on geopolitical or policy strategy considerations.

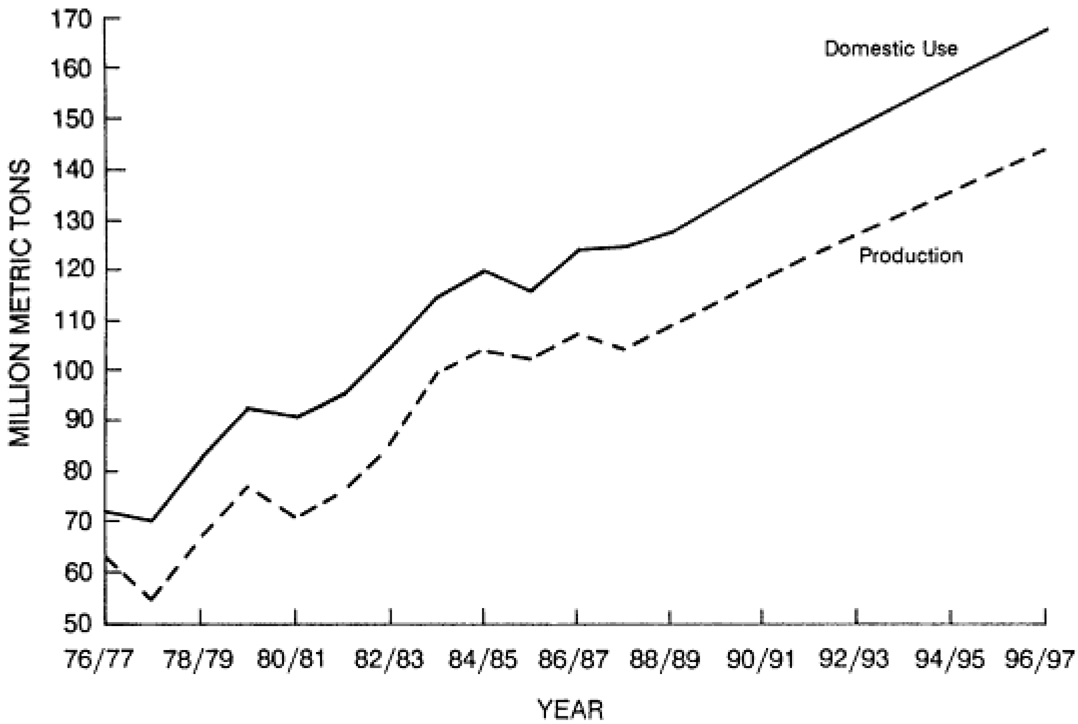

Figure 23
Asia less HIEA and India Wheat

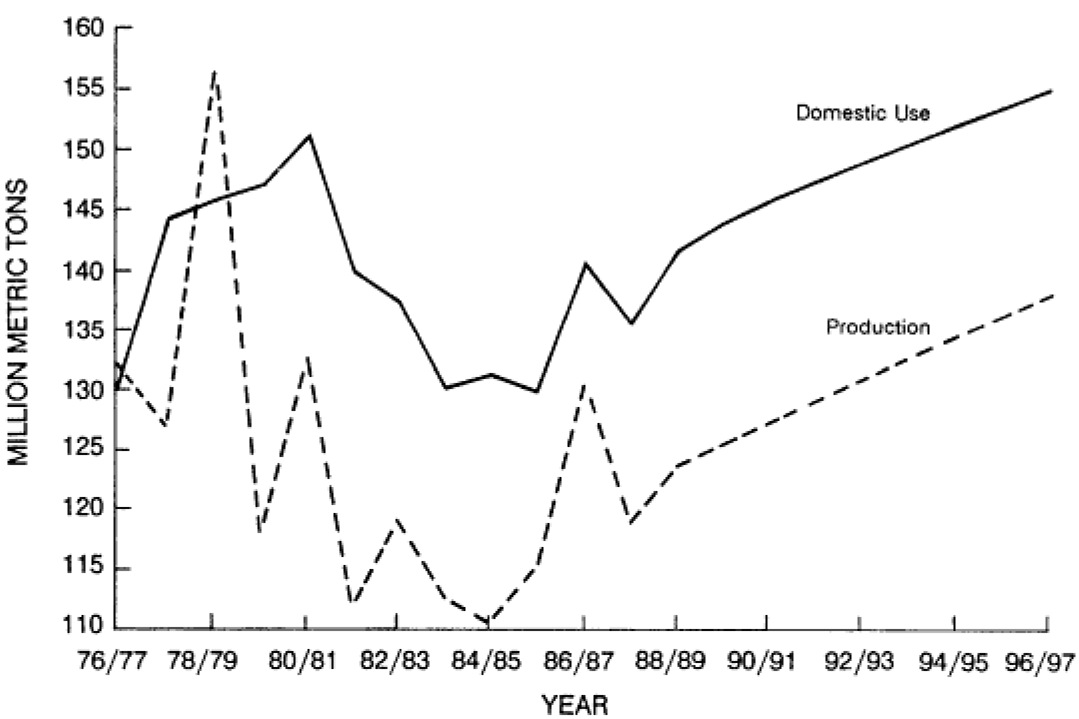

Figure 24
Centrally Planned Economies Wheat

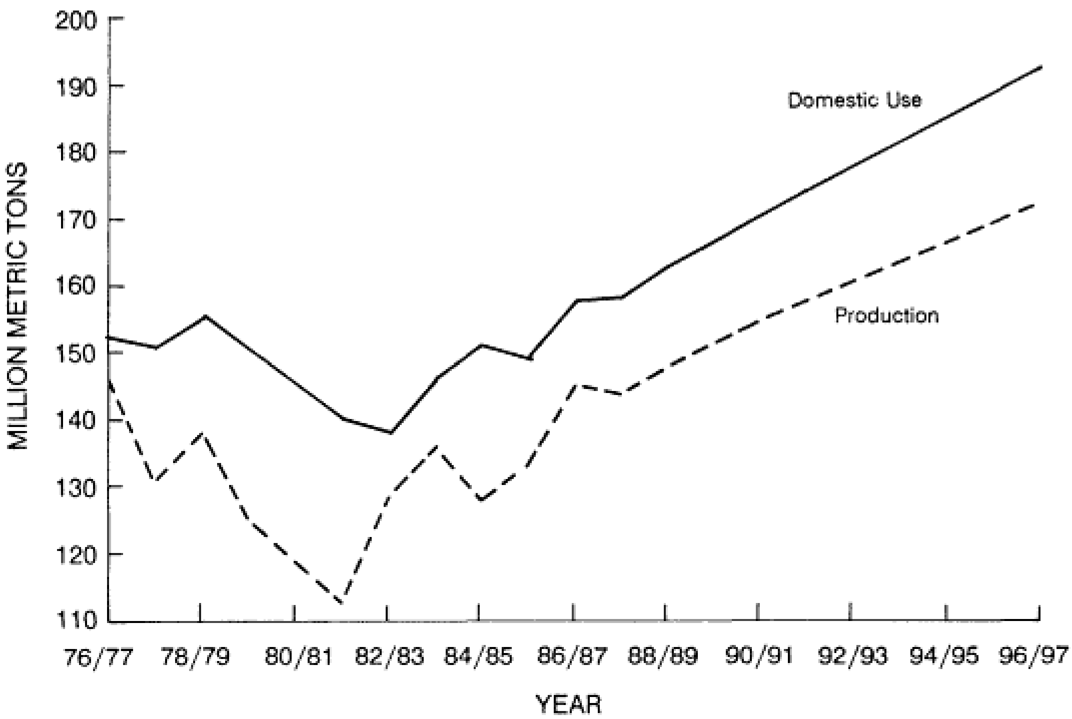

Figure 25
Centrally Planned Economies Coarse Grains

A conclusion of the recent 1988 World Food Conference (Helmuth and Johnson) is that there needs to be a shift in priorities. Third World countries must have assistance in developing their entire infrastructures—education, health care, highways, harbors, marketing and distribution systems—as well as their agricultural and industrial sectors. Only through long-term, sustainable growth can the problem of food security be solved. When Third World nations are able to efficiently produce and sell the products for which they have a comparative advantage, they will have command of the resources necessary to feed their populations. When economic development reaches this point, the investment of developed nations in economic assistance returns benefits to the donors as well as to the recipients.

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Appendix D

Outlook for Grains and Soybeans to 2000

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INTRODUCTION

This paper evaluates the global outlook for wheat, coarse grains, rice and soybeans to the year 2000. This includes forecasts of production, consumption, net trade and stocks by major regions and world prices. The primary assumptions regarding GDP growth, population, inflation rates and exchange rates were specified by the organizers of the session. A minimum set of simulations were requested and included a base run using the assumptions specified and a set of sensitivity runs using alternatives to the basic assumptions. This paper will simulate the base run and a high demand and low demand simulation.

The base simulation attempts to strictly follow the specified base line line assumptions. The two alternative simulations used the high GDP/high population alternative and the low GDP/low population alternative. These three simulations seem to provide a reasonable upper and lower bound to the base simulation. The three simulations will be referred to as Base Run, High Demand, and Low Demand. When the simulations are actually attempted, it becomes obvious that the assumptions do not reflect the most reasonable assumptions which could be chosen. For example, all developing countries are assumed to have real GDP growth of 4.5% per annum (p.a.). This ignores the differences between developing countries such as the large foreign debt of many Latin American countries, the stagnate and sometimes negative growth of many Central African countries, and the relatively more rapid growth of many Asian countries.

MODEL DESCRIPTION

The simulation model used in this exercise is the International Commodity Markets Division's world grain and soybeans model.[1] The model is a global, partial-equilibrium, net-trade model of the grains and soybeans markets. Fifteen of the major grain producing,

[1] Donald O. Mitchell. 1985. "A World Grains and Soybeans Model". Division Working Paper No. 1985-7, Commodity Studies and Projections Division, The World Bank, December 1985.

consuming and trading countries are modeled individually and the remaining countries are grouped into nine regions.

The model is econometrically estimated using primarily OLS from annual data over the period 1960-1984. The model is linear in both the variables and parameters. The main country-level exogenous variables are population, GDP, exchange rates and the consumer price index. World fertilizer prices are also exogenous to the model.

The commodities included in the model are wheat, rice, coarse grains (maize, oats, barley, sorghum, rye, millet, and mixed grains), soybeans, soymeal and soyoil. Individual models have been estimated for each commodity and country or region with cross linkages between commodities. Soybeans are modeled in terms of beans on the production side but in terms of oil and meal in the consumption and trade components.

Production for each country or region is determined as the product of separately-estimated harvested area and yield equations. Harvested area is determined by a two-stage process wherein total area harvested is determined first and then allocated among competing crops on the basis of lagged per hectare revenues. Yields are estimated as a function of the ratio of lagged crop prices to current fertilizer prices, the proportion of area planted to high-yielding varieties in the case of rice and wheat and a linear trend.

Per capita imports of each commodity are estimated directly for importing countries as a function of population, income, domestic supply and prices. Ending stocks are estimated as a share of consumption and prices. Total consumption is obtained as an identity. Net exports are estimated for exporting countries as a function of the level of each commodity available for export and world prices. Consumption in the exporting countries is estimated as a function of population, income and prices.

A single world price is assumed for each commodity, and the model is solved simultaneously for this price. The price in each country or region is then defined as the export price converted to local currency and deflated by the consumer price index of the country. Regional exchange rates and consumer price indexes are constructed as weighted averages of the data for individual countries.

A price equation is used to solve the model for the nominal export price for each commodity. The equation for wheat and corn are specified as functions of the U.S. crop loan rates and the ratio of stocks-to-utilization for the major exporting countries. This specification reflects the role of U.S. government policy as the determinant of the U.S. and world price floor, because the loan rate programs of the United States effectively bid grain away from the world market at the price floor or loan rate. For rice and soybeans, the U.S. loan rates are less important determinants of price and the price equations for these commodities depend upon the ratio of stocks-to-utilization and the prices of substitute commodities. Specific policy information is included for the United States on variables such as diverted areas and support prices. Agricultural policies for other countries are not included in the model.

ASSUMPTIONS

The following assumptions were provided by the session's organizers. Based on these assumptions, three simulations were run corresponding to a Base Run and High Demand and Low Demand alternatives. The High Demand simulation paired the high GDP growth alternative with the high population growth alternative, while the Low Demand alternative paired the low GDP growth alternative with the low population growth alternative.

1 Base Case Real GDP Growth (Percentage P.A. Growth)

	Historical		Predicted					
	1973-80	1980-86	1987	1988	1989	1990	1990-95	1995-2000
Industrial	2.8	2.3	2.5	2.5	2.5	2.3	3.1	3.3
Developing	5.0	3.3	4.5	4.5	4.5	4.5	4.5	4.5
CPEs								
USSR	3.4	2.6	2.3	2.3	2.3	2.3	2.3	2.3
Other E. Europe	2.9	1.8	2.1	2.1	2.1	2.1	2.1	2.1

2 Test Ranges for GDP Projection Assumptions

Industrial:	-0.5% p.a. on either side.
Developing:	-1.0% p.a. on either side.
CPEs:	0 5% p.a. on the downside, 1.0% p.a. on the upside.

3 Base Case Population Growth (Percentage P.A. Growth)

	Historical		Projections		
	1973-80	1980-86	1986-90	1990-95	1995-2000
Industrial	0.7	0.5	0.5	0.4	0.4
Developing	2.2	2.0	2.0	1.9	1.8
CPEs	0.8	0.7	0.7	0.6	0.6
World	1.8	1.7	1.7	1.6	1.6

4 Test Ranges for Population Projection Assumptions

Industrial:	0.1% p.a. on either side.
Developing:	0.2% p.a. on either side.
CPEs:	0.1% p.a. on either side.

5 Base Case Inflation Projections (Percentage Change P.A.)

1987-90	1990-2000
5.5	4.0

6 Exchange Rates—Constant real exchange rates in 1986 levels were assumed.

7 Policy Changes—The Common Agricultural Policy of the EEC and the US farm policy contained in the 1985 Farm Bill were assumed to remain unchanged through 2000.

SIMULATION RESULTS

The results of the three simulations are reported by major economic region: industrial, developing and centrally planned countries. This does not reflect the model aggregations (which includes substantially more detail) but was a convenient format for presentation.

The simulated prices are shown in Table 1 for the three alternatives. The Base Run projects rising nominal prices through 1990 for the grains and then a decline through 1995. Soybean prices are projected to rise through 1989 and then decline in 1990. Nominal prices rise for all grains and soybeans from 1995 to 2000. In real 1987 dollars, all prices are

TABLE 1 Simulated Prices, US $ per Ton

	Actual	Prelim A/	Projected (Nominal)				Projected (Real 1987 $s) B/			
	1987	1988	1989	1990	1995	2000	1989	1990	1995	2000
Wheat										
Base Run	133.5	156.2	165.6	172.7	153.8	178.7	148.8	147.1	107.7	102.8
High Demand			168.8	178.2	173.2	210.3	151.7	151.8	121.2	121.0
Low Demand			165.8	169.7	145.1	161.9	149.0	144.5	101.6	93.1
Maize										
Base Run	75.7	93.9	101.2	101.4	93.8	110.0	90.9	86.4	65.7	63.3
High Demand			103.2	106.4	103.5	127.9	92.7	90.6	72.4	73.6
Low Demand			100.7	99.5	86.8	99.4	90.5	84.7	60.8	57.2
Rice										
Base Run	230.3	300.7	302.8	321.6	288.8	346.7	272.1	273.9	202.2	199.5
High Demand			310.0	339.9	340.7	421.8	278.5	289.5	238.5	242.7
Low Demand			299.8	307.0	250.1	284.4	269.4	261.5	175.1	163.6
Soybeans										
Base Run	215.8	278.9	281.9	227.9	215.4	256.7	253.3	194.1	150.8	147.7
High Demand			290.0	254.1	247.9	314.4	260.6	216.4	173.5	180.9
Low Demand			278.8	216.4	187.4	218.6	250.5	184.3	131.2	125.8

PRICES ARE FOR THE CALENDAR YEAR IN NOMINAL DOLLARS PER TON AND REFER TO THE FOLLOWING:

WHEAT (CANADIAN), NO. 1, WESTERN RED SPRING (CWRS), IN STORE, THUNDER BAY.
RICE (THAI), WHITE, MILLED, 5% BROKEN, GOVERNMENT STANDARD, EXPORT PRICE, FOB BANGKOK.
MAIZE (US), NO. 2, YELLOW, FOB GULF PORTS.
SOYBEANS (US), NO. 2, YELLOW, CIF ROTTERDAM.

A/ JANUARY-JUNE 1988 AVERAGE.

B/ BASED ON AN INFLATION RATE OF 5.5% P.A. FROM 1988-90 AND 4.0% P.A. FROM 1990-2000.

projected to decline from 1990 to 2000 after rising from 1987 to 1989 or 1990. By 2000, real wheat prices are projected to decline 23% relative to 1987. Maize prices are projected to decline 16%, rice prices are projected to decline 13.4%, and soybean prices are projected to decline 32% relative to 1987. These projected declines are very much in line with historical trends over the last several decades. The High Demand simulation would increase real prices of wheat, maize, rice and soybeans by 18%, 16%, 22% and 22% respectively in 2000 relative to the Base Run.

Production is shown for the three country groups for selected years in Tables 2-4. Several interesting results emerge. First, projected growth rates over the 1985-2000 period are generally lower than over the historical 1970-85 period. This reflects both the results of starting from a higher base in the second period and a slower increase in actual growth over the second period. For example, in the industrial countries production under the Base Run for wheat and coarse grains are projected to grow 2.4% p.a. and 1.7% p.a., over the 1985-2000 period, compared to 4.1% and 3.5% p.a., respectively, over the 1970-85 period. Over the first period, wheat and coarse grain production increased 85.4 million tons and 169.5 million tons respectively while during 1985-2000 wheat and coarse grain production is projected to increase 80.5 million tons and 121.0 million tons respectively. Therefore a slightly smaller incremental production increase in wheat is projected for 1985-2000 and a greater slowdown in incremental production for coarse grain production is forecast.

For the developing countries, wheat, coarse grains, rice (paddy), and soybeans production increased 108.2, 46.7, 154.6 and 24.3 million tons respectively during 1970-85. For the 1985-2000 period, these crops are projected to increase 110.5, 77.1, 178.5 and 32.8 million tons respectively. The slower growth rates shown in Table 2 still result in larger incremental production projected for 1985-2000 than for the previous 15 years.

The centrally planned countries' production has grown slowly during 1970-80—except for rice which starts from a very small base. For the main crops which are wheat and coarse grains production increased only 33.4 million tons during 1970-85 or .9% p.a. A shift of area harvested away from wheat and into coarse grains has taken place during the period while yields have not increased significantly. For the forecast period 1985-2000, production is expected to further emphasize coarse grain production while wheat production remains nearly constant at 118 million tons.

The two simulation alternatives show little production response relative to the Base Run in the developing and centrally planned economies but relatively greater response in the industrial countries. The industrial countries are able to increase land devoted to crops easily by either converting pasture land or, in the case of the United States, by reducing the land diverted from production under the government programs. The developing and centrally planned countries do not have diverted area or large pasture lands which can easily be brought into crop production. In fact, land which is suitable to crops is already being used for crops in most developing countries, and bringing new land into crops often requires clearing forests, draining lowlands, terracing or other capital intensive activities. These investment activities are not likely to be captured by a short term area adjustment model, and in fact this is a weakness of the model used in this analysis. Finally, the ceteris paribus assumption associated with short run supply response estimates are not met because all model crops are allowed to adjust. This reduces the supply response because the relative crop prices do not change significantly as all the prices tend to move together. Since relative crop prices determine the allocation of land between crops, this effect is cancelled out and results in lower supply response estimates. Further evidence of the low total elasticity of

TABLE 2 Industrial Countries' Grain and Soybeans Production (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	102.1	140.5	165.5	187.5	200.0	218.5	268.0	4.1	2.4
High Demand					222.5	240.7	307.4		3.4
Low Demand					206.6	208.8	241.8		1.7
Coarse Grains									
Base Run	251.2	304.1	331.9	420.7	424.8	477.1	541.7	3.5	1.7
High Demand					457.6	500.7	588.2		2.3
Low Demand					419.1	462.5	514.3		1.3
Rice (Paddy)									
Base Run	21.6	24.4	21.3	23.0	21.7	20.9	21.9	.4	-.3
High Demand					23.3	24.3	27.6		1.2
Low Demand					20.1	18.4	17.8		-1.4
Soybeans									
Base Run	31.1	42.7	49.9	59.1	66.7	76.0	96.9	4.4	3.4
High Demand					72.0	85.5	114.8		4.5
Low Demand					64.2	69.7	84.8		2.4

TABLE 3 Developing Countries' Grain and Soybeans Production (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970–85	1985–2000
Wheat									
Base Run	92.7	125.5	149.5	200.9	234.5	276.8	311.4	5.3	3.0
High Demand					234.8	279.2	316.9		3.1
Low Demand					234.8	275.0	308.5		2.9
Coarse Grains									
Base Run	211.0	226.6	268.3	257.7	288.3	309.7	334.8	1.3	1.8
High Demand					289.0	310.3	336.1		1.8
Low Demand					288.1	309.2	334.1		1.7
Rice (Paddy)									
Base Run	290.3	331.6	374.5	444.9	493.4	557.2	623.7	2.9	2.3
High Demand					493.5	558.3	625.9		2.3
Low Demand					493.2	556.2	622.0		2.3
Soybeans									
Base Run	12.5	21.8	29.9	36.8	49.3	59.1	69.6	7.5	4.3
High Demand					49.5	59.3	69.9		4.4
Low Demand					49.2	58.9	69.4		4.3

TABLE 4 Centrally Planned Countries' Grain and Soybeans Production (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	119.0	90.5	127.7	109.4	117.6	119.3	118.4	-.5	.5
High Demand					118.0	120.7	120.3		.6
Low Demand					117.7	118.8	117.5		.5
Coarse Grains									
Base Run	112.8	114.6	131.4	155.8	173.6	192.6	209.9	2.2	2.0
High Demand					174.9	195.0	214.4		2.2
Low Demand					173.3	190.5	207.2		1.9
Rice (Paddy)									
Base Run	1.5	2.2	2.9	2.9	4.1	5.0	5.9	4.5	4.8
High Demand						4.1	5.0	6.0	3.7
Low Demand						4.1	4.9	5.9	4.8
Soybeans									
Base Run	.7	1.1	1.1	.9	1.3	1.4	1.6	1.7	3.9
High Demand					1.3	1.5	1.6		3.9
Low Demand					1.3	1.4	1.5		3.5

agricultural supply is provided by Binswanger et al.[2] In this study, the estimated total agricultural supply elasticity was (.06).

Consumption is given in Tables 5-7 for the three country groups. The results are largely as expected both within the Base Run and between the two simulation alternatives and the Base Run. However, as a precusor to reviewing the results it is important to remember that income, population and prices are all changing between the three simulations and the relative magnitudes of the price and income elasticities become important in determining the magnitude and direction of consumption changes.

The industrial country results for the Base Run show a continuation of past trends with wheat consumption growing at 1.4% p.a. over the forecast period, coarse grain consumption projected to grow at 1.8% p.a. and soybean meal and oil consumption growing at 3.3% p.a. Rice consumption continues to decline due mainly to declining consumption in Japan which accounts for most of the rice consumption in the industrial countries. Under the High Demand simulation, the level of wheat consumption declines while coarse grains, soybean oil and meal increase and rice consumption remains unchanged. The decline in wheat consumption in the High Demand simulation reflects a combination of lower consumption due to higher prices and low or negative income elasticities which offset the more rapid population growth under this simulation. Wheat consumption remains nearly constant in the Low Demand and Base Run simulations. Rice consumption also increases under the Low Demand simulation relative to the other simulations reflecting the negative income elasticity of demand in Japan.

The developing country results show that wheat consumption and soybean oil and mean consumption are the most responsive to the alternative simulations. Under the High Demand simulation, wheat consumption in 2000 is 8.7% higher than in the Base Run while soybean meal and oil are 13.9% and 14.4% higher, respectively. Coarse grain consumption is 5.9% higher in 2000 under the High Demand simulation relative to the Base Run while rice consumption is only 1.2% greater.

The trends in consumption in the developing countries in the Base Run suggest that soybean oil and meal will continue to grow the most rapidly during 1985-2000 as during 1970-85. Soybean oil is projected to grow 4.4% p.a. during 1985-2000 and soybean meal will grow a projected 4.2%. Wheat consumption is projected to grow 3.5% p.a. during 1985-2000, while coarse grains and rice will grow an estimated 2.4% p.a.

The centrally planned countries are projected to have very slow wheat consumption growth under the Base Run. However, coarse grains, rice and soybean products are projected to grow at 2.3-3.3% p.a. Under the High Demand simulation, consumption would grow substantially more rapidly. Under the High Demand simulation, wheat consumption would increase from 0.3% p.a. in the Base Run to 1.0%. Coarse grain consumption would increase from 2.3% to 2.9% for the same case and soybean meal and oil would increase from 3.2% to 4.6% and from 3.3% to 4.3% respectively. Soybean meal and oil consumption also increase under the Low Demand simulation reflecting the trade off between price and income elasticity. Under the Low Demand simulation, prices remain low relative to wheat and coarse grains and this stimulates exports. The High Demand simulation also results in larger imports than for the Base Run because of higher income growth which offsets the higher prices.

The net exports or imports shown in Tables 8-10 are largely a reflection of the previously

[2] Hans Binswanger, Yair Mundlak, Maw-Cheng Yang and Alan Bowers. 1985. "Estimation of Aggregate Agricultural Supply Response from Time Series of Cross Country Data." Division Working Paper No. 1985-3, Commodity Studies and Projections Division, The World Bank, December 1985.

TABLE 5 Industrial Countries' Grain and Soybeans Consumption (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	90.4	86.6	94.7	108.3	116.7	125.2	133.3	1.2	1.4
High Demand					115.6	123.1	130.1		1.2
Low Demand					116.8	125.5	133.1		1.4
Coarse Grains									
Base Run	272.6	280.6	306.3	343.6	377.1	409.5	448.6	1.6	1.8
High Demand					385.6	417.6	459.6		2.0
Low Demand					370.0	395.3	427.5		1.5
Rice									
Base Run	15.6	17.5	15.4	13.5	12.8	11.8	10.6	-.8	-1.3
High Demand					13.0	11.9	10.6		-1.3
Low Demand					13.0	12.3	11.5		-.9
Soybeans Meal									
Base Run	26.6	34.1	41.4	47.6	53.7	61.2	78.0	4.0	3.3
High Demand					56.5	70.3	87.8		4.2
Low Demand					52.8	61.8	73.4		2.9
Soybean Oil									
Base Run	4.9	6.2	7.0	8.1	9.1	10.8	13.1	3.4	3.3
High Demand					9.4	11.4	13.9		3.7
Low Demand					8.9	10.3	12.2		2.8

TABLE 6 Developing Countries' Grain and Soybeans Consumption (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	119.9	155.3	202.7	255.0	304.1	361.2	424.3	5.2	3.5
High Demand					313.8	382.1	461.2		4.0
Low Demand					297.8	344.3	393.2		2.9
Coarse Grains									
Base Run	199.5	221.1	266.9	274.5	317.9	350.4	392.1	2.2	2.4
High Demand					325.3	364.0	415.1		2.8
Low Demand					314.7	342.4	376.5		2.1
Rice									
Base Run	198.6	220.2	255.5	299.7	336.3	381.7	429.7	2.8	2.4
High Demand					337.5	384.6	434.8		2.5
Low Demand					335.0	378.9	424.7		2.4
Soybean Meal									
Base Run	10.0	11.7	18.2	22.9	26.9	33.8	42.3	5.7	4.2
High Demand					28.4	37.0	48.2		5.1
Low Demand					26.1	31.5	37.7		3.4
Soybean Oil									
Base Run	2.9	3.8	6.5	7.6	9.3	11.6	14.6	6.6	4.4
High Demand					9.8	12.8	16.7		5.4
Low Demand					8.9	10.7	12.8		3.5

TABLE 7 Centrally Planned Countries' Grain and Soybeans Consumption (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	126.4	114.7	147.5	132.1	132.0	134.8	137.2	.3	.3
High Demand					135.2	143.7	152.6		1.0
Low Demand					133.1	135.1	136.7		.2
Coarse Grains									
Base Run	90.9	115.8	139.2	172.3	190.7	219.6	243.2	.4	2.3
High Demand					195.3	231.0	263.6		2.9
Low Demand					194.3	223.3	248.1		2.5
Rice									
Base Run	1.0	1.5	1.9	2.7	3.0	3.4	3.8	6.8	2.3
High Demand					3.1	3.7	4.4		3.3
Low Demand					3.0	3.3	3.6		1.9
Soybean Meal									
Base Run	1.9	4.6	7.2	7.3	8.5	10.0	11.7	9.4	3.2
High Demand					9.0	11.4	14.4		4.6
Low Demand					9.5	11.6	14.0		4.4
Soybean Oil									
Base Run	.2	.5	.7	.8	1.0	1.1	1.3	9.6	3.3
High Demand					1.0	1.3	1.5		4.3
Low Demand					1.0	1.2	1.4		3.8

discussed trends in production and consumption. However, because of stock changes, the figures do not equate to the residual of consumption minus production. As shown in Table 7, the industrial countries are large net exporters of wheat and coarse grains. Wheat net exports are projected to increase by 107% over the forecast period from 64.6 million tons in 1985 to 133.6 million tons by 2000. This large increase in net exports is due to the developing countries while the CPE's imports remain nearly constant. Coarse grain net exports from the industrial countries are also projected to grow rapidly—reaching 90.7 million tons by 2000. The largest portion of the increase is expected to go to the developing countries, although the CPEs are expected to nearly double net imports during 1985-2000.

Rice exports from the industrial countries are expected to grow to 5 million tons by 2000 under the Base Run. Due to slower consumption growth over the forecast period, the developing countries are expected to remain largely self-sufficient in rice, and rice exports are not expected to undergo the rapid growth projected for wheat and coarse grains.

Soybean meal net imports are projected to grow to 5.3 million tons by 1990 and then fall to 3.2 million tons by 2000.[3] The industrial countries are net meal importers due to the large exports from Brazil, Argentina and other Latin American producers to the EEC, Japan and other industrial countries. Soybean oil exports (soyoil plus the oil equivalent of soybeans) are projected to grow due to imports from both the CPEs and developing countries.[4]

World stock levels are shown in Table 11. Under the Base Run simulation, stock levels would decline through 1990 and then rebuild over the balance of the decade. Stock levels would remain relatively high but below the large levels of 1985-87. The High Demand scenario would lower stock levels but not to a severely low level. The Low Demand simulation would lead to stock levels nearly as large as during the last several years.

CONCLUSIONS

The historical data and the results from the simulations show a number of trends which have emerged over the period since 1970 and which are expected to continue. These trends have important implications for trade levels, food security, export earnings and expenditures if they continue.

One of the most predominate trend which emerges from the historical data and the forecast is the increasingly widening gap between grain production and consumption in both the developing countries and the centrally planned economies. This gap is supplied primarily by exports from the industrial countries.

In the developing countries the wheat gap is large and projected to grow larger in the future. The level of wheat net imports in the developing countries has grown from 28.7 million tons in 1970 to 51.6 million tons in 1980. By 1990 it is projected to rise to 71.6 million tons and to 114.7 million tons by the year 2000 under the Base Run. The developing countries were net exporters of 7.4 million tons of coarse grains in 1970, but imported 14.7 million tons in 1980 under the Base Run. They are projected to be net importers of 57.5 million tons by the year 2000. The rice gap is relatively small because production and consumption are concentrated in the developing countries. The developing countries continue to be net exporters of soy products because of the large South American exports. The centrally planned economies have also faced a widening import gap since the 1970s.

[3] Soybean meal is measured as the meal equivalent of beans plus soybean meal.
[4] Soybean oil is measured as the oil equivalent of beans plus soybean oil.

TABLE 8 Industrial Countries' Grain and Soybeans Net Exports (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	28.1	48.7	70.6	64.6	85.8	100.6	133.6	5.7	5.0
High Demand					98.4	126.7	178.6		7.0
Low Demand					80.5	86.4	105.7		3.3
Coarse Grains									
Base Run	-5.5	23.6	42.8	16.1	46.5	67.8	90.7	9.5	12.2
High Demand					56.5	89.7	128.2		14.8
Low Demand					47.5	66.1	83.6		11.6
Rice									
Base Run	2.2	1.7	3.9	.6	1.6	2.8	5.0	-3.7	15.2
High Demand					2.8	5.2	9.3		15.5
Low Demand					.4	.4	1.0		3.5
Soybean Meal									
Base Run	1.2	-1.1	0.1	.6	-5.3	-4.9	-3.2	-2.7	-13.1
High Demand					-3.4	-.4	5.0		15.2
Low Demand					1.3	1.6	2.1		8.7
Soybean Oil									
Base Run	.9	.5	1.6	1.8	1.6	2.5	3.8	4.7	5.1
High Demand					2.2	3.7	6.0		4.0
Low Demand					1.3	1.6	2.1		1.0

TABLE 9 Developing Countries' Grain and Soybeans Net Imports (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	28.7	36.3	51.6	54.8	71.6	85.3	114.7	4.4	5.0
High Demand					81.2	103.9	146.2		6.8
Low Demand					65.2	70.2	86.4		3.1
Coarse Grains									
Base Run	-7.4	2.4	14.7	17.0	30.0	40.9	57.5	8.3	8.5
High Demand					36.7	53.9	79.1		10.8
Low Demand					27.1	33.4	42.7		6.3
Rice									
Base Run	1.7	1.2	2.4	-.2	1.3	2.6	5.0	-5.1	24.3
High Demand					2.4	4.7	8.8		28.9
Low Demand					.1	.4	1.2		13.9
Soybean Meal									
Base Run	-.1	-5.3	-6.3	-7.1	-12.8	-13.7	-13.7	-32.9	-4.5
High Demand					-11.4	-10.7	-8.0		-.8
Low Demand					-13.5	-15.9	-18.1		-6.4
Soybean Oil									
Base Run	.8	.1	1.0	1.1	.9	1.6	2.7	2.1	6.2
High Demand					1.4	2.7	4.8		10.3
Low Demand					.5	.7	1.0		.6

TABLE 10 Centrally Planned Countries' Grain and Soybeans Net Imports (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	-.6	12.4	18.9	19.1	14.3	15.3	18.9	26.2	.1
High Demand					17.2	22.8	32.4		3.6
Low Demand					15.3	16.2	19.3		.1
Coarse Grains									
Base Run	1.9	21.2	28.1	17.5	16.4	26.8	33.3	16.0	4.4
High Demand					19.7	35.8	49.0		7.1
Low Demand					20.4	32.6	40.9		5.8
Rice									
Base Run	.5	.5	1.4	.7	.3	.2	.0	2.3	-4.7
High Demand					.4	.4	.5		1.7
Low Demand					.3	.1	-.2		-5.7
Soybean Meal									
Base Run	1.4	4.2	6.3	6.6	7.4	8.8	10.5	10.9	3.1
High Demand					8.0	10.3	13.1		4.7
Low Demand					8.5	10.5	12.8		4.5
Soybean Oil									
Base Run	0.0	.4	.5	.6	.8	.9	1.1	4.7	4.1
High Demand					.8	1.0	1.3		5.3
Low Demand					.8	.9	1.1		4.1

TABLE 11 World Ending Stocks (million tons).

Commodity	Actual				Projected			Growth Rates	
	1970	1975	1980	1985	1990	1995	2000	1970-85	1985-2000
Wheat									
Base Run	73.3	63.9	78.2	122.9	109.3	136.1	135.0	3.5	.6
High Demand					109.1	115.7	104.3		-.9
Low Demand					119.8	149.4	158.3		1.7
Coarse Grains									
Base Run	67.1	58.6	82.8	158.9	125.9	152.3	156.8	5.9	.1
High Demand					112.1	123.4	117.3		-1.6
Low Demand					134.1	161.9	175.6		.7
Rice									
Base Run	17.7	19.3	22.1	26.4	24.3	28.6	31.6	2.7	1.2
High Demand					23.4	27.0	29.6		.8
Low Demand					24.9	29.0	32.7		1.4
Soybeans									
Base Run	4.1	11.0	13.7	10.6	18.1	18.0	20.9	6.5	4.6
High Demand					14.9	14.3	13.5		1.6
Low Demand					18.9	19.3	21.9		5.0

In 1970, the centrally planned economies exported 0.6 million tons of wheat and imported 2.9 million tons of coarse grains. By 1980, imports of wheat reached 18.9 million tons and coarse grains reached 28.1 million tons. By the year 2000, coarse grain imports are projected to rise to 33.3 million tons under the Base Run while wheat imports are expected to remain near the 1980 level of approximately 19 million tons.

The reasons for this divergence between consumption and production are different for the developing countries and the centrally planned economies. The developing countries have increased imports in spite of very rapid increases in domestic grain production. For example, from 1970 to 1985, grain production grew at 2.8% p.a. while consumption grew at 3.2% p.a. Income growth permitted both greater quantities of grains to be consumed and also a different mix of grains. Imports in many developing countries are also the only source of wheat because it cannot be grown in tropical areas. The demand for wheat imports has grown more rapidly than the demand for rice or coarse grains. This trend is expected to continue until the year 2000, but can be expected to change when consumers' incomes in developing countries rise enough to allow more livestock and poultry products to be consumed, which will lead to increase coarse grain imports.

The centrally planned economies have increasingly relied on imports because production has grown slowly. From 1970 to 1985, total grain production grew at .93% p.a. while consumption grew at 1.42% p.a. Unlike the developing countries, grain imports reflect stagnant production more than rapid demand growth. Over the longer term, the demand for coarse grains is projected to grow faster than wheat to satisfy the demand for livestock and poultry products.

A second trend which is projected to emerge is the slowing of the growth rates of production in the developing countries. Total grain production is projected to grow at 2.3% p.a. from 1985-2000 compared to 2.8% p.a. from 1970-85. This reflects a number a factors which primarily relate to the growth of yields and the maturing of the "Green Revolution". Since the first high-yielding varieties were released in 1965, the "Green Revolution" has allowed rice and wheat production to grow much faster than population. This was possible because the improved crop varieties were able to yield twice as much as traditional varieties when heavily fertilized and properly irrigated. This technology has now been extended to nearly all the best land and further expansion will be difficult. Investments in new irrigation systems have slowed, and expanding harvested area is constrained by the availability of suitable land not already cropped. Consequently, grain production is likely to grow more slowly in the future than during the period since 1965. This will further increase the demand for imports.

Much of the slowdown in the growth of grain production will be in Asian rice production. This leads to an interesting question: Will rice imports and prices increase sharply as countries turn to the world market to supplement domestic rice production? In my view, this will not be the outcome. Instead, countries will turn to wheat imports to satisfy domestic demand because wheat prices are typically 50-60% of rice prices and because many consumers in developing countries prefer wheat to rice to add variety to the diet. Wheat is also readily available from a number of major exporting countries. Rice imports are further complicated by the large number of types and qualities of rice and the difficulty of matching consumer preferences and market supplies.

These trends suggest increasing dependence of the developing and centrally planned countries on industrial country exports of grain. However, this does not necessarily imply increasing real grain prices. The simulations suggest that the industrial countries and certain of the developing countries can supply these requirements at real prices which are below 1987 levels—even under the High Demand simulation.

Appendix E

Workshop Statement

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First and foremost, and in line with the agenda item, I give precedence to the estimation of food aid requirements, drawing principally on FAO's experiences in recent years. The most recent FAO estimates of requirements were made in the early 1980s and comprised projections to 1985 and 1990. We have not yet made any formal assessments for the 1990s but I believe that the conceptual and quantification problems we faced continue to provide useful reminders for future applications. I also draw on our assessment of world agriculture to the year 2000 which we published nearly a year ago, to give an impression of the possible implications for food aid requirements for the future. In the second part I briefly summarize the two main agricultural projection models used by FAO. One of these is the long-term study *Agriculture: Toward 2000* to which I have just referred. It adopts a relatively optimistic scenario of demand and production growth for developing countries, compared with trends, but nonetheless implies quite large increases in their net import requirements for cereals and livestock products. The other study is essentially a price equilibrium model for assessing commodity demand, supply and trade prospects over the medium term, which we completed in 1985 with Projections to 1990, and which we plan to carry forward in the coming biennium.

ESTIMATION OF FOOD AID REQUIREMENTS: SOME BASIC ISSUES

When we were developing a revised approach to estimating food aid requirements five years ago, we reviewed all of the main global studies, including ones by IFPRI, USDA and FAO, which gave projections of requirements to around 1985 or 1990. The various estimates ranged from about 11 million tons to some 35 million tons of cereals or cereal-equivalent a year, and under one FAO hypothesis went as high as 66 million tons. Differences in country coverage explain part of the wide range but differences in assumptions and heuristics are undoubtedly the main causes. The estimates based on nutritional considerations were the highest ones, but the assumptions underpinning these estimates were somewhat simplistic. I will say more about nutrition-based estimates in a moment.

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Our own revised approach was a hybrid one, with our estimated total of food aid requirements coming to 20.2 million tons of cereals projected for 1985. This was based on assessment of three components at country level: (i) non-project food aid, or food aid for balance of payments support, (ii) project food aid and (iii) food aid to meet emergencies. I have brought along some copies of our detailed paper on this and will therefore only summarize it briefly here. Non-project food aid was estimated as the difference between projected total import requirements and projected imports on commercial terms (i.e. effective demand *less* domestic production *less* commercial imports). Commercial imports were projected for this purpose using an elasticity of commercial imports with respect to the ratio of foreign exchange earnings to the price of cereals, estimated from past time series, and, of course, projections of foreign exchange earnings and cereal prices. The second component, project food aid was estimated by our colleagues in the World Food Programme, taking into account individual country circumstances, questionnaire replies from countries and consideration of absorptive capacity. The estimates included requirements for food-for-work projects, nutrition projects and to help in building up small scale food security reserves in certain countries. These estimates covered edible oils and milk powder as well as cereals. The third component, emergency food aid requirements, was based on time series analysis of shortfalls in cereals production below trend. We assumed that food aid assistance would be needed to meet shortfalls which exceeded five percent of trend in the case of low-income net importers and ten percent in the case of other developing cereal importing countries.

Before proceeding to a consideration of nutrition-based estimates of requirements, I would make some general remarks on the models underpinning food aid estimates. Firstly, they have usually been neutral about changes in such things as income distribution policies, distribution policies regarding domestic food supply, food price Policies and domestic poverty-oriented programmes in food aid recipient countries. Thus, generally, it is implicit that the estimates of requirements constitute requirements of international food aid. Secondly, the same considerations imply that the estimates are neutral about such matters as targetting or, to put it another way, about tolerable degrees of leakage. Thirdly, it needs to be borne in mind in appraising studies of requirements that some of them focus explicitly on cereal food aid requirements while those which are based on nutritional considerations usually convert dietary energy gaps into cereal equivalents. Thus, an estimated requirement does not necessarily imply that the total quantity should be optimally supplied in the form of cereals.

NUTRITION-BASED ESTIMATES OF FOOD AID REQUIREMENTS

It seems to me thoroughly logical to try to base estimates of food aid requirements on nutritional considerations or, expressed in another way, on the need to raise food intakes of the world's hungriest people to an acceptable level. Conceptually, the same idea is captured in the Guidelines and Principles for Food Aid adopted by governments in the Committee on Food Aid Policies and Programmes in 1978 by which it is agreed that priority in food aid allocations should be given to low-income food-deficit countries. The same Guidelines and Principles are referred to in the Food Aid Convention in relation to cereal food aid. In fact, the bulk of food aid is provided to this group of countries. For instance, of total cereal food aid of 12 million tons in 1986/87 10 million tons went to these countries.

Clearly, however, there are many different ways of estimating food aid requirements on nutritional criteria. Certain "traditional" methods which relied solely on estimates or projections of national averages of dietary energy intake, and thereby ignored within-country distribution of intakes, are clearly flawed. And there is also the problem of defining what one means by an "acceptable level" of intake.

In the latest two of the periodic FAO World Food Surveys, considerable efforts have been made to refine the approach. I will refer briefly to the most recent of these, the Fifth World Food Survey, which we published in 1985. In this Survey we estimated the distribution of energy intake in each developing country for 1979-81. In brief, for countries for which we bad detailed data of food consumption by household, our analysis suggested that the log-normal distribution of dietary energy intake was appropriate. For other countries, the parameters of the log-normal distribution were estimated indirectly, using FAO food balance sheets to proxy the mean and, wherever possible, estimates of the relationship between food consumption and income in order to derive the variance. The critical cut-off point was set at a rather frugal level based on basal metabolic rate (BMR). In the case of adults and adolescents, for instance, 1.2 BMR or 1.4 BMR per caput was used, that is to say the maintenance requirements of dietary energy, taking into account alternative concepts of intra-individual variation. For India, for example, 1.2 and 1.4 BMR are equivalent to 1,450 and 1,610 kcal per day and in Egypt 1,550 and 1,720 kcal repectively. These allowances, I stress, are much below the recommended allowances which were set by FAO and WHO nearly 20 years ago, which included energy needs for normal working activity.

Based on these considerations we then asked how much additional energy (expressed in cereal equivalent) would be needed to bring people with less than 1.2 or 1.4 BMR up to these levels from their present positions. of course, the answer depends heavily on assumptions on the ways in which the extra food would be "injected" into the food system and therefore on the implied leakages. Some very large numbers can be generated in this way, but I will focus on the rock-bottom estimates. These estimates assume perfect targetting with no leakage, and count only the additional food needed by people to bring them up to the alternative cut-off points. The additional food needs would have amounted to 8 million tons of cereals to reach the 1.2 BMR level or 14 million tons to reach 1.4 BMR, for the developing countries as a whole, according to the assumptions I have outlined.

I stress that I am not putting these numbers forward as complete estimates of the total food aid requirements of these countries. In the first place, perfect identification and targetting would doubtless constitute an extremely costly approach and therefore some allowance would have to be made in all realism for leakage. Secondly, it must be remembered that the energy distribution curves used in the survey implicitly included the food aid which was actually provided in 1979-81, that is to say about 9 million tons of cereals plus other food donations. All of this, or a substantial part of it would therefore have to be added.

Of course, in extrapolating forward, allowance would have to be made for changes in the numbers of people projected to have energy intakes below 1.2 or 1.4 BMR. In this connection, the most recent calculations by FAO in *Agriculture: Toward 2000* point to their numbers increasing by some 10 percent by the year 2000 compared with 1979-81. Moreover, the projection of the number of undernourished people to the year 2000 is based on the assumption that all countries would be able to afford to purchase commercially their net import requirements as projected to that year. We have not made any detailed analysis of this particular aspect. However, as an indicator-and only one indicator I admit-our projections point to a rather large decline in the agricultural trade surplus of developing countries as a whole, assuming constant 1983-85 world market prices.

FAO'S LONG-TERM AGRICULTURAL PROJECTION MODEL: AGRICULTURE TOWARD 2000

As I indicated earlier, I conclude with a brief description of the methodology of FAO's main projection models and their results. I start with *Agriculture: Toward 2000* (AT 2000). I have extracted a brief methodological note and two summary tables of results for distribution to you. (See Annex to this paper).

In summary, on the side of demand and production, separate projections have been made for 94 developing countries, the developed countries and the USSR and Eastern Europe, and covering all major agricultural commodities. on the side of demand, the projections separately cover the main uses, i.e. food, feed (linked to projections of output of livestock products), industrial uses, seed requirements and waste. Special attention has been given to the projections of production in developing countries, taking into account country-specific circumstances and constraints, as well as major input needs. In general, projected import requirements and export availabilities for developing countries were derived as differences between the projections of their domestic effective demand and production.

For developing countries, the tables I am circulating show our main results concerning their export supply capacity and export growth possibilities. For cereals, we project further considerable expansion of their import requirements, to a gross volume of about 160 million tons, compared with around 100-110 million tons in the past few years. The world market for cereals is however, projected to grow at rates significantly below those of the past 15 years. Large increases in their net import requirements of both cereals and livestock products are also projected. As regards the developing countries' main agricultural exports, the tables show a somewhat mixed pattern of projected growth rates of export availabilities compared with past growth. But, of course, a projected availability can only be transformed into an actual market if the demand can be generated. The scope for this is becoming smaller, not only in developed importing countries but also in debt-strapped developing country markets.

FAO'S MEDIUM-TERM COMMODITY PROJECTIONS: THE WORLD FOOD MODEL

I turn now to FAO's other main projection model, which underpin our medium-term projections of commodity market prospects, which I will summarily refer to as our World Food Model (WFM). This differs from AT 2000 in a number of respects. AT 2000, for example, explicitly adopts certain normative criteria, notably on the side of production, and thus has a planning orientation. It also makes no explicit assumptions about prices and the role that they play in market clearance and decision making. Moreover, the study is not solely geared to the generation of market equilibrium but is also expected to Provide conclusions on such important matters as input needs and investment requirements, to cite some of its features. The World Food Model, by contrast focuses on world market prospects, built up from consideration of supply/demand/trade equations for about 150 countries and groups of residual countries. The WFM, as I have already said, also allows for the generation of marker equilibrium, achieved by (i) a formal mathematical model incorporating prices into its demand, production, trade, and stocking equations; (ii) respect for the usual identities at country and global levels; and (iii) the inclusion of equations which link domestic prices to world market prices. In these respects, it is similar in concept to the USDA's GOL model. I will not go into the projection results we generated for 1990, partly as these were published some years ago and are therefore available, and partly because the interest of this gathering relates mainly to the 1990s which we have yet to explore with the model in a formal way. However, the results did form one of the building blocks for the AT 2000 study I have already mentioned and, in very broad terms, its conclusions with regard to the slowdown of trade are basically similar. That is to say, for the period we covered from 1980 up to 1990, trade growth showed market slowdowns compared with the 1970s in particular. At the same time, on the food security front we anticipated no significant improvements in the per caput consumption levels of the low-income food-deficit countries as a whole.

Finally, by way of information, I should mention that so far, although we have also published some results from the model on the possible impact on food security of scenarios involving shocks on the side of production, we still have some way to go in improving the model's structure to tackle other important questions. I refer, in particular, to simulations regarding policy adjustments and alternative configurations of the world trading environment. Indeed, to conclude and bearing in mind the food aid orientation of this agenda item, one important issue for exploration in the future might well be that of the relationship between food aid requirements, the reform of agricultural policies, and the liberalization of agricultural trade.

ANNEX: EXCERPTS FROM AGRICULTURE: TOWARD 2000.*

Methodology of Projections: A Summary Note

Demand, Production, Trade

The projections of demand, production and trade are carried out for each of the commodities and countries analysed individually (see list of commodities and countries covered). The overall quantitative framework for the projections is based on the Supply Utilization Accounts (SUAs). The SUA is an accounting identity showing for any year the sources and uses of agricultural commodities in homogeneous units (see note to the list of commodities), as follows:

FOOD + INDUSTRIAL NON-FOOD USES + FEED + SEED + WASTE + (CLOSING STOCKS - OPENING STOCKS) = PRODUCTION + (IMPORTS - EXPORTS)

There is one such SUA for each of the historical years (generally 1961 to 1985) and the bulk of the projection work is concerned with drawing up SUAs (by commodity and country) for the year 2000. Different methods are used to project the individual elements of the SUA, as follows:

Food demand per caput is projected using the base year data for this variable (the three year average 1982/84), the FAO food demand model (a set of estimated food demand functions—Engel curves—for up to 52 separate commodities in each country) and the assumptions of the growth of per caput incomes (GDP). The results are adjusted as required by the commodity and nutrition specialists taking into account the historical evolution of per caput demand. Subsequently total projected food demand is obtained by simple multiplication of the projected per caput levels with projected population.

Industrial demand for non-food uses is projected as a function of the GDP growth assumptions and/or the population projections and subsequently adjusted in the process of inspection of the results.

Feed demand for cereals is derived simultaneously with the projections of livestock products by multiplying projected production of each of the livestock products with country-specific input/output coefficients (feeding rates) in terms of metabolizable energy supplied by cereals and brans. The part that can be met by projected domestic production of brans is deducted and the balance represents cereals demand for feed. Feed use of non-cereal products is obtalned by ad-hoc methods using historical data mostly as a proportion of total production or total demand. The study does not project feed use of oilmeals. This is a serious lacuna planned to be filled in future development of the analytical framework.

Seed use is projected as a function of production using seeding rates per hectare. This is part of the projections of input requirements, discussed below.

Waste is projected as a proportion of total supply (production plus imports).

* July 1987. Rome: Food and Agriculture Organization of the United Nations (Pages A5-A10; 85;88;103).

The study does not project year 2000 stock changes. This does not mean that present stocks are assumed to remain constant but rather that changes to adjust them to "desired" or "required" levels will occur in the years between now and 2000. It is impossible to project country and commodity specific adjustments in any one particular year. The general point is made in the report that current stocks of particular commodities and countries are out of balance with "desired" or "required" levels. If the adjustments occur in any year(s) before 2000, the impact on production will appear only as temporary deviation(s) from the smooth growth path represented by a curve joining the base year production level to that of 2000, ignoring fluctuations in the intervening years. Whether or not year 2000 production includes a provision for "normal" stock changes (i.e. to maintain stocks at the desired percentage of consumption already achieved before 2000) makes little difference to the average growth rate of production for 1983/85-2000 if the deviations from the constant growth rate path in the intervening years are ignored.

Production and trade projections for each country involve a number of iterative computations and adjustments as follows:

(1) Commodities in deficit in the base year (developing countries only): a preliminary "target" level is set for 2000 taking into account the projected demand, production growth possibilities (evaluated in more detail in subsequent steps of the analysis) and the general objective that self-sufficiency should be raised or, as the case may be, its past rate of decline should be contained if possible, depending on the country/commodity situation.

(2) Commodities exported in the historical period and the base year (developing countries only): it is assumed that they will continue to be exported in amounts which will depend on the country's possibilities to increase production, a preliminary assessment of import demand on the part of all the other countries which are deficit in that commodity and an assessment of the country's possibility to have a share in total world import demand resulting from an analysis of trends and other relevant factors. Since for world balance total deficits of the importing countries must be equal to total surpluses of the exporting countries there is an element of simultaneity in the determination of the production levels of all commodities in all countries. This is solved in a number of successive iterations rather than through a formal model, the key element being expert judgements of market shares in world exports and of somewhat more formal evaluations of the production possibilities, as explained below. Based on the above considerations, preliminary production "targets" are therefore set for the export commodities of each developing country. They are equal to their own domestic demand plus the preliminary export levels. Once the preliminary production targets are set for all commodities, the missing elements of the demand side of the SUA which depend on the levels of production (feed, seed, waste) can be filled in.

At this stage complete preliminary SUAs are available for 2000 for all commodities and all the developing countries, showing for each commodity and country all the demand elements and production. The differences between total demand and production are the preliminary net trade positions (imports or exports). The next step is to derive preliminary world balances. Similar SUAs are, therefore, constructed for the developed countries.

(3) For the European CPEs the procedure followed is more or less the same as that described above for the developing countries, though the judgemental element concerning objectives of self-sufficiency and exports may not be identical. Moreover, there is no further evaluation of the projected production levels in terms of land and yields in different agro-ecological land classes, an operation carried out for the developing countries only (see below).

(4) For the developed market economies (DMEs) the demand components of the SUA are projected in the same manner as for the other countries. Production is, however, projected as trend in the manner described in the relevant section of Chapter 3 (paragraphs 3.126-3.128). The net trade balances thus obtained for the DMEs are subsequently reviewed together with those of the developing countries and the European CPEs as follows:

(5) For the commodities not produced, or produced only in insignificant quantities in the DMEs (tea, coffee, cocoa, bananas, natural rubber, jute, cassava), nearly all their demand translates into import requirements. This, together with the import requirements of the developing countries in deficit and those of the European CPEs, define the total market available to the developing exporting countries. Their provisional production and export levels, set as described above, are then adjusted judgementally to equate them to the total import requirements.

(6) A second set of commodities comprises those produced in substantial quantitites in both the DMEs and the developing countries but for which the latter have been traditionally substantial net exporters (mainly sugar, vegetable oils and oilseeds, citrus, tobacco, cotton). DME production trends of some of these commodities, particularly sugar and oilseeds, have been strong resulting in import substitution and declining net imports from the developing countries. If these production trends continued, net DME imports from the developing countries of some of these commodities would decline further and the DMEs could turn into net exporters. Assumptions were therefore introduced that farm protection policies in the DMEs would be adjusted to check production growth so as to enable the developing countries to continue to be net exporters. No radical departures from past trends in the net exports of the developing countries are, however, incorporated into these assumptions. The results, which in practice reflect the above assumptions for the DMEs as well as those concerning export availabilities of the major developing exporters, are shown in Table 3.8. It is emphasized that these assumptions reflect present evaluations of possible policy stances as revealed by past trends in policies. As such they represent only one possible trade outcome and the scope for different results for some of these commodities is very wide, particularly for those in which the developing countries are low cost producers, e.g. sugar. In such cases the outcome is overwhelmingly determined by the farm protection policies of the major DME consumers and producers. Therefore, a much higher degree of uncertainty applies to these trade projections compared with those of the other commodities.

(7) The last group of commodities comprises those for which the developing countries and the European CPEs are major importers and the DMEs are the major suppliers of these imports (mainly wheat, coarse grains, milk). For these commodities, the net exports of the developing exporters are determined first (step 2, above) and subsequently the net export balances resulting from the trend projections of the DMEs are confronted with the remaining deficits of the developing importers and the CPEs. As discussed in Chapter 3, these projected DME export balances generally exceed the import requirements of the rest of the world. The final step of this analysis computes the extent to which the production trends of the DMEs must be modified for world balance.

At this stage the projections of demand, production and trade are complete: there is one projected SUA for each country and commodity and world imports equal world exports. These projections are, however, still provisional pending a more detailed evaluation of the feasibility of the production projections of the developing countries.

TABLE 3.7 Cereals in the Developing Countries: Production, Demand,[1] Net Balances and Self-Sufficiency.

	Demand Per Caput kg	Total	Production million tons	Net Balance	SSR percent	Growth Rates Period	Demand percent p.a.	Prod'n
94 Developing Countries								
69/71	190	491	480	-17	98	61-70	3.6	4.0
83/85	234	820	762	-61	93	70-85	3.8	3.4
						61-85	3.7	3.5
2000	265	1250	1154	-95	92	84*-2000	2.7	2.6
Africa (Sub-Saharan)								
69/71	142	38	36	-2	97	61-70	2.1	1.7
83/85	135	54	43	-9	79	70-85	2.9	1.5
						61-85	2.7	1.7
2000	148	100	83	-17	83	84*-2000	3.9	4.2 3/
N. East/ N. Africa								
69/71	294	53	46	-6	87	61-70	2.9	2.5
83/85	372	96	60	-35	63	70-85	4.6	2.1
						61-85	3.9	2.2
2000	395	153	93	-60	61	84*-2000	3.0	2.7
Asia								
69/71	182	338	332	-11	98	61-70	3.8	4.4
83/85	231	565	559	-15	99	70-85	3.7	3.7
						61-85	3.8	3.8
2000	266	830	811	-19	98	84*-2000	2.4	2.4
Asia (excl. China)								
69/71	172	179	174	-9	97	61-70	3.0	3.1
83/85	190	269	269	-9	100	70-85	2.9	3.3
						61-85	3.1	3.2
2000	211	398	380	-18	96	84*-2000	2.5	2.2
Latin America								
69/71	224	63	66	3	105	61-70	4.3	4.2
83/85	269	105	100	-2	96	70-85	3.8	3.2
						61-85	4.0	3.4
2000	309	167	168	1	101	84*-2000	2.9	3.3
Low Income Countries								
69/71	180	324	317	-11	98	61-70	3.6	4.3
83/85	221	529	520	-15	98	70-85	3.6	3.5
						61-85	3.6	3.7
2000	250	784	77	-14	98	84*-2000	2.5	2.5
Low Income (excluding China and India)								
69/71	168	73	69	-5	95	61-70	3.1	2.5
83/85	165	102	95	-7	92	70-85	2.6	2.6
						61-85	2.7	2.4
2000	176	167	153	-13	92	84*-2000	3.1	3.1
Middle Income Countries								
69/71	215	168	163	-6	98	61-70	3.7	3.4
83/85	263	291	242	-46	83	70-85	4.1	3.0
						61-85	4.0	3.1
2000	295	465	384	-81	83	84*-2000	3.0	2.9

84* = average for 1983/85; rice is included in terms of milled.

[1]Demand is for all food and non-food uses, e.g. feed, seed etc., but excludes stock changes. For this reason, the sum-total of production and net trade in the historical data is not identical to domestic demand.

[2]Net cereal deficits for all the developing countries including the smaller ones not covered in the group of 94 are 20 and 69 million tons for 69/71 and 83/85, respectively. The projected deficit should, therefore, be increased by some 15 million tons to cover all the developing countries.

[3]Africa's growth rate of cereals production would be 3.3 percent per annum if measured from the post-drought production achieved in 1985.

Evaluation of Production Projections

(8) For each developing country (excluding China) the base year data set is expanded to include a complete description of crop and livestock production systems in terms of the main parameters. For crops this is a matrix (size 33 × 21) with data on area, yield and production of each crop in each of the 6 agro-ecological land categories (described in Chapter 4, paragraph 4.26). In steps 1 and 2 (above) the crop production projections were specified only in terms of aggregate production and occasionally also in terms of area and yields, total not by land classes. The more detailed production analysis is therefore concerned with evaluation of these production projections in terms of land and yield by agro-ecological class. This is equivalent to creating for 2000 a matrix similar to that of the base year. In doing so certain land and yield constraints by agro-ecological class have to be respected.

(9) For this purpose two additional data sets are used. The first one (land data set) has data for each country of potential agricultural land by class and how much of it is used in the base year. The second (global technology data set) comes from a survey of yields prevailing in different parts of the developing world and the inputs associated with such yields in each of the agro-ecological classes. This is done judgementally and iteratively by specialists on different countries and on crop production. Assumptions are first made of what are feasible rates of harvested land expansion by agro-ecological class (through use of more land from the reserves and or through increased cropping intensities, including expansion of irrigation). Similar assumptions are made for yield increases and the land allocation to each crop. Since a multitude of detailed assumptions and different specialists are involved, continuous iterative computations of the whole system are made to ensure that the constraints of land availability and the and the permissible levels of increases (both by land class) are respected.[1] The end result is that either the initial production target is accepted or is revised downwards for some crops because land resources (of the required class, where applicable) are not sufficient or because it requires yield increases considered by the specialists to be beyond achievement by 2000 even under reasonably improved policies.

(10) Similar production analysis procedures are applied to the livestock production, except that the relevant parameters are animal numbers and yields (off-take rates, carcass weight, milk yields, eggs per laying hen) for the livestock species considered.

Final Adjustments

(11) For the commodities and countries for which the provisional production "targets" had to be lowered during the feasibility tests, the resulting import requirements would be higher than originally estimated. It results, therefore, that the provisional world balance achieved in steps 1 to 7 is disturbed. A final iteration is made to adjust production and trade balances of other countries to make up the shortfall in production in the developing countries whose initial provisional "targets" were found to be infeasible.

At this stage, the world demand, production and trade picture is completely quantified. The remaining steps in the analysis are concerned with quantifying the projected requirements of the developing countries for inputs and investments as well as the mechanization/employment implications.

[1] A more formal description of the procedures presented here is to be found in a paper "Crop Production and Input Requirements in Developing Countries"' published in the 1983 issue of the European Review of Agricultural Economics, Vol. 10, No. 3.

TABLE 3.8 Main Agricultural Exports, Aggregates for 94 Developing Countries

		Thousand Tons			
		61/63	69/71	83/85	2000
Sugar (raw equivalent)	Exports	11,590	13,310	17,700	26,300
	Imports	4,230	4,850	11,340	19,400
	Net Exports	7,360	8,460	6,360	6,900
Oilseeds & veg. oils (oil equivalent)	Exports	3,870	3,920	9,950	18,920
	Imports	1,010	1,530	7,510	16,720
	Net Exports	2,860	2,390	2,440	2,200
Coffee & products (beans equivalent)	Exports	2,790	3,240	4,100	4,870
	Imports	140	150	280	500
	Net Exports	2,650	3,090	3,820	4,370
Cocoa & products (beans equivalent)	Exports	1,040	1,220	1,560	1,990
	Imports	40	60	90	200
	Net Exports	1,000	1,160	1,470	1,790
Tea	Exports	620	680	950	1,320
	Imports	200	220	390	670
	Net Exports	420	460	560	650
Tobacco & products (unmanufactured equivalent)	Exports	440	530	770	1,010
	Imports	110	160	320	520
	Net Exports	330	370	450	490
Cotton (lint)	Exports	2,100	2,580	1,990	2,300
	Imports	470	640	1,110	1,600
	Net Exports	1,630	1,940	880	700
Rubber	Exports	2,120	2,840	3,530	4,700
	Imports	330	500	740	1,080
	Net Exports	1,790	2,340	2,790	3,620
Bananas	Exports	3,410	5,000	5,900	7,350
	Imports	300	370	380	470
	Net Exports	3,110	4,630	5,520	6,880
Citrus & products (fresh equivalent)	Exports	1,210	2,280	10,330	15,960
	Imports	110	210	740	1,380
	Net Exports	1,100	2,070	9,590	14,580
All above ($ mill. current prices)	Exports	8,861	1,108	42,129	
	Imports	1,736	2,413	15,526	
	Net	7,125	8,695	26,603	
Total agriculrure ($ mill. current prices, growth rates from values at constant 1979/81 prices)	Exports	13,062	17,423	63,884	
	Imports	6,032	8,420	51,151	
	Net	7,030	9,003	12,733	

Growth Rates, Percent per annum 61-70	70-85	83/85-2000	Value of Exports, Average 1983/85 $ Million	Percent of Total Ag. Exports
1.3	1.7	2.5	7,238	11.3
1.1	7.5	3.4	2,708	
1.4	-3.8	0.5	4,530	
0.1	6.8	4.1	9,668	15.1
4.9	13.3	5.1	6,790	
-2.0	-2.4	-0.6	2,978	
2.4	1.5	1.1	9,555	15.0
1.4	3.9	3.7	475	
2.4	1.4	0.8	9,080	
1.6	1.4	1.5	2,738	4.3
5.2	4.1	5.1	241	
1.6	1.3	1.2	2,914	
1.1	2.4	2.1	2,035	3.2
1.4	4.6	3.4	960	
0.9	1.1	0.9	1,075	
1.5	2.2	1.7	1,956	3.1
4.8	6.4	3.1	1,434	
0.2	0.1	0.5	522	
3.0	-2.0	0.9	2,982	4.7
3.3	4.3	2.3	1,748	
2.9	-8.6	-1.4	1,224	
3.5	1.4	1.8	3,184	5.0
5.4	2.9	2.4	766	
3.2	1.0	1.6	2,418	
4.7	0.9	1.4	1,135	1.8
2.3	1.5	1.4	115	
4.9	0.9	1.4	1,020	
7.2	11.3	2.8	1,638	2.6
7.1	8.8	3.9	290	
7.3	11.6	2.7	902	
			42,129	66.0
			15,526	
			26,603	
2.1	2.2		63,884	
5.7	7.4		51,151	
-3.8	-7.3		12,733	

TABLE 3.12 Net Cereals Balances by Major Importers and Exporters[1]

	1969/71	1979/81	1983/85	2000
Developing Net Importers	-33.8	-87.3	-98.4	-157
Oil Exporters[3]	-5.8	-28.3	-37.3	-61
Mexico	0.2	-5.9	-6.2	
Saudi Arabia	-0.5	-3.1	-5.7	
Algeria	-0.5	-3.0	-4.3	
Iran	-0.5	-2.7	-4.9	
Iraq	-0.4	-2.7	-3.8	
Indonesia	-0.9	-2.6	-1.9	
Venezuela	-1.0	-2.5	-2.9	
Nigeria	-0.4	-2.1	-1.9	
Others	-1.8	-3.7	-5.7	
Other Net Importers	-28.0	-59.0	-61.1	-96
China (incl. Taiwan Province)	-3.8	-15.8	-10.8	
Brazil	-1.0	-6.3	-4.8	
Egypt	-1.1	-5.9	-8.2	
Korea, Rep.	-2.5	-5.7	-6.4	
Cuba	-1.2	-2.1	-2.2	
Morocco	-0.3	-2.0	-2.3	
Malaysia	-0.9	-1.7	-2.4	
Bangladesh	-1.3	-1.3	-1.7	
Vietnam	-1.8	-1.3	-0.3	
Peru	-0.7	-1.3	-1.2	
Chile	-0.5	-1.1	-0.9	
India	-3.6	0.4	-1.7	
Others	-9.4	-14.9	-18.2	
Developing Net Exporters	14.1	21.5	29.5	45
Argentina	9.4	14.4	20.2	
Thailand	2.9	5.2	7.1	
Others	1.8	1.9	2.2	
ALL DEVELOPING COUNTRIES[2]	-19.8	-65.8	-68.9	-112
East Europe and USSR	-0.1	-43.9	-41.7	-30-40
NET BALANCE, ALL ABOVE	-19.9	-109.7	-110.6	-142-152
DEVELOPED MARKET ECONOMIES	22.6	113.1	117.4	
North America	49.6	129.4	118.5	
EEC(O)	-16.2	3.1	17.2	
Other W. Europe	-5.1	-11.1	-5.6	
Oceania	8.9	14.6	16.8	
Japan	-14.4	-24.5	-26.6	
Others	-0.2	1.6	-2.9	

[1] A minus sign denotes net imports. All quantities include rice in milled terms.

[2] Including developing countries not included in the 94 study countries. Countries listed separately had net imports of the one million tons or more in 1979/81, except for India.

[3] IMF classification of countries (20) in which fuel exports accounted for more than 50 of total exports in 1980 (IMF, World Economic Outlook, 1986).

Input Requirements

The crop production projections and the global technology data set described above are subsequently used to estimate the inputs required for the projected production. These inputs are: fertilizer (N,P,K), power in terms of man-day equivalents (subsequently decomposed into the parts to be provided by draught animals, labour and machinery), seed (distinguishing traditional and improved seed) and crop protection chemicals (in monetary units, given the great diversity of the products actually used).

The input use coefficients in the global technology data set are specified as the amounts of, for example, N fertilizer required per hectare for a given yield in each agro-ecological land class and crop. These coefficients are made country-specific on the basis of data on total input use in the base year. Subsequently, total input requirements in 2000 are calculated by simple multiplication of these input coefficients by the projected harvested land areas.

The above discussion covers the inputs into crop production. For livestock, only the cereals feed requirements are estimated, as explained earlier. In addition, in countries which use significant areas for cultivated fodder production, an allowance is made for future land requirements for this purpose. This is, however, done in order to complete the land use accounts rather than in relation to livestock production. It proved impossible to draw-up complete balance sheets of feed resources and uses, including grazing land, crop residues and non-cereal concentrates. This is an area for future improvement of the study's data base and methodology.

Employment and Mechanization

The methodology for projecting labour use and requirements of mechanization is explained in Chapter 4, paragraphs 4.75-4.76 and it is not repeated here. A more formal description of an earlier version of the method was published in the 1982 issue of the *European Review of Agricultural Economics*, Vol. 9, No. 2, under the title "Power Inputs from Labour, Draught Animals and Machinery in the Agriculture of the Developing Countries". Some significant improvements were introduced in the present application.

Investments

The methodology for estimating investment requirements for the developing countries (excluding China) and the main items covered are presented summarily in Chapter 4.

In the first place, the investment goods to be added to the base year capital stock of agriculture are estimated in physical units. Most of the required additions are taken from the projections of production and inputs which identify, for example, the additional land to be developed, to be irrigated, the additions to the tractor part and to livestock needs. These additions are the cumulative net investment requirements of the entire period between the base year and 2000. Subsequently, requirements for replacement investment are derived for the capital goods which must be replaced periodically. These are added to the net requirements to obtain estimates of gross investment.

Once the estimates in physical units are made they are valued at average unit prices in $ of 1979/81 to obtain the investment requirements in monetary terms. The problems encountered in this evaluation (assumptions on unit prices, derivation of the $ values for more recent years) are discussed in Chapter 4, paragraph 4.97.

Appendix F

Food Aid Needs during the 1990s

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Fifteen years ago, the developing countries had a $15 billion agricultural trade surplus. That surplus has now disappeared. Self-sufficiency for most categories of basic commodities has declined, indicating a growing gap between consumption and production. The volume of food aid to these nations has risen sharply during the last decade. These trends raise some disturbing questions about the future.

- Will the food production-consumption deficit in developing countries continue to widen?
- Will the developing countries' reliance on food imports and food aid grow?
- If so, will food supplies and low prices, and food aid funding be available to accommodate the need?

This paper presents a set of 10-year projections for production, consumption, and trade of agricultural products for the world and for developing countries. The underlying long-term trends in world agricultural production, consumption, and trade suggest abundant supplies during the coming decade. However, increases in production and consumption will not be evenly spread among all countries. A rising reliance on food imports and food aid is expected in a number of low-income countries.

The projections are based on assumptions about production technology and resource use, agricultural and trade policies, world commodity price levels, and international economic growth and credit availabilities. These assumptions appear to have a relatively high probability of occurrence compared to other scenarios. However, other developments, such as changes in international economic and financial integration or developing country growth in non-agricultural exports and foreign exchange could also have an impact.

Agricultural production in developing countries has trended upward about 2.9 percent a year since 1950. The per capita rise was 0.8 percent a year, but demand increased even faster, and the growth in agricultural imports exceeded exports. Self-sufficiency

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(production/consumption) for total cereals fell from more than 55 percent in the early 1960s to nearly 50 percent in the 1980s. Self-sufficiency also declined for vegetable oils (from 128 to nearly 100 percent) and for cotton (from 160 to 125 percent).

Agricultural imports by the developing countries has climbed 3.2 percent a year since the mid-1970s. Food aid flowing to these countries has risen about 3.7 percent a year and has been accounting for an increasing proportion of total agricultural imports.

GLOBAL DEMAND AND SUPPLY FACTORS

During most of the 1980s, most world agricultural commodity markets are characterized by large stocks and low prices. The 1988 North American drought's impact on production and prices is assumed to be a short-term digression from long-term trends. The projections presented here assume that the trend towards excess supplies will cause minor changes to be made in agricultural or trade policies in the major producing/exporting countries. Combined with the drought effects, these policy changes will help balance world markets during the next five years, but will fall short of a degree of trade liberalization that would help sustain a balance in world markets.

World Demand

Forces that generate demand—such as population and income growth—were weaker in 1981-86, compared with 1970-81 (Table 1). Population growth has generally slowed, except in low-and middle-income developing countries. Per capita income growth has fallen and even slipped to negative values. Only the centrally planned economies have seen growth. Export growth has similarly declined, except for low-income and centrally planned economies. And, prices for agricultural products, increasing in 1970-81, declined sharply in 1981-86. These forces, their weakened states combined, imply declines or smaller increases in agricultural trade. Can we anticipate a strengthening in these forces?

The answer is "yes" for some forces, but "no" for others. World demand for agricultural products will likely grow more slowly during the coming decade than during the boom of the 1970s, but faster than in the past five years. Several conflicting forces shape this outlook:

- World population growth peaked during the 1960s at nearly 2 percent a year. The trend to slower population growth, now about 1.6 percent a year, is expected to continue. But even that relatively slow rate will produce about 80 million more people to feed and clothe each year, a significant demand-building fact of life.
- Many countries will experience slower income growth than in the 1970s. But income is likely to grow faster than in the early 1980s, particularly in developing countries.
- Most commodities will be available on world markets at low prices during the 1990s, frequently with favorable credit terms.
- The debt problem will continue to constrain both income and import demand in debtor countries, but to a lesser degree over time as debt is retired, restructured, forgiven, or otherwise resolved.

Total and per capita demand growth will continue to be fastest in the developing countries, particularly in the newly industrialized countries. Growth of agricultural demand in developing countries has been projected at 3 percent per year, well above that of the middle-income countries (FAO 1987). Demand growth will continue to be strong in the centrally-planned economies, especially in China.

TABLE 1 Determinants of Global Agricultural Demand

Item	World	Devloping			Developed			Centrally planned economies
		Total	Low income	High income	Total	EC	U.S.	
Share of world population, 1986	100	54.51	42.15	12.37	14.72	5.35	5.07	30.76
Annual population growth rates (percent)								
1970-81	1.84	2.41	2.45	2.31	0.77	0.34	1.05	1.48
1981-86	1.65	2.39	2.45	2.19	.54	.10	.92	.93
GDP per capita (1980 dollars)								
1970	2,363	837	420	2,217	8,496	8,249	9,790	1,407
1975	2,576	974	468	2,658	9,453	9,186	10,534	1,577
1980	2,808	1,084	482	3,104	10,803	10,521	11,805	1,694
1986	2,931	1,073	484	3,082	12,027	11,356	13,056	1,869
Annual growth rate in GDP per capita (percent)								
1970-81	1.61	2.40	1.32	3.11	2.34	2.21	1.93	1.72
1981-86	.80	-.23	-.06	-.15	1.87	1.60	1.56	1.94
Exports per capita (1980 dollars)								
1970	376	236	112	646	1,293	1,818	674	101
1975	441	245	111	694	1,658	2,375	908	128
1980	526	270	93	863	2,166	3,056	1,197	141
1986	603	263	84	873	2,746	4,059	1,018	180
Annual growth rate in exports per capita (percent)								
1970-81	3.14	.92	-2.97	2.72	5.11	5.18	5.16	2.72
1981-86	2.68	.14	.81	.10	4.20	5.09	-2.78	5.82
Change in agricultural import prices								
1970-81	8.59	9.67	9.82	9.61	9.59	9.59	8.58	6.21
1981-86	-3.46	-4.88	-5.42	-4.56	-2.84	-2.91	-1.64	-2.62

SOURCE: Lee and Shane; updated.

Demand for agricultural products is not only growing but also shifting to higher quality and more highly processed foods. More of the world's population will seek higher quality diets. We will see a continuing gradual shift toward higher valued and processed products, particularly in developing countries. Distribution and processing margins will account for a growing share of total food expenditures.

People with rising incomes will want more protein, generating a growing demand for feedstuffs. World use and trade of feed grains are expected to climb faster than for food grains. Developing countries use 35 percent of their wheat and coarse grain for feed and they will likely increase that percentage. Many middle-income developing countries will maintain imports of feed grains rather than meat in order to generate employment at home.

World demand for high-protein feedstuffs will rise even faster than for feed grains. Livestock feeding in the centrally planned economies is inefficient, principally because of the composition of feed rations. The average protein content is low, particularly in the USSR and Eastern Europe. The ratio of high protein feeds to feed grain there is about 6 percent, compared with more than 25 percent in Western Europe.

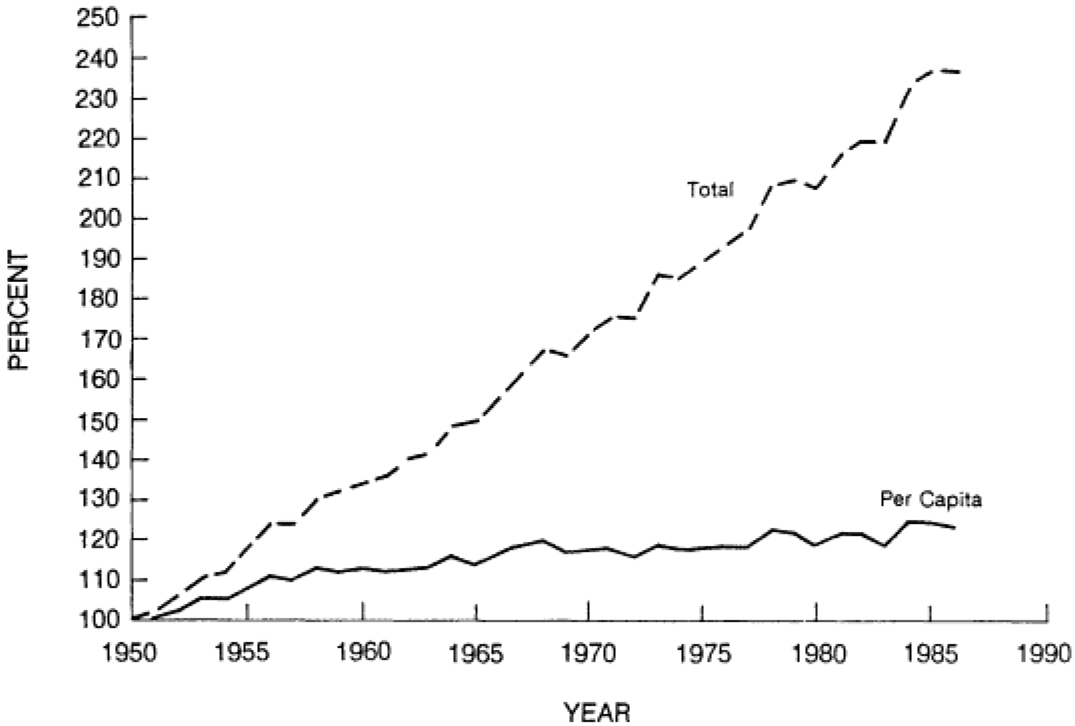

Figure 1
World Agricultural Production

World Supply

World agricultural production trended steadily upward between 1950 and 1986 at 2.4 percent a year (Figure 1). The per capita increase averaged 0.5 percent a year. Growth in production was not evenly distributed: some countries and regions became large surplus producers while others experienced rising deficits. Although the growth in production has fallen below the long-term growth rate during the last seven years, it is unclear that this represents a slowing in production growth.

Technical change and increased use of purchased inputs have significantly affected production. Area for major crops increased substantially in the 1950s and 1960s, but most production increases over the last 15 years were due to increasing yields per acre (see Figures 5 and 8). Government-supported research and extension programs helped boost productivity as did price support programs.

World grain and soybean yields have risen an average 2.3 and 1.8 percent a year during the last 25 years. We have seen most of the effect of the "Green Revolution" in rice and wheat, but other technologies and productivity enhancing production practices continue to emerge. The growth in crop yields has recently shown minor signs of slowing down, perhaps responding to lower world producer prices rather than the lack of technical innovations. Increasing feed efficiency will likely continue to boost livestock productivity. There are a number of new technological developments for the livestock sector, although their dissemination and adoption will likely be slow because of environmental and health concerns and constraints imposed by investment or management requirements.

The growth in agricultural production will likely fall below the last decade's 2.4-percent rate:

- Some countries enjoyed high growth rates during the last 10 years which will be difficult to sustain. Examples are China, Malaysia, Saudi Arabia, and the Ivory Coast.
- Low world prices and slower demand growth will probably slow yield growth rates. Average yields for wheat and rice will likely climb at a slower pace than in the past 15 years, during which use of high-yielding varieties rapidly expanded in major producing areas. The growth in coarse grain yields may also slide below the 2.3 percent long-term trend.
- Low world market prices are likely to discourage countries with rapidly expanding production and self-sufficiency from becoming significant agricultural exporters. China and India are examples.
- Low world prices will also deter production expansion in other countries, particularly those with high costs of production.

The Soviet Union, China, and the European Community (EC) will play critical roles in world production. The Soviet push for greater efficiency will probably not result in the same type of fundamental restructuring and investment in agriculture that caused China's spurt in output. And China will find it difficult to sustain recent trends in agricultural output and trade. The EC will likely continue to restrain its production incentives; its rate of growth in output will probably slow.

World Trade Prospects

Even with little multilateral movement toward trade liberalization, a confluence of factors are moving us towards the long-term rising trend in world agricultural trade—3.5 percent a year since 1960, faster in the 1970s, but slower in the 1980s (Figure 2). There has been a trend toward world integration of agricultural markets. In addition, world commodity and financial markets are becoming more closely linked. During the early 1980s, a number of countries responded to balance-of-payments and debt problems by curtailing imports, income growth, and investment. The debt problems are being slowly resolved. Full resolution, though not likely within the next 5-10 years, will mean brighter trade prospects. The tendency to accumulate surpluses implies relatively low agricultural prices for some time. Thus, we can expect:

- Somewhat slower growth of supply than in the last decade.
- Somewhat faster consumption growth than during the 1980s.
- A shift of the production/consumption balance so that the current large stocks of grains gradually drop.
- Growth in world trade moving back toward historical rates.

The gains in world agricultural trade flowing from this scenario will be gradual. Prices, particularly for grains, are likely to remain relatively depressed. World trade in farm products may expand 3-4 percent per year, below the 4-5 percent of the 1970s, but well above the stagnation of the 1980s.

World demand for wheat should continue to show strong growth, particularly in the developing and centrally planned countries. China will account for the largest increment of world wheat demand as the per capita consumption gains of the last decade continue. Expanding feed use is a relatively new factor contributing to the growth prospects for wheat. With consumption growing, the several-year-old recovery of world wheat trade will continue. World trade has recovered three-fourths of the 22-million ton drop of 1985/86. Although gains will be slower, the upward trend is clear. World wheat trade will probably grow about 3 million tons over each of the next five years, only slightly slower than the pace of the 1970s and early 1980s.

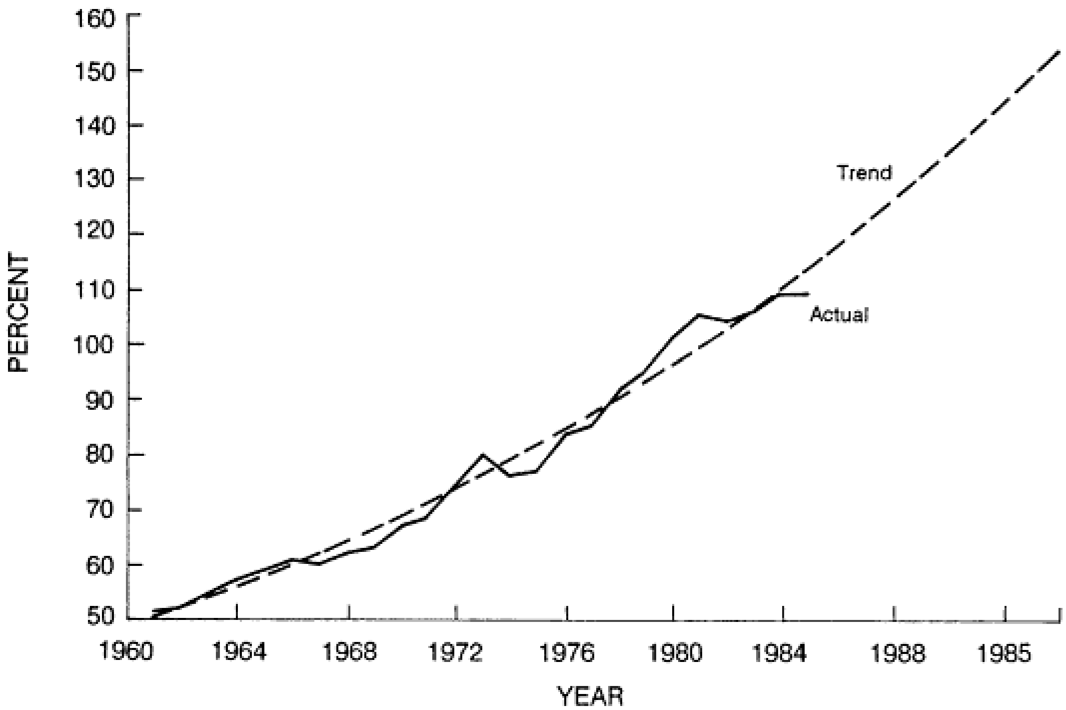

Figure 2
World Agricultural Export Volume

Demand for *livestock products* will expand at a somewhat slower rate than in the 1970s as slower growth in incomes and population offset consumer preferences for improved diets. Beef will continue to dominate world trade in meat. But, poultry meat trade should expand, with the major poultry meat importers of North Africa and the Middle East together with several Asian markets providing much of the gain. Poultry meat will likely account for virtually all of the per capita increase in the world's meat consumption.

Growing feed-use will account for all of the gains in coarse grain use. Large gains in feed use are expected in Mexico, North Africa, the Middle East, and East Asia as poultry and livestock operations expand to supply the meat demand generated by growing population and income. Large gains are also expected in the centrally planned economies. World coarse grain trade has shown virtually no increase over the last 2 years after its precipitous decline in 1984/85. But, an anticipated increase in demand for coarse grain in importing countries will translate into growing world imports. Developing country markets, where consumption is rising, are particularly likely to increase feed imports, as will China and newly industrialized countries in Asia. Total world trade in coarse grains is likely to increase by 2.3 million tons a year, roughly half the rate of the 1970s. Large supplies of feed-quality wheat on world markets will add to the pressure on coarse grain prices. Competition among various feed grains will be intense.

Growing world demand will expand trade in *oilseeds and products*. although growth will be restrained by the EC's continuing move toward self-sufficiency. The strongest growth in import demand is likely to come from the centrally planned economies whose increasing oilseed and protein meal imports will enable them to more efficiently use feed grains.

World *cotton* trade over the last 2 years differs from the grain pattern. Cotton trade has jumped to a record level, world stocks have dropped precipitously, and prices have strongly recovered. Cotton trade will expand only modestly over the next decade because trade levels are already high and consumption is growing slowly. Trade grew by only about 100,000 bales a year during the 1960s and 1970s. Growth is unlikely to greatly exceed those gains. Increasing barriers to textile trade will mean a smaller volume of world cotton trade and lower prices for the world's cotton exporters.

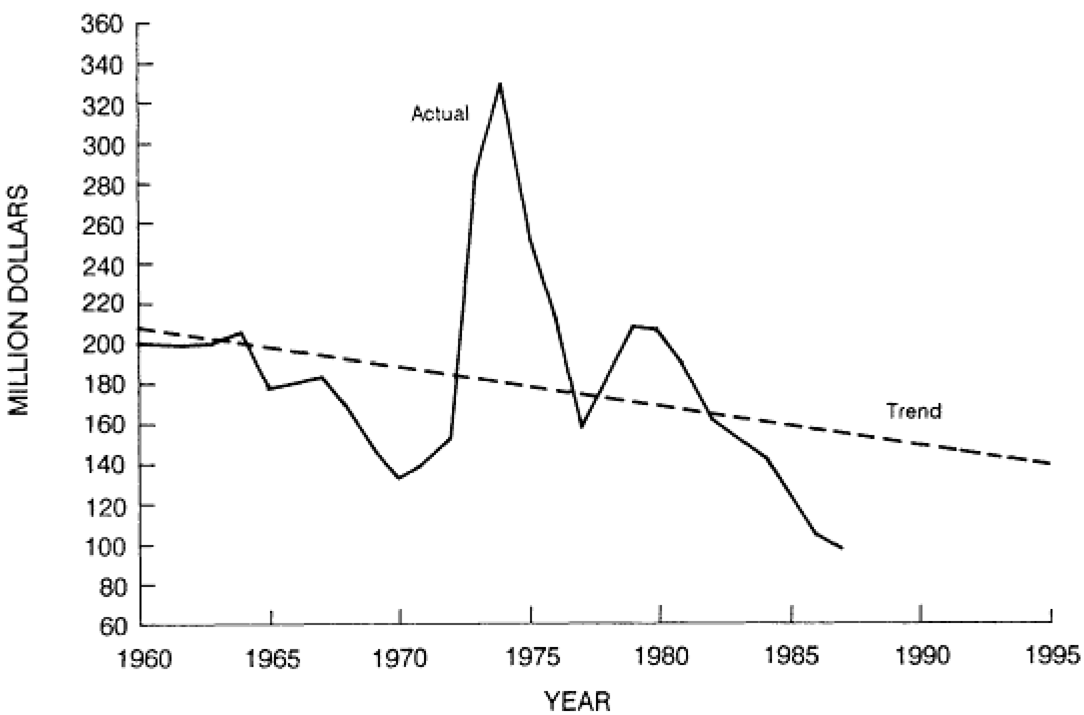

Figure 3
Wheat Prices: Hard Red Winter

Excess Capacity Remains

While grain, oilseed, and cotton stocks are beginning to drop, world agriculture will continue to have excess capacity for the rest of this century, particularly in the developed exporter nations. Growth of agricultural production in the developed market economies would need to be cut to approximately 1 percent per year, half of the projected expansion in productive capacity, to balance output with domestic and export demand according to FAO (1985).

Prices

Fierce competition between exporters for world markets burdened with surpluses have caused a sharp drop in world prices in the 1980s. Average cereals prices during the last 3 years, measured in 1982 constant dollars, were 40-50 percent below levels of the early 1960s. Soybean and soybean oil prices declined 35-40 percent and cotton prices are 45 percent lower. Wheat prices have trended downward at about 2 percent a year since 1960 (Figure 3). Other cereals and oilseeds have followed similar trends.

Price patterns have been erratic however. After a sharp but short spike in prices in the mid 1970s, prices of most commodities have continued to decline sharply in the 1980s. Just as the 1970s price peak was an anomaly, the current low prices are below long run market-clearing equilibriums. Prices are expected to rise during the next several years as some of the current surpluses are worked off. However, the major producing/exporting countries will have problems in idling excess production capacity and will continue to compete for foreign markets. Other countries will promote exports to earn badly needed foreign exchange. Thus, world prices are expected to remain low for an extended period unless major regional production problems emerge.

OUTLOOK FOR DEMAND, SUPPLY, AND TRADE IN DEVELOPING COUNTRIES

Developing countries are increasing their food production, but growth in population and per capita consumption are causing food use to rise faster. The growth in production and in food demand is unequally distributed among the developing countries. Some countries are gradually becoming more self-sufficient, but the food gap in other low income countries is widening. Some parts of Africa and Latin America will probably become more dependent on food aid in the coming decade.

Demand in Developing Countries

Growing demand would brighten prospects for global agricultural exports if sustainable economic growth generated the revenues to pay for increased food imports while meeting debt payments. However, despite the recovery from the world recession of 1981-82, the debt repayment problem continues to constrain developing countries' agricultural imports. Resolution of this problem is one major precondition for the return to a normal world trading environment.

The process of adjusting to the over accumulation of debt in the 1970s has had several major consequences. For the developing countries, there has been a decline in per capita income growth, a direct result of policies to constrain imports at least partially by inhibiting aggregate demand. Imports have also declined as countries attempted to control balance-of-trade deficits. Falling prices for their exportable products have been an additional constraint on many countries' ability to buy imports with export revenues.

Export revenues have not grown as expected, partly because of increased competition for export markets. The increasing competition, resulting from various attempts to generate revenues for debt repayment, has driven down commodity prices, further exacerbating the repayment problems.

Renewed growth in developing countries will require investment in new industries or in existing export industries. The world's creditor nations have withdrawn credit or been reluctant to extend more credit to the debtor nations. This has resulted in reductions in gross domestic capital in the debtor countries. The ability of the developing countries to generate renewed growth is predicated on their capacity to increase investment and exports. Therefore, if a substantial number of countries are simultaneously reducing their capital formation as well as their imports, increased export sales could become extremely difficult. Such has been the case since 1982.[1]

[1] For a more complete discussion of the effect of the Third World debt problem on agricultural trade, see Shane and Stallings (1987).

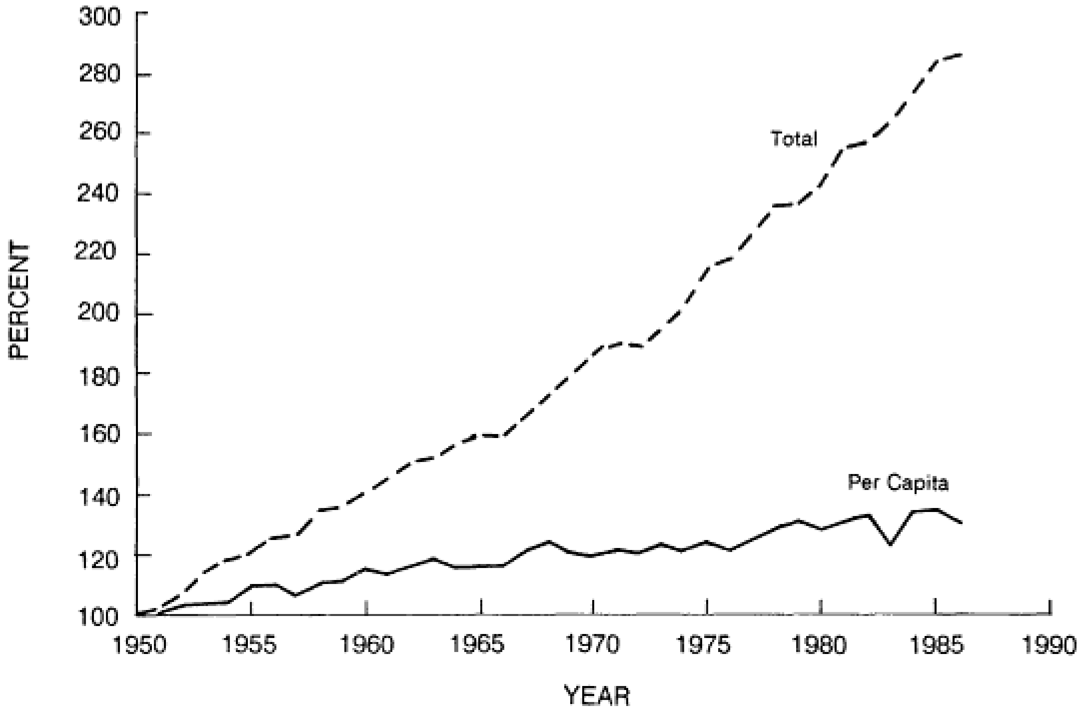

Figure 4
Agricultural Production in Developing Countries

Supply in Developing Countries

Agricultural production in all developing countries rose steadily during the last 35 years, averaging 2.9 percent a year, compared with 2.4 percent for the world. Per capita production rose nearly 0.8 percent a year (Figure 4). Although production has risen faster than population growth. consumption has risen even faster. As a result, self-sufficiency has tended to decline for a number of commodities, and imports have risen.

The *cereals* sector is the best, and most important, example of these trends. Between 1960 and 1987, the growth in production of total cereals averaged 2.7 percent a year in developing nations. The 1.9-percent growth rate of average yields contributed more to increasing production than did the average 0.8 percent annual expansion in area (Figure 5). The growth in area tapered off during the 1980s and average yields have not risen for the past three years. However, the long-term outlook is for cereals production to continue to rise, although at a slower rate.

Self-sufficiency in cereals in developing countries has declined from an average of more than 55 percent in the early 1960s to about 50 percent during the 1980s (Figure 6). Net cereal imports by these nations increased from less than 10 million tons a year during the early 1960s to more than 50 million tons last year. Net cereal imports climbed slightly more than 8 percent a year since 1960 (Figure 7). During the 1980s, net cereals imports have risen about 2.5 million tons a year. The rate of increase in cereal imports is expected to slow slightly.

Oilseeds present a similar story (Figure 8). Total oilseed production has increased rapidly since 1973, averaging 3.5 percent a year. Increasing average yields, 1.9-percent growth rate, contributed more than did area expansion, 1.6 percent. Oilseed area climbed

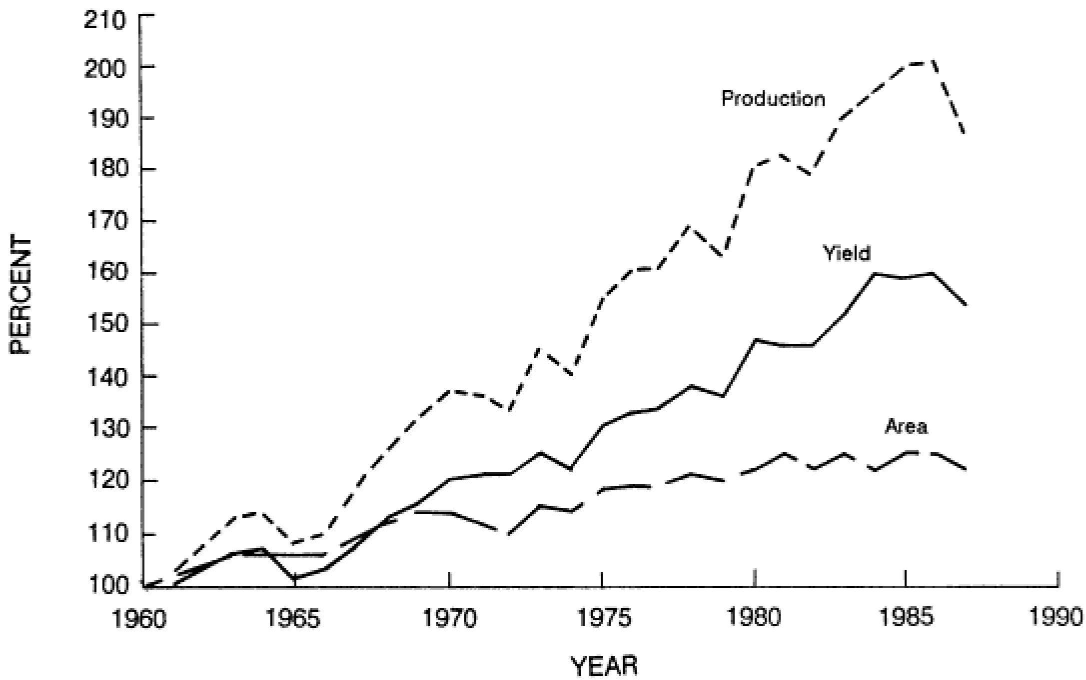

Figure 5
Total Cereals: Area, Yield, Production

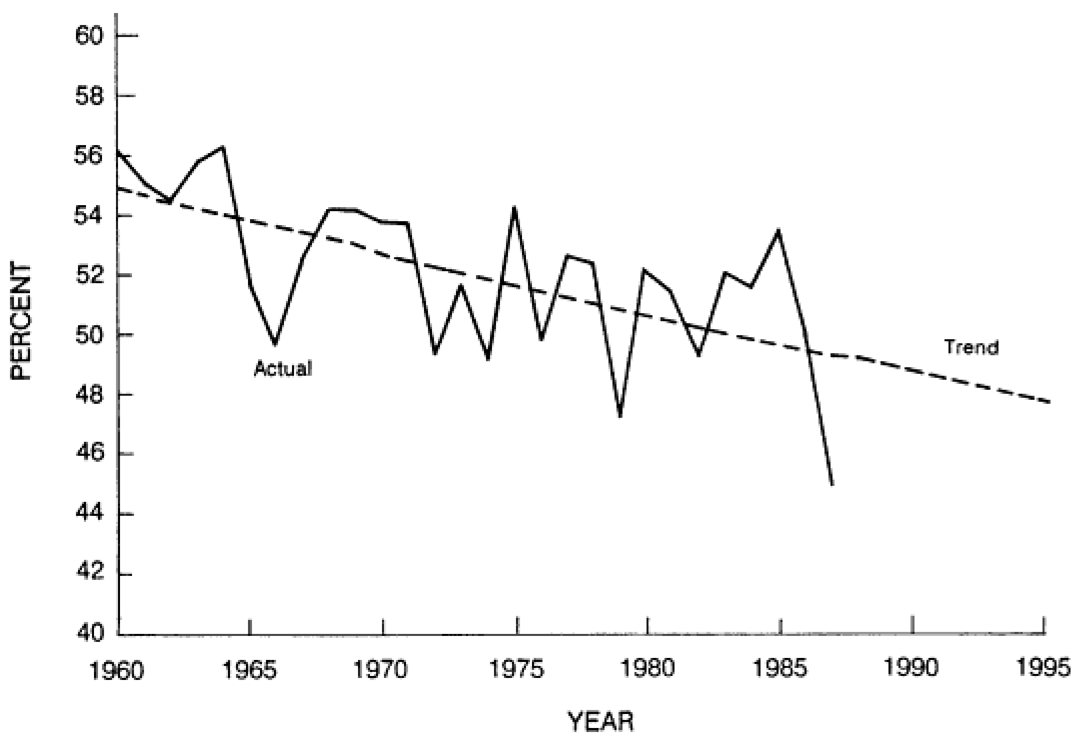

Figure 6
Cereals Self-Sufficiency in Developing Countries

significantly faster than cereals area. Average oilseeds yields, as with cereals, have not risen for three years.

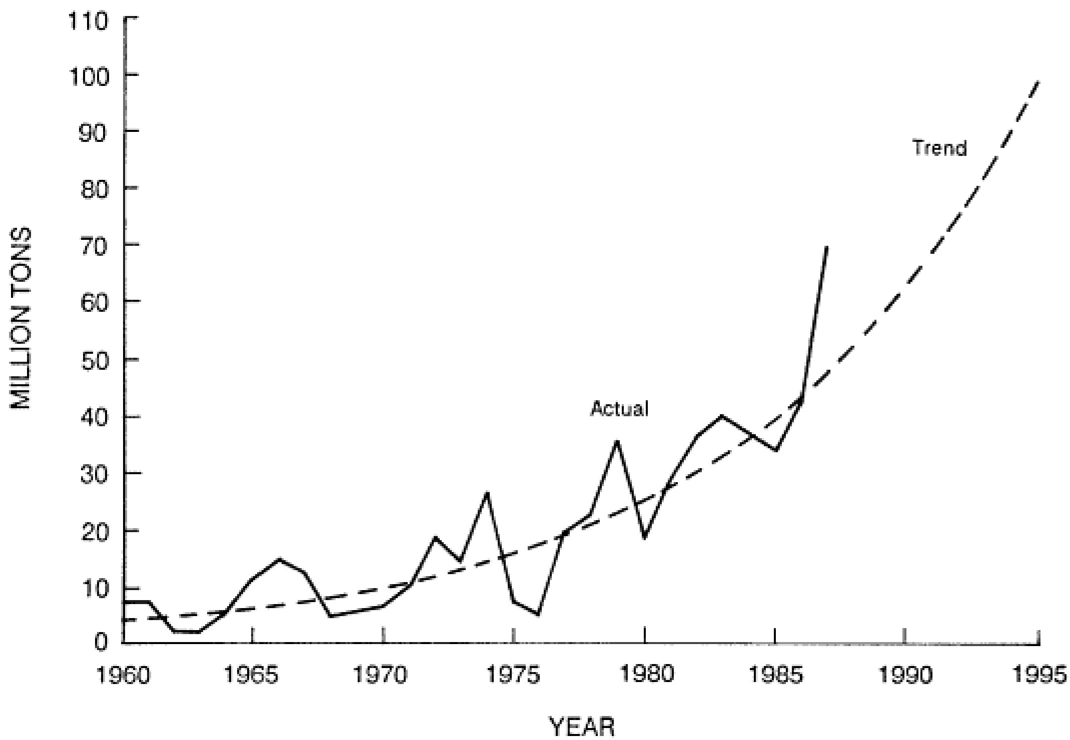

Figure 7
Net Cereals Imports in Developing Countries

Although developing country self-sufficiency in oilseeds has remained relatively constant, self-sufficiency for the byproducts—vegetable oils and protein meals—has declined (Figure 9). The self-sufficiency ratio in vegetable oils declined from about 128 percent in the late 1960s to nearly 100 percent in 1980, but recovered to 108-112 percent in recent years. Vegetable oil net exports declined from the 1965-75 average of 1.2 million metric tons to less than 1 million tons in the early 1980s (Figure 10). Vegetable oil exports have risen during the last three years as Malaysian palm oil production and exports increased and are expected to continue rising in the 1990s.

Cotton has been a major export crop for some developing countries. Yield increases contributed to nearly all of the 2-percent growth rate in output, since planted area changed little. As with cereals and vegetable oils, both cotton self-sufficiency and net exports declined. Self-sufficiency fell from more than 160 percent in the early 1960s to around 120 percent in the last several years. Net exports fell more than 15 percent during the same period.

Natural Resource and Technology Concerns

Future agricultural production gains in the developing countries will depend on land use and the continued adoption of yield-enhancing technology. The expansion in area planted to major crops (cereals, oilseeds, and cotton) has fallen well below the 0.7-percent long term growth trend during the last six years (Figure 11). Although productivity gains continued to boost production, the future for technological advances is uncertain.

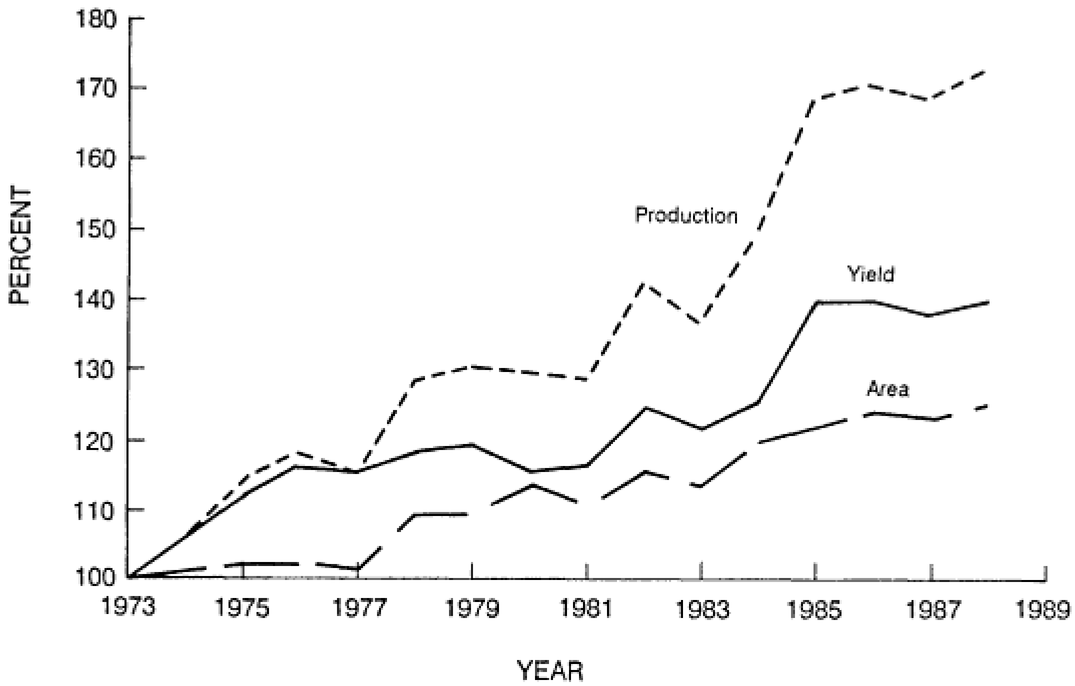

Figure 8
Oilseeds: Area, Yield, and Production in Developing Countries

Land is being used more intensively in the developing countries. Multiple cropping and increasing intensity of slash and burn agriculture are mining soil fertility and, in some cases, causing permanent loss of productive capacity, as well as siltation of downstream irrigation and flood control infrastructure. Deforestation and desertification are resulting from intense competition for food and fuel. It is unlikely that changes in land use will make significant additional contributions to production in the future unless producer prices increase significantly.

Gains in agricultural output will depend more on technological advances because of the constraints on increasing planted area. However, the "green revolution" technology has already been widely distributed. Indeed, appropriate application rates for fertilizer and pesticides have been exceeded in some areas. And, there does not appear to be radical technological breakthroughs immediately on the horizon which can have the same impact on output as did the high yielding varieties. Management constraints and health concerns will limit the use of livestock growth hormone technologies in the developing countries during the next 10 years. Meat production will likely rise, even on a per capita basis, but only as a result of better management of traditional production and feeding practices.

Trade Prospects for Developing Countries

In the 1960s, the developing countries' total net agricultural exports averaged $15 billion (in real 1974-76 dollars). Since the early 1970s, the trade surplus has disappeared (Figure 12). The volume of agricultural imports by developing countries has risen at a 3.2-percent compound growth rate since 1967, while exports grew at only 2.1 percent. The gap widened rapidly in the late 1970s and early 1980s as rising per capita income and the availability of international credit boosted demand. Commercial agricultural imports by developing countries declined in 1985 and 1986 as the debt problem intensified and the growth in credit slowed.

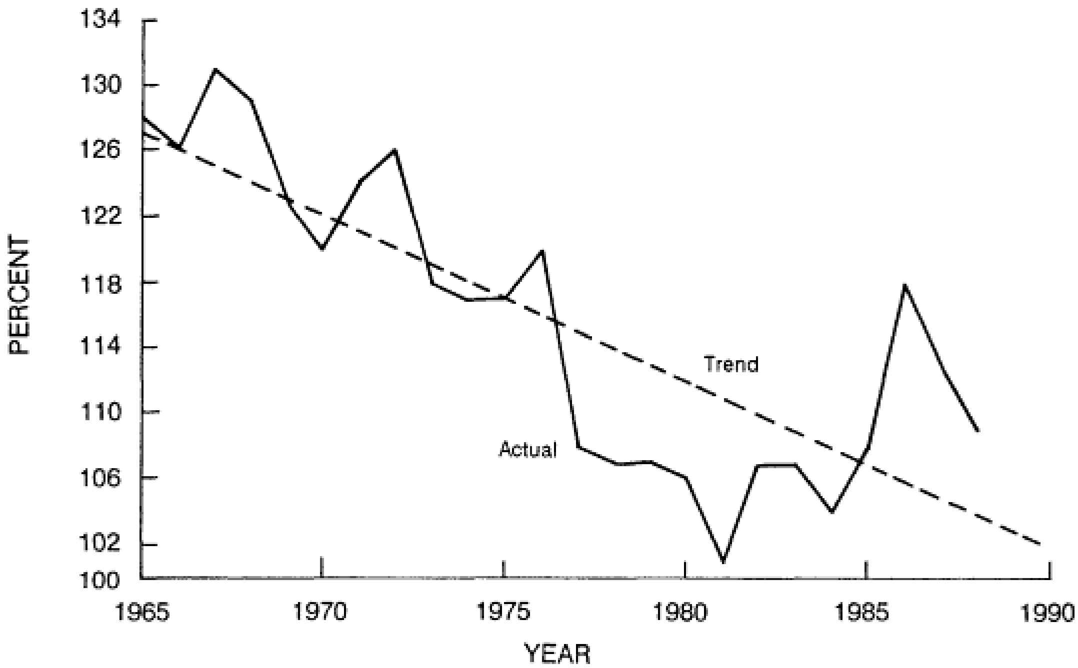

Figure 9
Vegetable Oil Self-Sufficiency in Developing Countries

Food aid shipments to developing countries trended upward at a 3.7-percent growth rate (1974-87). The volume of all food aid products (13.3 million tons in 1987) has grown an average of 350,000 tons a year during the last decade (Figure 13).

An estimated additional 19.7 million tons of cereals are needed in 69 developing countries in 1987/88 to meet minimum nutritional standards. Increases in food aid to meet nutritional need are largest in South Asia (6 million tons) and in East Africa (5.7 million) (ERS, 1987).

Although cereals dominate total food aid (92 percent of volume during the last three years; Figure 14), contributions of dairy products and other noncereals have been growing much faster. During the last 10 years, the trend growth rates for cereals was 1 percent, compared with 9.7 percent for dairy products and 13.7 percent for other noncereal products.

Food aid as a percentage of total imports rose significantly the last several years. During the late 1970s and early 1980s, cereals imported as food aid accounted for 12.18 percent of total cereals imports. Since the mid-1980s, cereal food aid comprised more than 20 percent of total imports.

One of the reasons for increased food aid in recent years has been the limited foreign exchange that developing countries have had available for commercial imports. In 1984 and 1985, 69 developing countries spent about 10 percent of their collective foreign exchange availabilities (defined as foreign exchange reserves plus export earnings minus debt service obligations) on commercial food imports; 30 countries used more than 10 percent, 8 used more than 20 percent, and 2 more than 30 percent.

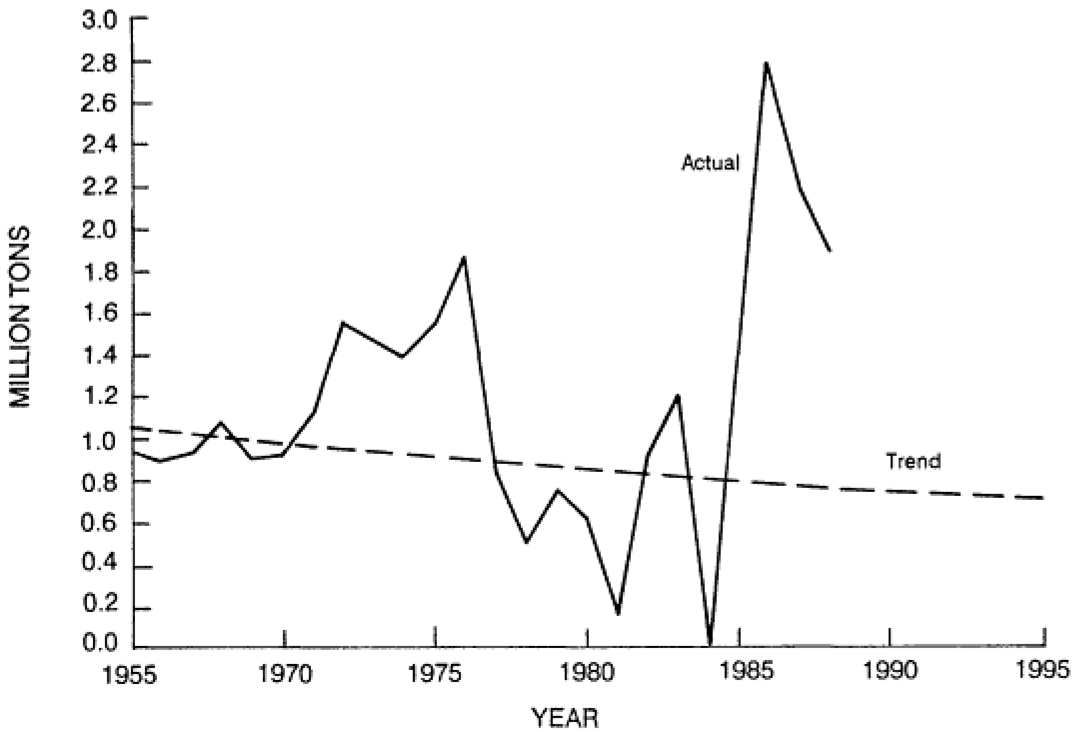

Figure 10
Vegetable Oil Net Exports in Developing Countries

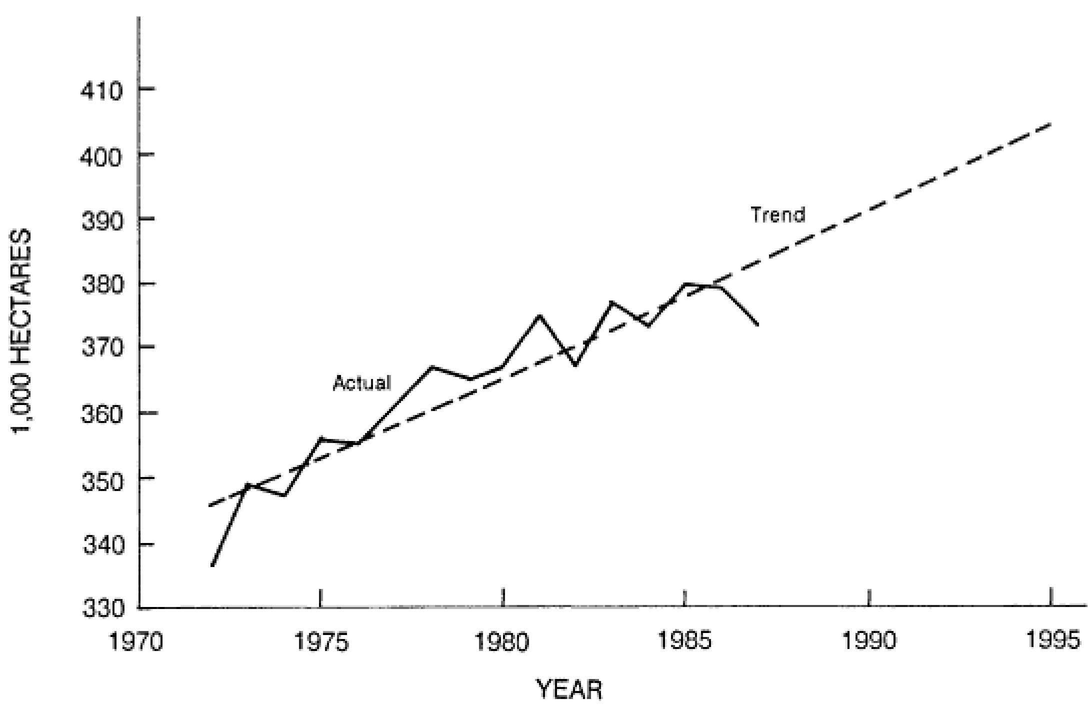

Figure 11
Area Planted to Major Crops in Developing Countries

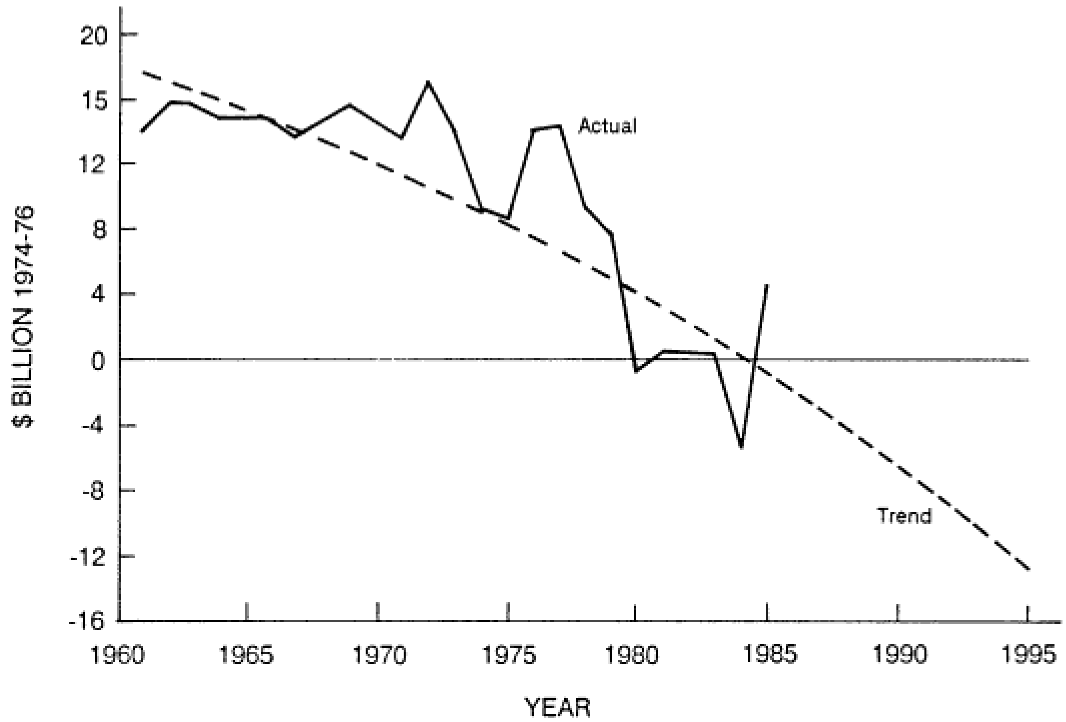

Figure 12
Real Agricultural Net Exports in Developing Countries

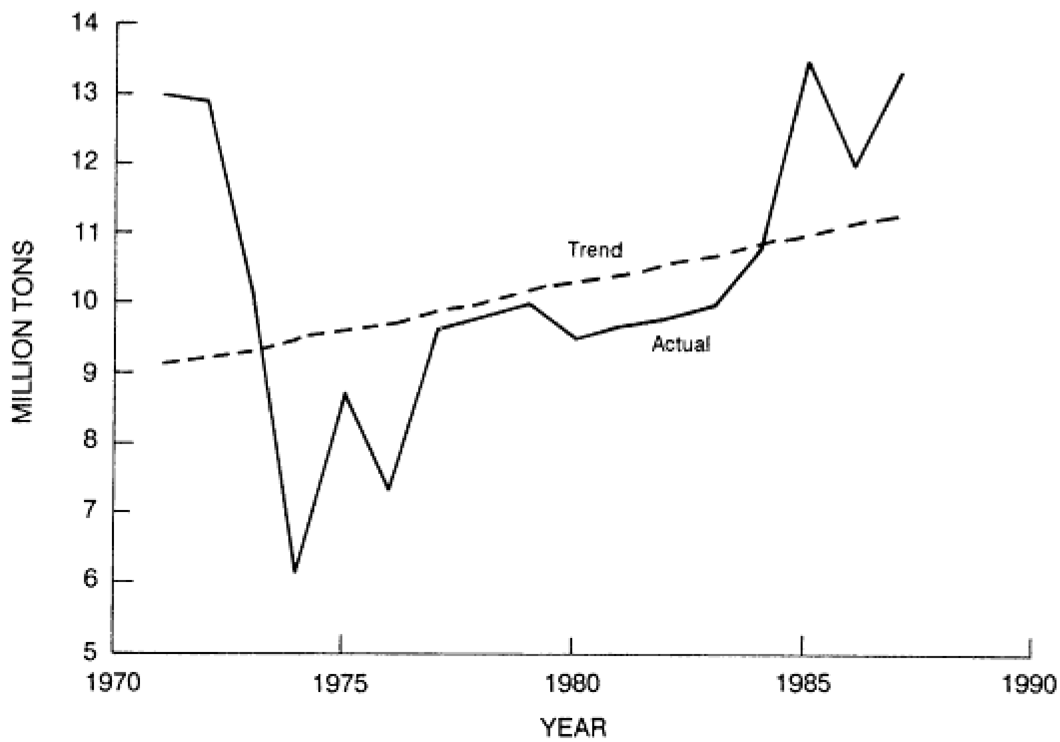

Figure 13
Volume of World Food Aid Shipments

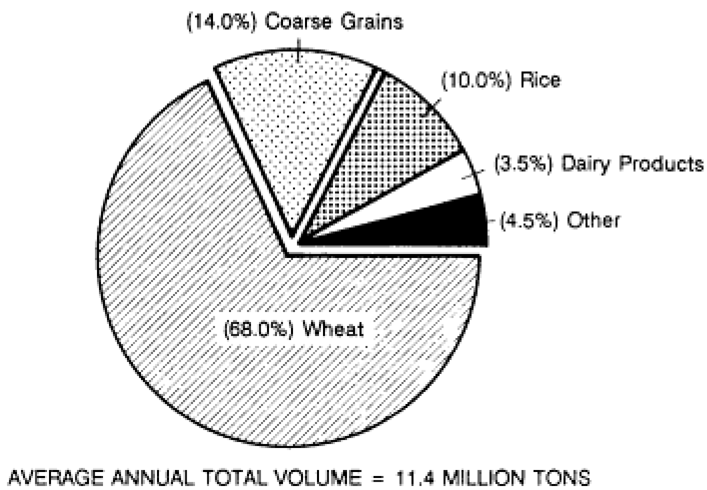

Figure 14
Composition of World Food Aid

CONCLUSIONS

Many of the long-term trends, interrupted in the 1970s and 1980s, may reemerge during the coming decade.

World agricultural production will continue to rise during the next decade, but at a slower pace than in the past. Surpluses will continue to persist, but will gradually decline from their current high levels. Real agricultural prices will rise slowly from current depressed levels, but excess production capacity in major exporting countries will keep real prices low for an extended period. International agricultural trade will pick up again, but not reach the growth rates of the 1970s.

Demand growth in developing countries will rise from current depressed levels, but stay below the 1970s because of lower population and income-growth rates. A few middle-income developing countries will enjoy rising per capita consumption, as well as quality improvements in diet. For the bulk of the low income countries, however, per capita consumption will stagnate. The growth in agricultural output will slow slightly as land resources increasingly become a constraint to expanded output. Productivity increases could slow somewhat during the next decade because "green revolution" technology is already widely distributed and no major new readily applicable technology breakthroughs are on the immediate horizon. Developing countries will continue to shift from being net agricultural exporters to becoming net importers. The need for both commercial food imports and food aid will rise significantly if current nutrition levels are to be maintained in the low-income countries.

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Appendix G

A Discussion of Long-Term Agricultural Commodity Forecasts and Food Aid Needs

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PREFACE

This paper compares the long-term projections of prices, supply, demand, and trade made by economists from the World Bank, U.S. Department of Agriculture, and Iowa State University for the XX International Conference on Agricultural Economists. Subsequently, the implication of these projections for food aid were discussed at a U.S. National Research Council workshop on Food Aid Estimates for the 1990s.

It should be noted that all of the projection summarized in this study were made prior to the drought of 1988. Nonetheless, we feel the projections are indicative of the long-run trends in the agricultural sector and, perhaps more importantly, how these trends can be altered by changes in economic growth, technological change, and the trading environment.

INTRODUCTION

The comparison of the properties and projections of agricultural commodity models is a relatively recent phenomenon (Meilke, 1987). However, it is an important way to (1) foster improvements in commodity modeling, and (2) expose the profession to areas of consensus and disagreement that exist among he handful of large scale models being used on a regular basis. It is equally important for any model commentator to acknowledge that it is far easier to criticize a model than it is to build one. Criticism is easy because model building involves an exercise in constrained optimization. The constraints in model building are capital, labor, data, and, perhaps just as importantly, the ability to assimilate, understand and describe the results of the analysis. Food aid needs modeling is further complicated by factors that cannot be internalized such as weather and political processes. Because of these constraints, model building involves trade-offs and compromises. These choices are often guided by the original purpose for which the model was developed; and while we

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sometimes argue the need for all-purpose models, what we generally have are models that were developed for a single purpose that then evolve and are adapted to fulfill other roles.

The difficulties are well illustrated by the tasks assigned to the model builders. First, they had to forecast future supply, demand and prices for many commodities and countries (or groups of countries) in order to compute net imports, also referred to as the "import gap." Second, they had to determine the volume of commercial imports and food aid that constitutes the total imports of net importing developing countries. The detail of the models necessary to perform either—let alone the two—assigned tasks, is very demanding, and thus forces compromises in model building.

The models presented at this conference fall into two categories. The first category includes models specifically designed to perform the first task. Food aid and commercial imports are not differentiated and, hence, are implicitly assumed to be perfect substitutes. It follows that these models do not address food aid needs directly. The Food and Agricultural Policy Research Institute (FAPRI), World Bank (WB), and Static World Policy Simulation Modeling (SWOPSIM) models fit this description. Models belonging to the second category have a comparative advantage in performing the second task since they were designed exclusively for that purpose. The International Food Policy Research Institute (IFPRI) model developed by Dr. Hannan Ezekiel appears to be an improvement on the other models in the second category. Consequently, we will focus on this model when discussing models belonging to the second category. In the remainder of the paper, our comments are organized under four broad headings: (1) model design and scope; (2) policy implementation; (3) model inputs and assumptions; and (4) model results.

MODEL DESIGN AND SCOPE

The FAPRI (Johnson, et al., 1988) model was initially designed to provide detailed short-to intermediate-run forecasts of the U.S. agricultural economy. As U.S. agriculture has become more open to international forces, the "foreign" component of the FAPRI model has been expanded to include econometric representations of many major trading nations. Nonetheless, while the country coverage for the FAPRI gains model is now fairly extensive, its "U.S. forecasting roots" are still obvious. Detailed and comprehensive evaluations of policy changes on the welfare of nations outside the United States are beyond the scope of the FAPRI model because of the limited country/commodity coverage. Even for the United States, the calculation of standard welfare measures from FAPRI is not a trivial matter. Most commodities involve multiple demands and complex expectations mechanisms that make calculating producer and consumer surplus difficult. The model is particularly useful in computing the "import gap," or the difference between domestic use and production, but falls short of estimating food aid needs.

Conversely, SWOPSIM (Roningen, et al., 1988) is an example of a model designed to evaluate trade liberalization scenarios. It was not intended to be used in a forecasting mode and it is normally calibrated on a historical time period. SWOPSIM is similar in design to other synthetic models developed by OECD, and Cahill. These models tend to provide comprehensive country coverage, although only five of SWOPSIM's eleven regions are single countries. Twenty-two commodities are produced and consumed in each SWOPSIM region, although in a few cases commodities are aggregated. Given the simple static supply/demand structure of SWOPSIM, welfare analysis involves rather straightforward calculation of consumer and producer surplus. We should not leave the impression that SWOPSIM has solved all of the problems involved in analyzing trade liberalization. SWOPSIM is a static model, and as such it can say nothing about the time path of adjustment from one equilibrium solution to another. In particular, the biological constraints and dynamics of livestock production are largely ignored. Stockholding, which is crucial in the short and medium run for grains, is modeled explicitly in FAPRI and WB, but stocks are assumed fixed in SWOPSIM. In addition, policy interventions are treated exogenously and incorporated as price wedges rather than as explicit policy variables (de Gorter, 1987).

FAPRI and the World Bank (Akiyama and Mitchell, 1988) models are dynamic, and one of their strengths is their ability to trace the time path of adjustment resulting from a policy change or exogenous shock (for example, drought). Stockholding is modeled explicitly, and for the United States most policy instruments, which are set exogenously, are embedded in the structure of the model. The WB model for grains is an annual econometric model as are the coffee, tea, and cocoa models which have features specific to perennial crop modeling. However, like FAPRI, the WB grains model began its life as a U.S. forecasting model. Its eclectic choice of countries to be modeled and the lack of policy detail in non-U.S. countries does not lend itself to an analysis of multi-commodity trade liberalization. The WB models do highlight a serious shortcoming in most of the current generation of multi-region, multi-commodity models in that they are almost without exception focused on temperate zone products and countries, even though the export value of the tropical products, sugar, and beverages accounts for almost 14 percent of the value of the world's agricultural exports (FAO, 1987).[1] Sugar and rice appear to be the only commodities of direct interest to LDCs that have been given much attention in current models.

All of the above models are partial equilibrium models, thus negating our ability to calculate the welfare costs and employment effects of agricultural policies on the nonagricultural sector. Similarly, agricultural inputs other than feed have been almost totally ignored in our modeling efforts. This implicitly assumes that agricultural inputs purchased from the general economy have perfectly elastic supply schedules.

Trade and domestic policies have important consequences for the value of agricultural assets. The wealth of the agricultural community is largely determined by the value of land. Thus, it is crucial to know the impact of various types of market interventions on the value of agricultural land since the effects can vary greatly across potential instruments (Hertel, 1988).

The IIASA model is a general equilibrium model especially designed to analyze world trade. Its general equilibrium framework is an advantage since it internalizes cross-sectoral effects in addition to cross-commodity effects. As far as this workshop is concerned, the shortcomings of the IIASA model are: (1) its somewhat aggregated commodity coverage, and (2) the fact that its imports are not partitioned into food aid and commercial imports.

At first glance, the Ezekiel model appears more useful for the purpose of this workshop than models that do not explicitly model food aid needs. However, it is less efficient at estimating the import gap than the partial equilibrium models in the first category (like the FAPRI model) which also rely heavily on trend variables such as population growth and GNP per capita growth to generate their forecasts. Unlike the Ezekiel model, models in the first category also allow for cross-commodity effects that may not have a negligible impact on the size of the import gap. Being influenced by the magnitude of the import gap, food aid needs estimates can be severely biased if the import gap estimate is inaccurate.

Every commodity is converted into cereal equivalents in the Ezekiel model. Such a transformation implies perfect substitutability between commodities. Alternatively, one

[1] In 1985, exports of tropical products, sugar and beverages contributed only 2.9 percent to the value of agricultural exports in developed countries as opposed to 36.6 percent for the LDCs (FAO, 1987).

can think of the model as a characteristic model with only one relevant characteristic: cereal equivalence. It can be argued that neither assumption is realistic, but that they can be justified on the grounds of simplicity. Characteristic models with one characteristic are not uncommon in the field of international trade, and the assumption is often used in the modeling of international trade of grains where the grade assigned to a given lot is a scalar.

First Stage (Import Gap)

Import Gap = Domestic Use-Production

Domestic Use = Food Use + Feed Use + Seed Use + Other Uses

-Domestic Use	— Food Use =	*f* (GNP/cap. trend rate of growth, income elasticities of demand at 5 yearly intervals, population growth)
	— Feed Use=	*f* (GNP/cap. trend rate of growth, income elasticities of meat demand, population growth)
	— Seed Use =	*f* (production)
	— Other Uses =	*f* (food use + feed use)

-Production = *f* (trend rate of growth for each staple food)

Second Stage (Commercial Imports and Food Aid Needs

Food Aid Needs = Import Gap-Commercial Food Imports

-Commercial Food Imports =	actual commercial food imports times GNP/cap. trend rate of growth

Figure 1
Estimation of Food Aid Needs in the Ezekiel Model

The methodology used by Ezekiel is characterized by two stages. In the first stage, the import gap is estimated as the difference between production and domestic use. As shown in Figure 1, production depends on the trend rate of growth for each staple food. Domestic use is the summation of food use, feed use, seed, and other uses. Food use is influenced by three parameters: (1) the GNP per capita trend rate of growth; (2) the income elasticities of demand; and (3) population growth. Feed use is a function of the same parameters except that the income elasticities for feed demand are proxied by the income elasticity for meat. Seed use is estimated as a proportion of production while other use is determined as a fraction of the sum of food and feed uses.

Food aid needs being the difference between the import gap and commercial imports, the second stage consists of estimating commercial imports and then deriving the residual food aid needs. Commercial food imports can be estimated by regressing commercial food imports on a given set of explanatory variables and by using these estimates to forecast the future. Foreign indebtedness, the import gap, foreign exchange earnings, and domestic and world prices can all be rationalized as potential explanatory variables. As pointed out by Ezekiel, regressing commercial food imports on these variables yields, at best, the country's willingness to buy commercial imports. Ezekiel argues that the modelers' objective must be more normative in the sense that it is the capacity to buy commercial food imports that should be calculated in order to get food aid needs and not food aid wants. To achieve this goal, Ezekiel uses actual commercial food imports and multiplies it by the GNP per capita growth rate, which supposedly reflects the country's ability to pay. Indeed, he implicitly assumes that the actual commercial food imports in the base year are representative of the country's ability to pay. Another problem with the methodology and its normative ambitions lies in the calculation of the import gap. If the objective is to estimate food aid needs in a normative sense, this should be reflected in the first stage as well by using cereal equivalent requirements instead of demand estimates. The problem goes beyond the semantics. Do we want to estimate food aid needs in its purest (normative) sense or do we want to calculate the difference between what consumers demand (given a budget constraint like per capita GNP) in excess of domestic production and what the central planner can afford to import? The latter concept is difficult to interpret because it estimates food aid needs based on market demand and the central planner's "capability" to satisfy this market demand via commercial imports assuming that prevailing prices are undistorted. Artificially maintained low prices (which are common in LDCs) would overestimate the so-called demand-based food aid needs.

Of greater concern to us is the lack of theory behind the proposed methodology. The import gap is determined in a first stage and assumed constant thereafter, even though food aid may affect both production and demand. In a standard micro problem, food aid could be seen as an initial endowment having an income effect affecting both demand and production of the various goods included in the model. There are no reasons why the difference between demand and production has to stay fixed when the endowment changes. Unless the receiving country has a minimum target price (a questionable target!), why should the demand for food aid not be infinite?[2] Food aid volume would thus be determined on the supply side if there were one in Ezekiel's model. In a country like Canada that uses marketing quotas to avoid excess supplies of grain, the expected grain donation has to be included in the determination of the quotas. Evidence suggests that food aid donations are price responsive in the sense that changes in prices can induce variations around the expected donation at any point in time. Perhaps the best method to model food aid would be to build a disequilibrium model. In practice, this would be next to impossible since political markets would have to be included. We are back to where we started and the Ezekiel compromise appears to be a viable alternative.

POLICY IMPLEMENTATION

The way in which agricultural policies are accounted for in the SWOPSIM and FAPRI models differs significantly (explicit policy variables do not appear in the WB model outside the U.S., and a trade liberalization scenario was not conducted). SWOPSIM involves more commodities but fewer individual countries than FAPRI. Agricultural trade liberalization in FAPRI is limited to grains in the U.S., E.C., Japan, Brazil, Argentina, and most importing countries, plus livestock in the U.S., E.C., and Japan.

In SWOPSIM, policy interventions are accounted for in using calculated by price wedges (between domestic and world prices) and policy insulation is accounted for by using elasticities of price transmission of less than one. The size of the price wedge in SWOPSIM is equated to the producer subsidy equivalent for each commodity, in each country, using a broad definition of policy intervention (USDA, 1988). To illustrate this point and to provide a contrast with FAPRI, we chose to investigate the treatment of Canadian wheat.

In SWOPSIM, the Canadian market price for wheat is 117 C$/mt but the supply inducing price is 200.1 C$/mt. Canada's price transmission elasticity is assumed to be one. To model trade liberalization, the per unit PSE in Canada, as well as in all other countries,

[2] The demand cannot be infinite if the receiving country has to pay for shipping. We are assuming that food aid is free.

is set to zero, and for some countries the elasticity of price transmission is increased. The maintained assumption is that a dollar transferred to producers under any program has the same effect on their production choices. In contrast, in FAPRI, no changes are made to the Canadian grains submodel to simulate trade liberalization. Implicitly, it is assumed that the parameters estimated in FAPRI reflect the response of both producers and the Canadian government as prices and policy transfers vary, and that these would be unchanged in the face of trade liberalization by other nations.

Neither of the extreme assumptions utilized in the SWOPSIM and FAPRI models are likely to be correct, with the truth probably lying somewhere in between. In fact, with the exception of the Canadian transportation subsidies, two-priced wheat, and fuel rebates, it is unclear exactly how to model Canadian grain policy. The Western Grain Stabilization Act and the Special Canada Grains Program are prime examples. Johnson, et al. (1988) argue that the effect of these programs (53 percent of total support in 1986) on supply decisions is zero and Roningen, et al. (1988) argue it has raised long-run price expectations by more than 35 percent of the market price. While this example may overstate the differences between SWOPSIM and FAPRI in regions where both have modeled trade liberalization, it does illustrate the different approaches taken by the two models.

Both SWOPSIM and FAPRI assume that the values of policy variables are determined exogenously and are not influenced by the economic environment (FAPRI analysts do interact with the model in determining the baseline forecasts) even though casual empiricism suggests that this is not the case. Why then, have most large commodity models not endogenized policies? First, policy analysis, almost by definition, requires that the value of key policy instruments be treated exogenously. In this way policy variables are easily manipulated to generate alternative "policy scenarios." Second, for short-run forecasting, policy variables are often specified in legislation, or are relatively easy to project on the basis of historical trends. In addition, short-run forecasts are normally, although not always, dominated by non-policy factors (drought, livestock cycles, etc.). However, for long-run forecasts, the endogenization of key policy variables would have the advantage of getting away from the assumption of invariant policies (or a policy black box) in the face of a changing economic environment.

The Ezekiel model does not have policy variables, which implies that its estimates of the import gap and food aid needs are independent of recent policy changes. Eventually, policy changes would be internalized in the trend variables, but short run and intermediate run forecasts would be inaccurate.

MODEL INPUTS AND ASSUMPTIONS

Commodity models can be no better than the data used to construct them. It is by now a cliche to state that as a profession we have invested far more resources in model building than in data improvement. Estimates of production, consumption, and trade for the major agricultural commodities, in most countries, is generally available. However, reliable data on commodity stocks, producer prices, and consumer prices are spotty or non-existent. Good data on livestock production, herd size, the age/sex composition of livestock populations, and average grain consumption per animal type is difficult to obtain for industrial countries and unreliable or unavailable for most other countries. Our data difficulties also extend to the policy arena where we have little easily accessible information on the policy instruments used in various countries, and the values of these instruments over a reasonable period of time. One of the lasting benefits of the USDA's work in calculating producer subsidy equivalents is likely to be a better understanding of the key policies in a number of countries.

Most of the assumptions embedded in our agricultural commodity models follow from neoclassical economic theory—although most models fail to exploit the full richness of this theory. However, a key assumption of all current large models is that of homogenous products (Goddard, 1987; de Gorter and Meilke, 1987). We find that for grains, let alone animal products, this assumption is not easy to defend. Trade in animal products often involves two-way trade in differentiated processed and semi-processed products, with trade further restricted to certain trading groups because of technical regulations. If this is a general representation of the trading environment, then the gains from trade liberalization are likely overstated in a homogenous product model unless the demand for new differentiated varieties increases substantially, an effect which is unlikely to be captured in an empirical model.

MODELS RESULTS AND LONG TERM OUTLOOK

The modelers invited to this workshop have different commodity coverage, different levels of aggregation for commodities and countries and different base periods for their simulations. In contrast with the WB and SWOPSIM models, FAPRI's and Ezekiel's predictions do not extend to the year 2000. There are significant differences in the forecasts of the four models. These differences can be attributed largely to the unique nature of each model's design. However, it should be noted that the alternative scenarios and some of the assumptions regarding exogenous variables are not identical across the models.[3] This undoubtedly contributes to the divergence in the predictions.

Prices

The SWOPSIM model predicts that by the year 2000 the real aggregate agricultural price index will be 3.8 percent lower than in 1986/87. Wheat, coarse grains, and soybean prices are expected to decline by 8.8, 9.6, and 9.8 percent, respectively, while dairy products and ruminant meats become more expensive by 3.1 and 10.2 percent. Within its narrower commodity coverage, the WB model forecasts larger price declines. Real prices for wheat (No. I CWRS), corn, and soybeans are forecast to be 23.0, 16.4, and 31.6 percent lower in 2000 than in the 1987 base year (Table 1). FAPRI's price predictions are more optimistic. Johnson, et al. (1988) expect real prices for both wheat and corn to increase slightly by 1995 relative to 1986/87, while the real price of soybeans should decline by 9.2 percent.

To determine the degree of sensitivity of the predictions, the modelers ran different scenarios by modifying exogenous variables such as yields, GDP and population growth rates. In addition, they simulated trade liberalization in developed countries. The predictions of prices prove to be sensitive to the new assumptions. Under a low growth scenario, SWOPSIM projects dairy prices to be 15.7 percent below the base run in 2000 as opposed to a rise of 18.3 percent under optimistic conditions. Such variations clearly reveal the high income elasticity of demand for dairy products. FAPRI's wheat price under the base run scenario for the year 1995/96 is $124/mt. If high growth or low yield conditions were to prevail, FAPRI anticipates the price of wheat to rise by 41.1 and 48.0 percent, respectively. The low growth/high yield scenarios would reduce the price to $86/mt and $84/mt. WB prices for

[3] For example, FAPRI uses slightly different GDP growth rates and the WB low and high growth scenarios include different population growth assumptions.

wheat, corn and soybeans, like SWOPSIM's, do not increase as much as FAPRI's in a high growth scenario. In such a scenario, WB real prices for wheat, corn, and soybeans would be 17.7, 16.3, and 22.5 percent higher in 2000.[4] This is somewhat surprising since FAPRI's 1995 projections do not benefit from the high growth taking place between 1995 and 2000. Based on FAPRI's results, it is evident that there is no substitute for rapid economic growth if the objective is to raise prices. Due to the high level of trade distortions present in animal product markets (e.g., quotas and technical regulations), SWOPSIM anticipates freer trade to be more effective in raising animal product prices than high growth. Freer trade's relative efficacy in increasing prices can also be extended to include wheat and coarse grains (in contrast with FAPRI).

TABLE 1 Percentage Change in Real Prices for Different Scenarios

	Base 1995/Base 1986[a]	Free Trade[b]/Base 2000[c]	High Growth/Base 2000[c]	Low Growth/Base 2000[c]
WHEAT				
FAPRI	6.0	12.9	41.1	-30.6
WB 1995	-19.3	N.A.	12.5	-5.7
2000	-23.0	N.A.	17.7	-9.4
SWOPSIM	-8.8	25.9	15.9	-13.8
MAIZE				
FAPRI	10.0	18.4	44.8	-29.9
WB 1995	-13.2	N.A.	10.2	-7.5
2000	-16.4	N.A.	16.3	-9.6
SWOPSIM[d]	-9.6	18.8	10.8	-9.8
SOYBEANS				
FAPRI	-9.2	-9.6	52.1	-31.4
WB 1995	-30.1	N.A.	15.0	13.0
2000	-31.6	N.A.	22.5	-14.8
SWOPSIM[e]	-9.8	6.8	14.2	-11.6

[a] The base for WB is 1987
[b] Trade scenarios differ between models.
[c] FAPRI's farthest projections are for 1995.
[d] Coarse grains prices.
[e] Oilseeds and products.
SOURCE: Meilke and Larue, 1988, p. 15.
NOTE: Prices are not directly comparable across models because the modelers have chosen prices for different products and the wedges between these prices are not constant over time (e.g., the WB price for wheat is the Canada No.1 CWRS price, while FAPRI's price is for a U.S. No.2. H.W. 13%)

FAPRI and SWOPSIM predictions also contrast in a freer trade environment. According to FAPRI, prices for soybeans and its byproducts would decrease, while the price of corn would rise. This may be attributed to the EC market, where trade liberalization would lower the demand for protein meals and increase the demand for coarse grains. SWOPSIM's freer trade world is kinder to oilseeds and its products with a projected 6.8 percent price increase over the base scenario for 2000. According to SWOPSIM, the price for dairy products would experience a tremendous boost in a less distorted world. The Ezekiel model

[4] As the time horizon is shortened, the impact of higher or lower GDP growth rates on real prices is reduced. For the year 1995, price increases due to higher GDP for wheat, corn and soybean would be 12.5, 10.2 and 15 percent respectively.

was not designed to forecast prices and cannot be compared to the other models on that basis.

TABLE 2 Percentage Change in Production for Different Scenarios

	Base 1995/Base 1986	Freer Trade/Base 1995	High Growth/Base 1995	Low Growth/Base 1995
WHEAT				
FAPRI	15.7	-0.5	1.5	-1.0
WB	23.5[a]	N.A.	4.2	-2.0
COARSE GRAIN				
FAPRI	13.2	0.7	1.7	-1.3
WB	17.4[a]	N.A.	2.7	-1.8
SOYBEANS				
FAPRI	28.6	0	3.2	-3.2
WB	41.0[a]	N.A.	7.2	-4.8
Agreegate Supply Growth				
SWOPSIM[b]	28.0	-1.0	3.0	-4.8

[a] The base used by WB is 1985.
[b] The base used by SWOPSIM is 2000.
SOURCE: Meilke and Larue, 1988, p. 17.

Production

SWOPSIM's results are aggregated and cannot be directly compared to FAPRI or WB. SWOPSIM projects aggregate supply to be 16 percent larger in the year 2000 than in 1986/87. Freer trade would imply a decrease in aggregate supply of 11 percent when compared to the base-run supply for 2000. Moreover, SWOPSIM's aggregate supply is not very sensitive to changes in GDP growth rates. SWOPSIM and WB agree that production will increase relatively more in LDCs than in developed countries.

As shown in Table 2, both FAPRI and WB expect wheat, coarse grains, and soybean production to increase by 1995. The WB model predicts higher production growth for the three commodities that the two models have in common. FAPRI and the WB model seem to confirm that production is not sensitive to changes in GPD with perhaps soybeans in the WB model being the one exception. One may suppose that the income elasticities for wheat and coarse grains are fairly low and/or that their supply curves are very inelastic.

Only FAPRI provided production changes on a commodity basis under a freer trade scenario. According to the model's results, trade liberalization would have no impact on aggregate soybean production and very little effect on wheat and coarse grain production (0.5 percent decrease and .7 percent increase respectively).

Trade

For net trade, SWOPSIM's results are aggregated over commodities, which makes it difficult to compare them with the FAPRI and WB predictions. SWOPSIM forecasts an improved agricultural trade balance for developed countries by the year 2000 (9.5 percent rise). The same holds for centrally planned economies (CPEs) but to a lesser extent since their net agricultural exports increased by only 2.6 percent as opposed to a fall of 12.1

percent for the LDCs. Higher GDP growth rates would raise developed countries' net exports by 23.3 percent and reduce the LDCs' agricultural trade balance by 6.1 percent. Freer trade would have the opposite effect by increasing the LDCs' self-sufficiency ratio by 9.1 percent and diminishing the developed countries' net exports by 12.5 percent. This could be explained by the higher (world) prices that would prevail in a world where trade was freer. These higher prices would reduce the LDCs' demand for imports from the industrialized world and would induce them to produce more.

TABLE 3 Net Trade—The Impact of High Growth (% Change)

	Developed Countries (net exports)		LDCs (net imports)		Centrally Planned Economies (net imports)	
	FAPRI	WB	FAPRI	WB	FAPRI	WB
WHEAT						
Volume 1995 (mil. tons)	89.0	100.6	70.8	85.3	17.2	15.3
Base 1995/Base 1990 (%)	9.9	17.2	14.0	19.1	-9.0	7.0
High Growth/Base 1995 (%)	6.7	25.9	10.0	21.8	-0.6	49.0
COARSE GRAINS						
Volume 1995 (mil. tons)	62.0	67.8	42.8	40.9	19.2	26.8
Base 1995/Base 1990 (%)	29.2	45.8	32.1	36.3	23.1	63.4
High Growth/Base 1995 (%)	19.4	32.3	21.5	31.8	19.8	33.6
SOYMEAL						
Volume 1995 (mil. tons)	-3.9	-4.9	-12.9	-13.7	9.0	8.8
Base 1995/Base 1990 (%)	-8.3	7.5	-16.2	-7.0	20.0	18.9
High Growth/Base 1995 (%)	21.1	18.4	-2.3	21.9	12.2	17.0

SOURCE: Meilke and Larue, 1988, p. 19.

Table 3 indicates the net trade of wheat, coarse grains, and soymeal in 1995 predicted by the FAPRI and WB models. The two models have very similar forecasts for both soymeal coarse grains. In the case of wheat, WB anticipates a larger volume of trade than FAPRI whose estimates for developed countries' net exports and LDCs' net imports are smaller.

Table 3 also shows the percentage change in expected net trade between 1990 and 1995. Again, the WB model shows more pronounced growth in developed countries' net exports and in LDCs' net imports than FAPRI. In general, both models agree on the direction of the changes (e.g., industrial countries' net exports of wheat and coarse grains should rise between 1990 and 1995). The exceptions are CPEs' wheat net imports and soymeal to increase during the same time period. FAPRI's net exports in 1995 are not as sensitive to changes in demand assumption as are the WB forecasts. According to FAPRI, freer trade would have no effect on soymeal net exports and would have only minuscule effects on wheat and coarse grain trade.

TABLE 4 Import Gap Estimates (million metric tons of cereal equivalent)

Country/Region	FAPRI	EZEKIEL
High income East Asia	16.0	12.7
Asia (excluding China and India)	30.0	18.7
Latin America (excluding Argentina)	21.0	8.83

The latest results from the FAPRI model show import gap estimates that can be used in comparison with the estimated import gaps from the Ezekiel model. The comparisons are noisy, since the country aggregations are not necessarily identical. Moreover, the FAPRI estimates consist of the sum of the import gaps for coarse grains and wheat while Ezekiel's estimate have a broader commodity coverage. Table 4 illustrates some of the differences in the two models. It should be noted that Mexico and Brazil are not included in Ezekiel's country coverage for Latin America. Adding FAPRI's estimates of the import gap for wheat and coarse grains for Mexico and Brazil to Ezekiel's import gap, global estimate increases the latter from 8.83 to roughly 19.0. Given its slightly more limited commodity coverage, one would have expected the FAPRI model to yield smaller import gap estimates.

Food Aid Needs

The model developed by Ezekiel is one that can partition the import gap and hence estimate food aid needs. The FAO model is also capable of accomplishing such a task. The Ezekiel model predicts that total food aid needs will reach 37.21 million metric tons of cereal equivalent by 1990, an increase of 81% over the estimated 1985 level (Ezekiel, 1988a; 1988c). Some previous studies have even larger estimates especially the ones that are nutrition-based (FAO, 1984). As expected, the region with the highest food aid needs is Sub-Saharan Africa with 13.71 million metric tons of cereal equivalents. South Asia has the highest ratio (81%) of food aid needs to the import gap (Ezekiel, 1988a).

CONCLUSION

Although there is some disagreement among the models on how real prices will evolve over the next decade, there is a consensus that agricultural price projections are quite sensitive to changes in GDP and that prices would rise under a freer trade scenario (except for soybeans in FAPRI). All three models agree that production will increase in the future. FAPRI does not expect freer trade to change the global production of soybeans, coarse grains, and wheat as the production efficiency gains from trade are largely offset by the removal of production subsidies. SWOPSIM on the other hand forecasts that aggregate supply of the developed countries would decline by 11 percent under free trade. Net exports of wheat and coarse grains by developed countries should be higher by 1995 (FAPRI, WB) and more so if trade was liberalized (FAPRI), but a more global outlook shows that the agricultural trade balance for developed countries is likely to deteriorate in a freer trade scenario (SWOPSIM). SWOPSIM's analysis also shows that producer surplus in developed countries would be considerably reduced by trade liberalization, which indicates the need for decoupled assistance programs, if maintaining farmers' well-being is to remain a major goal of farm policy.

The Ezekiel model is not as elaborate in its design as the other models in estimating the import gap. We believe that its performance would be enhanced if it could borrow import gap estimates from models especially designed for that purpose. Unfortunately, most of the models that specialize in trade forecasts suffer from a higher degree of country aggregation. Food aid needs are growing rapidly and so is the proportion of food aid in the import gap for many regions. This is alarming since most of the countries have already benefited from the Green Revolution and are not expected to experience much higher growth rates in production. As shown by the simulation results for high economic growth and freer trade, improved market efficiency could have a dramatic effect on production, prices and trade. Perhaps it is time for an "economic revolution". Hopefully, the current General Agreement on Tariffs and Trade (GATT) negotiations will force developed countries and LDCs to make some progress on trade liberalization. Needless to say, the removal of inefficient domestic marketing programs in LDCs would greatly improve food production and distribution and would limit food aid needs.

It is difficult to judge the validity of the above predictions. It was argued at the outset that some of the assumptions used to simplify the structure of the models are too restrictive and perhaps unrealistic. Nevertheless, we believe that this forecasting exercise has generated useful information if it is interpreted with caution. Regardless of the choice of analytical instrument (empirical models vs. economic theory), one has to impose assumptions in order to obtain tractable results. As long as the results emerging from the models are consistently close to reality, the choice of assumptions should not be overly questioned. This rule is not exclusive to empiricists. The Heckscher-Ohlin-Samuelson model is still the best theoretic trade model despite the well-known limitations of its assumptions. Like *2times2* $\times$ *2* theoretical models, econometric models are useful approximations of reality. As such, they do not have to be perfectly accurate to be valuable.

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