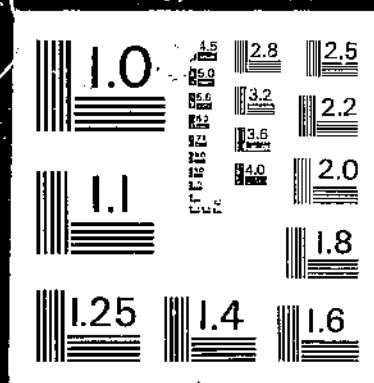WORLD FOOD SITUATION: PROSPECTS FOR WORLD GRAIN PRODUCTION, CONSUMPTION, AND TRADE. (Foreign Agricultural Economic Report). / Martin E. Abel (and others). Washington, DC: Economic Research Service, Sep. 1967.

USDA-FAEF

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WORLD FOOD SITUATION

Prospects for World Grain Production,
Consumption, and Trade

Foreign Agricultural Economic Report No. 35

U.S. DEPARTMENT OF AGRICULTURE

FOREWORD

Food enough has been a chief concern of most of mankind throughout most of man's history. Only in recent times and for only a few of the world's people has the specter of hunger been driven over the horizon.

In this last third of the twentieth century, the question of the world's food supply has achieved a new urgency. Thanks to improving health practices, world population is increasing rapidly, especially in the less developed countries. This, together with dwindling surplus stocks, has led some to believe that needs for food will quickly outrun potential supplies.

The Economic Research Service has made a number of studies pertaining to the world food situation. Some, like "The World Food Budget, 1970," compared projected supplies of food with needs based on standards of minimum diets. Others compared the needs for food aid in the less developed countries with our own capacity to produce on our diverted acreage of cropland. Each of these, and others as well, has been used to appraise the world food situation. Each, when considered in the light of its basic assumptions, has made useful contributions to our understanding. But each often has been used without careful regard to these basic assumptions, methods of analysis, and limitations of application.

This study is a careful new look ahead to 1980 at the world food situation as reflected in projected supply of and demand for grains. Grain is used as an indicator of the world food situation because most of man's food comes, either directly or indirectly, from grain.

This study differs from previous ones in two important respects. Present and projected supplies of grain for the whole world are considered. Grains produced in the developed importing countries are as important to total supply as production in the less developed countries, or in the major exporting countries.

Second, in this study, economic demands for grain are related to economic growth generally, which comes in part from increased agricultural production, especially in the less developed countries. Thus, growth in agricultural production and in incomes become key variables in the analysis of the demand for food. In contrast a fixed standard of minimum diets was used in some earlier work.

The quantitative estimates for specific time periods are based on assumptions which may not be fully realized, as is true with any projection; nevertheless, this study takes into account the many complex world relationships more fully than previous studies. The implications of this study are important for countries with food deficits and for those exporting grain. They are particularly important in the formulation of assistance plans and U.S. farm policies.

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SUMMARY AND CONCLUSIONS

Much attention has been given recently to the world food problem. Interest and concern has been focused on the situation in the less developed countries and on whether the world will be able to produce enough food to sustain probable increases in population and to support desired or satisfactory rates of economic development.

This report deals with production and utilization of grains. Most of man's food comes, directly or indirectly, from grains, so that trends in grain production and consumption fairly represent trends in the total food situation.

Data for the 1959-61 period and for 1964/65, and projections to 1970 and 1980 are presented for grain production, consumption, and trade. Grain production and consumption prospects for groups of countries and regions are analyzed separately and combined to form a world picture. The geographic breakdown employed in this study is as follows:

    I. Less Developed Countries
        India
        Pakistan
        Net grain exporters
        Others (excluding net grain
          exporters)

    II. Developed Countries
        United States
        Grain exporters (less the
         United States)
        Eastern Europe (including the USSR)
        Others (free world)

    III. Communist Asia

This approach enables us to distinguish between prospects for agricultural development in the developed and less developed countries, and between commercial and noncommercial trade in grains.

The conceptual framework for this study differs in several ways from that for previous studies. Thus, it may seem to the reader that the conclusions of this study are at odds with those of earlier reports. This is not so when one takes into account the differences in the assumptions and estimating techniques used.

Earlier studies assumed that per capita food consumption in the less developed countries would increase at a specified rate and reach certain nutritional targets by some specified future date. In contrast, this study shows how per capita food consumption rises as production, income, and the demand for food increase. Thus, we deal with a more realistic set of economic demands than those based on what might be considered nutritionally desirable.

Some earlier studies compared projected grain import needs of the less developed countries, calculated on the basis of certain nutritional targets, with projected production in the United States alone. They did not take into account production trends in the rest of the world, as this study does. Thus, results of this study differ from those of earlier ones. But if one should use the data in this study to make the same comparison as those made in such earlier reports he would arrive at a similar conclusion.

This study confirms the results of other studies that indicate that future grain import requirements of the less developed countries are likely to increase considerably. In 1959-61, the grain importing LDC's imported 20.7 million metric tons of grain annually, one-third of which was on a concessional basis. In 1964/65, the same countries produced 209 million metric tons and imported 29.0 million metric tons, over one-half of which was on concessional terms. By 1970 the grain importing LDC's will produce 246 million metric tons and are expected to need 30.7 million metric tons of grain imports.

In 1970, total world supply of grain will about be in balance (the excess of production over disappearance of about 6 to 7 million metric tons is so small in relation to the total that errors in estimation or vagaries of weather could easily shift the balance). This near balance is achieved with 158 million acres harvested for grain in the United States. This compares with 150 million acres harvested for grain in 1964/65.

If the historical rates of increase in grain production in the LDC's were to continue to 1980, they would require between 54 and 58

million metric tons of grain imports. If the rate of increase in grain production were moderately improved, the LDC's would require 52 million tons of grain imports by 1980. If the rate of growth of grain production gradually accelerated to 4 percent annually by 1975 and continued at that rate to 1980, the LDC's would require about the same import levels as in 1964/65. But because of the very large inputs that would be required, this rate of growth is viewed as most unlikely.

Some improvement in average diets would be possible under each of these rates of increase in food production in the less developed countries, with the grain imports that are projected. However, only when the rate of increase in grain production accelerates to 4 percent per year by 1975 and continues at that rate will the less developed countries meet average minimum calorie standards by 1980.

Protein consumption also would increase under each assumption, but the protein may be of inadequate quality. Further gains in protein consumption would be required to provide nutritionally adequate diets.

In spite of the likelihood of growing grain imports by the LDC's, it is projected that the world would have a significant surplus of grain in 1980 if 186 million acres were harvested for grain in the United States. This surplus ranges from 30 million tons if grain production in the LDC's continued to increase at historical rates up to about twice that amount if the LDC's were to achieve a 4-percent rate of growth in grain production.

The projections to 1980 of U.S. production and exports are based on world prices at about the average level of the past 3 years. Harvested grain acreages are assumed to be 186 million acres in 1980, compared with about 165 million acres in 1967.

If the United States pursues supply management policies to balance world grain supplies and demands at prices at about the average level of the past 3 years, it could maintain or increase slightly its historical share of world grain trade. However, only about 165 million harvested acres of grain would be required. These levels are well below the acreage levels that could be achieved, even in a short-run period.

The results of this study imply that the world probably will continue to have excess production capacity by 1980. Any problems of food shortages would arise out of the distribution of productive capacity or of commodities among countries. The production capacity of the developed countries will grow regardless of growth in the LDC's. The proportion of that capacity which is used will depend on production and trade prospects, and government policies.

The projection that production will exceed use is not likely to materialize. Production and use are likely to be balanced through some combination of the following measures: (1) reduction of trade barriers, particularly by the developed importing countries, which could increase total use of grain, (2) limitation of potential production by some kind of restraints, or (3) continued sharing of concessional exports to the importing LDC's and (4) perhaps somewhat lower prices.

The analysis also suggests that maintainin; stable world grain prices will continue to be a problem. Increased production in the developed importing and exporting countries other than the United States could add to the world grain surplus. A resulting downward pressure on prices might be avoided by arrangements among nations for sharing the task of restraining supply and supplying the concessional markets.

The size of the agricultural development task in the less developed countries is tremendous. A near doubling of the historical rates of growth in food production would be required if these nations are to break their dependence on food aid, reach minimally acceptable levels of food consumption by 1980, and achieve higher rates of economic growth. This would require unprecedented rates of change in resource commitments. It would require massive efforts by many developing nations and considerable assistance from developed countries. The resources that would be required are far in excess of present levels of investment in agricultural development.

Improvement in rates of growth in food production in the less developed countries will depend on the will and ability of these nations to take needed steps. It will require extremely large increases in (a) the availability and use of a wide variety of such production inputs as fertilizer, water (irrigation), pesticides, machinery, and, where possible, land; (b) public and private investment in research to create the technology and trained personnel required to get the needed gains in agricultural productivity; and (c) investments to create the marketing, storage, and transportation systems required to support the desired agricultural production revolution and to provide the incentives to bring it about.

WORLD FOOD SITUATION
PROSPECTS FOR WORLD GRAIN PRODUCTION, CONSUMPTION, AND TRADE

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INTRODUCTION

There is great interest in whether the world will be able to produce enough food to sustain likely increases in population and to support desired or satisfactory rates of economic development. This is one of the most complex and important problems facing modern man. A wide variety of factors that affect food production, consumption, and trade must be dealt with simultaneously. These include the natural resources of nations, the science and technology of making resources more productive, a wide range of economic and political factors, and the cultural and institutional factors that condition human behavior.

The world food situation has for centuries been dynamic. Population has been continuously changing. So too has the cultivated area. Crop and livestock yields have gone up, and in some areas of the world have increased sharply. Changes among countries in agricultural production, economic growth, and trade in agricultural products have been marked.

It is not change per se that creates problems, Rather, problems are created when the rates of change among several factors get out of balance. The world is changing faster today than at any previous time. As the rate of change accelerates, it becomes increasingly difficult to maintain desired balances among many variables.

The scientific and technological revolution, which started in the developed countries over a century ago, has only recently reached many less developed countries. One of the most dramatic examples of how science and technology can rapidly accelerate rates of change is the growth of population. From man's beginning (and archeologists now tell us this was more than a million years ago) to the start of this century, population grew to one billion. In the last 66 years, two billion more people have been added. It is now estimated that, by the year 2,000, another three billion people may be added to the three billion now on earth.

The present and anticipated upsurge in population growth rates reflects the impact of science and technology on reducing death rates. This phenomenon has been particularly striking in the years following World War II. It is most marked in the less developed countries where there has not been a reduction in birth rates to match the sharp decline in death rates. It is estimated that the death rate in Ceylon dropped by 40 percent in one year due to the use of DDT. Malaria has been virtually eliminated from India, resulting in a sharp increase in average life expectancy. The lives that have been saved by the rapid adoption of public health measures and other medical advances throughout the less developed world are now threatened because food production has not adequately kept pace with population and income growth.

Serious problems of food adequacy and economic development arise when the population growth of a country persistently exceeds the rate of growth in food production or the ability to purchase food from outside sources. (Another type of food problem--that of surpluses--arises when a nation's production capacity greatly exceeds available domestic and foreign outlets.) The solution to the problem of inadequate food supplies lies in three basic areas: (1) reducing the rate of growth in population, (2) expanding food production through increasing cultivated

area and yields, and (3) developing the economic capacity to purchase needed food supplies. Usually all three approaches are involved, although the relative importance of each may vary among countries.

Many analyses bearing on the question of the world capacity to produce sufficient food have been done by the Economic Research Service, 1/ other agencies of Government, and individuals and institutions. 2/ Each of these studies differed from the others in terms of scope and the assumptions used. This study presents another in a series . analyses by the Economic Research Service of the prospective world food situation.

This study projects to 1980 levels of world production, consumption, and trade for all grains. The significance of the projections are revealed in terms of world food supply and needs, international trade, and implications for U.S. agriculture.

1/ Lester R. Brown, Man, Land and Food, FAER 11, ERS, USDA, 1963; The World Food Budget, 1970, FAER 19, ERS, USDA, 1964; Quention M. West, "Foreign Supply and Demand Projections: Outlook for U.S. Agricultural Exports," Journal of Farm Economics, Vol. 48, No. 5, December 1966.

2/ For example, Agricultural Commodity Projections for 1970, FAO, Rome, 1962; and The World Food Problem; Report of the Panel on the World Food Supply, President's Science Advisory Committee, Vol. I and II, The White House.

CONCEPTUAL FRAMEWORK

This analysis limits itself to the investigation of production, consumption, and trade prospects for grain. Grains directly and indirectly account for the bulk of the total world food supply. Thus, prospects for grains are a good indicator of those for total food situation.

The geographic unit of inquiry is the world subdivided into several countries and regions as follows:

I. Less Developed Countries
   India
   Pakistan
   Net grain exporters
   Others (excluding net grain exporters)

II. Developed Countries
   United States
   Exporters (less U.S.)
   Importers (free world)
   Eastern Europe (including USSR)

III. Communist Asia

Estimates of grain production, consumption, and trade for groups of countries were derived by making separate estimates for individual countries and aggregating to get a group estimate.

The less developed countries are considered separately because they have had the poorest record for increasing per capita food supplies. Among the less developed countries (LDC's), India and Pakistan are analyzed separately because together they account for nearly one-third of total grain imports by the less developed grain importing countries. Grain imports by India and Pakistan are almost entirely on concessional terms, whereas a significant portion of grain imports by the other less developed importing countries is on commercial terms. Prospects for agricultural development in India and Pakistan have a very significant effect on future total grain imports by the developing countries, particularly on concessional imports.

The less developed grain exporting countries (Argentina, Mexico, Burma, Thailand and Cambodia) are considered separately because they have had a reasonably good rate of increase in production and exports. Further, they compete with developed exporting countries (Australia, Canada, France, South Africa and the United States) in commercial world markets.

The developed countries include the United States, grain exporters that compete with the U.S. for commercial world markets, the importing countries outside the Communist-bloc, and Eastern Europe and the USSR. Past and prospective grain production and trade situations between the United States and competing developed exporters are compared. Production and trade developments in the other developed free-world countries provide a picture of past and prospective commercial world grain imports. Eastern Europe and the USSR are of special interest because these nations switched from being net exporters to net importers of grain in the early 1960's. Future grain production and trade prospects for this region will have an important bearing on the world grain production and commercial trade.

Communist Asia is included in the analysis to complete the world picture. Information on agricultural development in this area is especially limited, and so too is the basis for long-run projections. However, inclusion of Communist Asia in the analysis gives a complete accounting of world grain production and consumption and trade.

A consistent economic framework is used to relate the rate of growth in agricultural output to the rates of growth of income and the demand for food. This is particularly relevant to the developing countries where agriculture accounts for a very large proportion of total economic activity. Of course, total demands for food include the influences of growing populations.

The agricultural sector provides a large and growing market for nonagriculturally produced goods in the LDC's, both production and consumption items. Also, agriculture provides many raw materials for industrial production and export. An acceleration of the rate of growth in agricultural development not only provides more food and fiber to rural people, but (a) increases the demand for industrial products, and (b) increases the supply of agricultural raw materials with which to increase industrial production and exports. An attempt has been made in this study to relate growth in income in the agricultural sector to increases in the rate of growth of agricultural output. Such accelerated economic growth increases incomes and the demand for food. (This relationship is shown in table 8 where growth rates in consumption vary directly with growth rates in production.) The interaction between agriculture and industry is not fully accounted for. But this omission is of minor significance in the total income picture because of the predominance of agriculture in the economies of the LDC's.

If the rates of growth of agricultural output were to double over a given period of time, the rates of growth of total income and consumption would increase significantly. That is, per capita demand for food would increase as per capita income rose. Thus, for a country that is a net importer of food, the absolute decline in imports resulting from increased domestic production would be less than the absolute increase in production. A more detailed description of the production-consumption model employed in this study is given in Appendix A.

The rates of growth in population used in the projections are the U.N. population projections as modified by FAO and used in their projection studies. FAO has adjusted the U.N. base period population upward on the basis of information available since the U.N. population projections were made. FAO uses the medium growth rate assumption of the U.N. applied to the adjusted population base. The projections reflect the influence of present and likely population control programs. Although these projections assume there will be greater efforts in family planning, population growth rates will not be affected much in the next 15 years. A stabilization of the upward trend in population growth rates is projected for some regions and a decline in population growth rates is projected for other regions by 1980. Thus, the population projections used in this study do not attempt to minimize the impact of population growth on the demand for food.

Projections to 1980 of grain production, consumption, and trade are made for the less developed countries under alternative assumptions concerning the rate of growth in their own grain production. Consideration is given to both grain used directly for food and that used for livestock feed. The latter will become increasingly important for a number of less developed countries. The demand for feed grains will increase as the demands for livestock products grow with rising incomes.

The projections for the developed countries are made on the basis of the most likely rates of growth in grain production and consumption assuming (a) world market prices of grains remain at about the average levels of the past 3 years and (b) that excesses of production over consumption would be withheld from markets; i.e., grain stocks would increase.

These assumptions enable us to examine what would be the likely levels of utilization of grain production capacity of the developed countries. This approach enables us to project surpluses or deficits that result from the assumptions employed, and to examine the sources of adjustments that may be needed in production, consumption, and trade.

The projected levels of production are determined mainly by economic, political and technological factors, not by fixed physical capacities. The developed countries could, of course, produce considerably more grain than is indicated by the projections. Much more of their potential production capacity would be used if they had additional incentives or accelerated programs of agricultural development.

For the developed countries, most of the future increases in the demand for grains will be for grains used as feed as opposed to grains used directly for food. Incomes in the developed countries are high and rapidly increasing. This significantly increases the demand for livestock and livestock products and thus the demand for grain used for feed. The rapid growth in the demands for livestock products is projected to continue.

For the United States, the projections of grain export availabilities represent the difference between production and total domestic consumption. Total grain consumption in the United States is projected to increase at relatively rapid rates, reflecting continued growth in the demand for feed grains. The projected level of grain production is what would likely occur with prices at about the average level of the past 3 years, assuming harvested grain acreage will be held at 158 million in 1970. It would reach 186 million in 1980 in the absence of programs that withhold acreage from production. For comparison, harvested grain acreage was 150 million acres in 1964, but averaged 184 million acres in the 1958-60 period. The levels of grain production and harvested grain acreage that could be achieved with additional incentives for and investments in grain production could be considerably greater than those assumed in this study.

Since this study focuses on long-run projections, it does not deal with year-to-year fluctuations in production due to changes in the weather. Such variations are important in the short-run, but are beyond the scope of this study.

The conceptual framework for this study differs in several ways from that for previous studies. Thus, it may seem to the reader that the conclusions of this study are at odds with those of earlier reports. This is not so when one takes into account the differences in the assumptions and estimating techniques used.

Earlier studies assumed that per capita food consumption in the less developed countries would increase at a specified rate and reach certain nutritional targets by some specified future date. In contrast, this study shows how per capita food consumption rises as production, income, and the demand for food increase. Thus, we deal with economic demands rather than needs as measured by diets considered nutritionally desirable.

Some earlier studies compared projected grain import needs of the less developed countries with projected production in the United States alone. They did not take into account production trends in the rest of the world, as this study does. Thus, the results of this study may differ from those of earlier ones. But one would reach conclusions similar to those of other reports if the data in this study were used to make the same comparisons.

THE FOOD SITUATION IN THE LESS DEVELOPED COUNTRIES

Adequacy of Diets

Two-thirds of the world's people live in countries with national average diets that are nutritionally inadequate. 3/ A country is classified as diet-deficit if the average annual per capita consumption of food results in a deficiency of calories, proteins, or fat below minimum levels recommended by nutritionists. The diet-deficit areas include all of Asia, except Japan, Israel, and the Asian part of the USSR all but the southern tip of Africa, parts of South America, and almost all of Central America and the Caribbean (fig. 1).

In 1959-61, all of the less developed countries in the free world were diet-deficit except Argentina, Brazil, 4/ Chile, Uruguay, Mexico and Costa Rica. Diets in the deficit areas

averaged 750 calories per day below the level of countries with adequate national average diets. The diet was 170 calories below the minimum nutritional standard of 2,400 calories required for normal activity and health. (Minimum nutritional requirements vary among countries with differences in climate, size of people. etc.). The daily consumption of protein in the less developed countries was only two-thirds the level in the diet-adequate countries.

3/ World Food Budget, 1970, FAER 19, ERS, USDA, 1964.

4/ Although on a national average basis Brazil was diet-adequate, the large northeast region has a substandard diet.

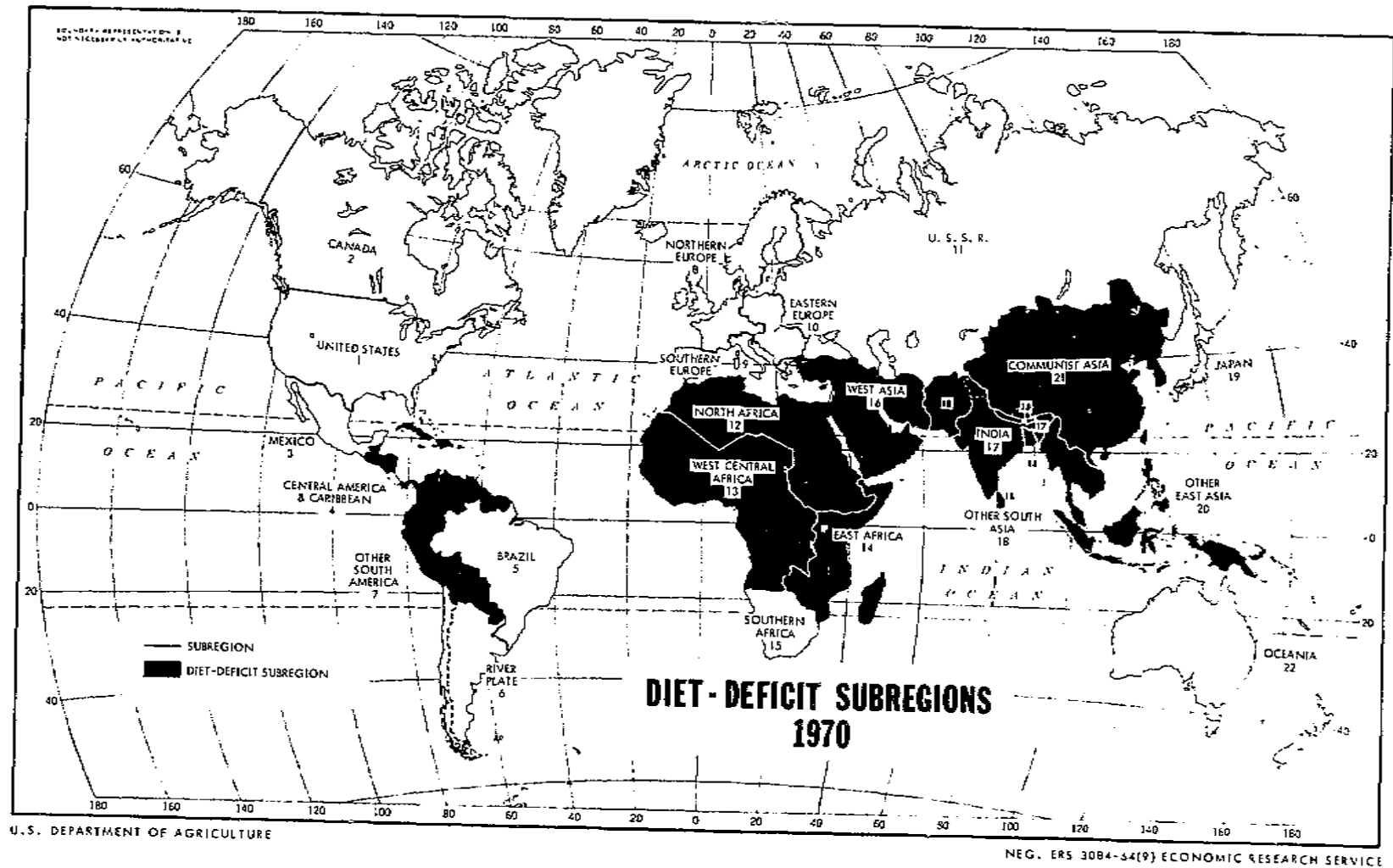DIET - DEFICIT SUBREGIONS
1970

Figure 1

The nutritional situation in the less developed countries in 1959-61 is summarized in table 1. India had a deficit of 240 calories per person per day. An increase in annual consumption of 27 kilograms of grain per person would have been required to overcome this deficit. The increase required for Pakistan would have been 19 kilograms per person and the average for all the less developed countries 18 kilograms. The total additional grain which would have been required to meet the calorie deficit of the less developed countries, excluding Communist Asia, in 1959-61 would have been about 25 million metric tons. Slightly over half was concentrated in India and Pakistan.

Protein was deficient in the national average diet of most of the less developed countries. However, if consumption of grain were increased sufficiently to meet the calorie deficit, there would be adequate quantities of total protein in the diet of most of the less developed countries, except Indonesia and Central Africa. In some countries the protein would still be of low quality and, for an adequate diet, would need to be supplemented by additional high quality protein.

Adequate average diet in a country does not mean that there are no serious nutritional and food problems. Because of an uneven distribution of food among people in a country due to the skewed distribution of food purchasing power, food availabilities, etc., large segments of the population can have inadequate diets.

Historical Trends in Food Production

Over the 1956-66 period world output 5/ of food products increased at about 2.4 percent per year (table 2), while the world population increased about 2 percent a year. The percentage increase in total food production was about the same in both the developed and the less developed countries.

However, there was a marked difference between the developed and the less developed countries in per capita food production, which takes into account the rate of growth in population. Per capita food production in the developed countries increased about 12 percent between 1956 and 1966, while per capita food production remained about constant in the less developed countries. Thus, the less developed countries collectively did no better than to keep pace with the rapid growth in population.

There are also differences in the rates of growth in per capita food production among the less developed countries. Food production per person remained about constant between 1956 and 1966 in India, trended slightly downward in Africa, but trended modestly upward in Pakistan, Latin America and other Asian countries, excluding the Communist countries.

Population Growth

Population of the less developed countries has been increasing at 2.5 percent per year (table 3). This annual growth rate is expected to increase to about 2.6 percent between 1965 and 1975 and then decline to 2.5 percent between 1975 and 1980. The decline in the population growth rate for the latter part of the projection period reflects the impact of population control measures. It is projected that population control measures will have only a slight impact by 1980. Because of the inherent time lag involved, even rapid acceleration in the next several years of efforts to control population growth, would not have a significant impact until after 1980.

PRODUCTION TRENDS IN EXPORTING COUNTRIES

Production and exports of grain in exporting countries other than the United States has followed sharp upward trends (table 4). Rates of growth varied considerably among countries.

Grain production in the developed exporting countries during 1956-66 increased at an average annual rate of 2.0 percent in Canada, 9.3 percent in Australia, 3.1 percent in France, and 2.4 percent in South Africa. The average rate for this group of countries was 3.3 percent per year.

Among the less developed exporting countries the average annual rate of growth in grain production was 2.1 percent in Argentina, 6.1 percent in Mexico, 1.2 percent in Burma, 3.6 percent in Thailand, and 2.2 percent in Cambodia. The average for this group was 3.1 percent per year.

Total grain production in the United States increased at an average annual rate of 2.8 percent between 1956 and 1966. However, because of production adjustments, there was virtually no increase in production between 1960 and 1966. During this latter period other exporting countries had very significant increases in production.

5/ Excluding Communist Asia.

Table 1.--Food situation in the less developed countries of the free world, 1959-61

Country or region	Calorie level per day	Calorie deficit per day	Grain availability per capita per year 1/	Grain required per capita to fill calorie deficit	Grain requirement per capita	Total grain to fill calorie deficit	Protein level per day	Protein deficit per day	Protein deficit if calories were adequate
	Calories	Calories	Kilos	Kilos	Kilos	1,000 metric tons	Grams	Grams	Grams
India.	2,060	240	159	27	186	11,400	56	4	0
Pakistan. . . .	2,120	180	180	19	199	1,800	56	4	2/
Net grain exporters 3/	2,480	0	216	0	216	0	63	0	0
Other less developed countries. . .	2,310	160	170	18	188	11,500	57	3	2
Total or average. .	2,230	170	170	18	188	24,700	57	3	2/

1/ Includes nonfood uses.
2/ Less than 0.5 grams.
3/ Argentina, Mexico, Burma, Thailand, and Cambodia.

Source: World Food Budget, 1970, as revised. U.E. Dept. Agr. Foreign Agr. Econ. Rpt. 19.

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Table 2.--Indices of world food production (excluding Communist Asia),
total and per capita, 1956-66

(1957-59 = 100)

Country or region	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
TOTAL											
World [1]	96	96	102	103	107	108	111	114	117	117	121
Developed countries [2]	96	96	102	102	107	107	111	112	116	116	122
Less developed countries	96	96	101	103	108	110	112	118	120	119	119
PER CAPITA											
World [1]	100	98	102	101	103	102	103	103	104	102	104
Developed countries [2]	98	97	102	101	104	103	106	105	108	106	111
Less developed countries	101	98	101	101	103	102	102	104	103	100	98
India	101	96	102	102	106	108	101	103	104	92	88
Pakistan.	104	99	95	105	108	106	102	112	109	108	105
Other Asia [3]	100	96	102	101	99	101	103	104	104	104	106
Africa [4]	102	100	100	100	102	97	102	103	101	100	96
Latin America	101	100	101	99	99	100	101	103	103	105	101

1/   Excluding Communist Asia.
2/   U.S., Canada, Europe, U.S.S.R., Japan, Republic of South Africa, Australia, and New Zealand.
3/   Excluding India, Pakistan, Communist Asia, and Japan.
4/   Excluding Republic of South Africa.

Table 3.--Population and annual growth rate, less developed countries of the free world, 1960-65 and projections to 1970, 1975, and 1980

Country or region	1960 population	:Growth rate :1960-65:	1965 population	:Growth rate :1965-70:	1970 population	Growth rate 1970-75	1975 population	:Growth rate :1975-80:	1980 population
	Millions	Percent	Millions	Percent	Millions	Percent	Millions	Percent	Millions
India....................	432.6	2.4	486.8	2.4	546.8	2.4	615.1	2.2	685.8
Pakistan................	100.2	2.6	113.9	2.6	129.3	2.6	146.7	2.3	164.3
Net grain exporters 1/	111.5	2.7	127.5	2.8	146.4	2.8	168.1	2.7	191.8
Other less developed countries.............	716.4	2.6	812.9	2.6	922.3	2.7	1,054.6	2.7	1,204.7
All less developed countries.............	1,360.7	2.5	1,541.1	2.6	1,744.8	2.6	1,984.5	2.5	2,246.6

1/ Argentina, Mexico, Burma, Thailand, and Cambodia.

Sources: 1960 and 1965 figures from Agency for International Development except for Nigeria. For Nigeria, United Nations estimates (52,000,000 to 57,500,000) were used instead of the AID estimates of 38,540,000 and 42,680,000. 1970 to 1980 figures from population projections prepared for the Food and Agricultural Organization's Indicative World Plan, adjusted by including Kashmir and excluding West Irian to make the projections comparable with the 1960 and 1965 figures, and by raising projections for Mexico and Thailand to bring them in line with the latest AID estimates of 1965 population.

Table 4.--Total grain production in the developed and less developed grain exporting countries, 1956-66

Year	Developed exporters					Less developed exporters				
	United States	Canada	Australia	France	South Africa	Argentina	Mexico	Burma	Thailand	Cambodia
	Million metric tons									
1956	137.6	32.0	5.7	19.3	4.9	14.8	6.0	5.0	5.6	1.4
1957	148.2	22.7	4.3	19.5	5.4	11.5	6.4	4.1	3.8	1.5
1958	172.6	23.7	9.2	18.6	4.7	15.2	7.2	5.1	4.8	1.5
1959	168.3	24.5	7.5	21.9	5.1	15.0	7.4	5.4	4.8	1.7
1960	180.4	26.7	10.9	23.0	5.4	11.3	7.3	5.2	5.7	1.8
1961	162.6	16.8	9.1	20.7	6.7	13.6	7.5	5.3	6.0	1.5
1962	161.3	29.4	11.1	25.2	7.0	13.0	8.6	5.5	6.8	1.9
1963	173.6	34.3	11.7	25.3	7.4	17.0	9.0	5.7	7.6	2.0
1964	159.7	28.6	12.9	26.0	5.8	20.5	9.8	5.6	7.3	1.9
1965	181.8	32.4	9.5	29.1	5.8	13.6	10.6	5.7	7.3	1.8
1966	181.5	39.0	13.9	26.3	6.2	17.5	10.9	5.7	8.1	1.8

Each of the grain exporting countries has significant potential for further substantial increases in production, either by expanding grain area, increasing yields, or both. The rate at which production increases will depend upon world grain price levels and the grain production policies and programs of the individual countries.

PROJECTIONS TO 1970

Production

Two sets of projections to 1970 of grain production and trade are presented in table 5.

Under projection I, grain production in 1970 is derived entirely from a trend fitted to the historical data for the 1954-66 period.

Under projection II, grain production in 1970 is projected on the basis of historical trends and agricultural policies and development plans that are likely to influence these trends. For example, an assessment is made of the extent to which India's new agricultural development programs will influence grain production and to what extent this causes a deviation from historical trends by 1970. The new agricultural development efforts in India are described in the P.L. 480 agreements of February and May, 1967.

The differences in production between the two sets of projections are not large. They represent the influence of changes in agricultural policies and programs during the late 1960's.

Projection II for 1970 is viewed as the most likely outcome. Because projection II contains some "normative" evaluations of the impact of agricultural policies and development plans, it would be well to review the difference between the two sets of projections to show why historical trends were modified.

Based on historical trends, the developed grain importing countries would have an estimated level of grain production of 95.0 million metric tons, compared with 92.5 million under projection II. The downward adjustment was made because a number of countries in this group have modified their policies away from "self-sufficiency" or "maximum grain production." Two such examples are Sweden and Japan. There are still other countries within the group for which it will be difficult to maintain past rates of growth in grain production because of limits on the rate of growth in acreages and yields.

Projections I and II for Eastern Europe and the USSR show the same level of grain production for 1970. Projection II takes account of the recent changes in Soviet agricultural policies and programs which have increased the supply of agricultural inputs and incentives, and therefore point to accelerated growth in grain production. 6/ Projection I is plagued by tremendous variability in grain production during the first and last years of the 1954-66 period. Production in 1954 was very low, and production in 1966 was very high (partly due to favorable weather, but mostly due to increased use of agricultural inputs). Because of the influence of the extreme values of the first and last observations, the trend line is severely biased upward and would give a 1970 estimate of grain production of 210 million metric tons. On the other hand, if these two observations were omitted from the analysis the estimate of grain production in 1970, based on the 1955-65 trend, would be about 180 million metric tons. This is a very large range in the estimates. A compromise procedure was used which omitted 1954 but included 1966. This resulted in a projected level of grain production of 192.6 million metric tons, the same as under projection II.

The historical trend analysis for Communist Asia yielded an estimated level of grain production of 145 million metric tons in 1970. This is 5 million metric tons below the level used in projection II. The slightly more optimistic view under projection II is based on the increased emphasis on fertilizer production and imports. As stated earlier, however, data on agricultural production and development for Communist Asia are, at best, very poor. And, the 5 million metric ton difference between the two projections probably lies well within the range of errors in the data used. The difference in production is not projected to affect imports which are assumed to be determined mainly by foreign exchange considerations.

6/ The European and Soviet Union Agricultural Situation: Review of 1966 and Outlook for 1967, ERS-Foreign 185, Economic Research Service, U.S. Department of Agriculture, Washington, D.C., May 1967, pp. 70-79.

Table 5.--World grain production and trade, 1959-61 average, 1964/65, and projections to 1970

Country or region	1959-61 average		1964/65		1970 I		1970 II	
	Production 1/	Net imports 2/	Production 1/	Net imports 2/	Production	Net imports	Production	Net imports
	Million metric tons							
Less developed countries:								
India	67.6	4.0	73.6	6.6	82.0	9.0	87.0	6.0
Pakistan	15.5	1.2	17.5	1.6	19.5	3.0	20.6	2.2
Other less developed countries, excluding grain exporters	105.7	15.5	118.0	20.8	138.0	22.5	138.0	22.5
Subtotal	188.8	20.7	209.1	29.0	239.5	34.5	245.6	30.7
Net grain exporters 3/	33.1	-9.4	45.2	-15.3	50.2	-14.9	50.2	-14.9
Total, all LDC's	221.9	11.3	254.3	13.7	289.7	19.6	295.8	15.8
Developed countries:								
United States 4/	170.4	-27.5	159.7	-38.2	217.1	-54.8	217.1	-54.8
Developed exporters (less U.S.) 5/	59.5	-18.0	73.4	-26.6	92.5	-36.5	92.5	-36.5
Other developed free world	83.1	32.8	89.2	37.0	95.0	56.0	92.5	58.5
Eastern Europe (incl. USSR)	156.2	-.1	171.6	7.5	192.6	4.3	192.6	4.3
Total, developed countries	469.2	-12.8	493.9	-20.3	597.2	-31.0	594.7	-28.5
Communist Asia	117.6	.7	130.8	4.9	145.0	5.7	150.0	5.7
World Total 4/	808.7	-.8	879.0	-1.7	1,031.9	-5.7	1,040.5	-7.0

1/ Calendar year basis.
2/ Year beginning July 1 for wheat and coarse grains, following calendar year for rice; negative numbers mean either a world surplus or an increase in stocks.
3/ Argentina, Mexico, Burma, Cambodia, and Thailand.
4/ Grain production in the United States is based on harvested acreages of 150 million in 1964 and 158 million in 1970.
5/ Canada, Australia, France, and Republic of South Africa.

Table 6.--Per capita availability of grains, less developed
countries of the free world, 1959-61, 1964/65, and projections to 1970 1/

Country or region	1959-61	1964/65	1970	Minimum require- ment
	Kilograms			
India	159	168	170	186
Pakistan 2/	180	172	176	199
Other less developed countries, excluding grain exporters. . . .	170	173	174	188
Net grain exporters	216	231	241	216
All less developed countries . .	170	176	179	188

1/ Based on production projected under projection II.
2/ The per capita grain availability data for 1964/65 and 1970 are based on a revised population
series which is approximately 8 percent higher than the one used for 1959-61. When revisions
of the per capita grain availability data for 1959-61 and of the minimum requirement level are made,
1964/65 and 1970 grain consumption levels will be closer to minimum requirements than indicated in
this table. Evidence indicates that per capita grain availability increased between 1959-61 and
1964/65; the 1959-61 average would have been 167 kilograms if the revised population data had been
used.

Differences also exist for India and Pakistan. In both, increased emphasis has been given to agricultural development. The supplies of fertilizer and new seed varieties and investments in irrigation development are expected to increase more than enough to offset a slower rate of expansion in acreage than in the past. The net result is some acceleration in the rate of growth of grain production during the late 1960's.

Total world grain production is projected to increase by a larger amount in the second half of the 1960 decade than in the first half, over 160 million metric tons in the latter period compared with about 70 million in the earlier period (projection II).

The United States shows an increase of 57 million tons in the second half of the decade compared with a decline of 11 million in the first half. Production in the second half was about 5 million tons greater than in the first half of the decade in the developed exporting countries, 6 million tons greater in Eastern Europe and the USSR, and 6 million tons greater in Communist Asia.

In the early 1960's total grain production in the United States declined slightly as a result of supply management programs designed to reduce grain stocks. These stocks have been brought down to more desirable levels. Thus, the large increase in production projected for the latter part of the 1960's is, in large measure, an increase to compensate for supplies that previously came from stocks. Much of this increase will come from improved yields. Only an 8 million acre increase from 1964/65 to 1970 is projected for harvested grain area.

The increased rate of growth in Eastern Europe and the USSR reflects more favorable agricultural production policies and programs now in effect, compared with the early 1960's.

The less developed grain exporters are expected to increase grain production by only 5 million metric tons in the latter part of the 1960's compared with an increase of 12 million metric tons in the early part of the decade. Argentina had a record grain crop in 1964/65 and this accounts for the apparent slowing down of growth in production in the less developed exporting countries.

Trade

Grain exports from the United States and the developed exporting countries are projected to grow at rapid rates between 1964/65 and 1970. A slight decline for the less developed exporting countries is indicated, but this results from the very large crop in Argentina in 1964/65, rather than a reversal in export trends. Exports from these countries are expected to follow an upward trend throughout the whole decade.

The grain importing developed countries are projected to substantially increase their imports between 1964/65 and 1970. Most of the growth will occur for coarse grains, reflecting continued gains in the production and consumption of livestock products. Imports into Eastern Europe (including USSR) are projected to decline as the rate of growth in production accelerates.

Imports by the less developed countries show only a modest increase between 1964/65 and 1970. This results from a slight decline in India's import requirements as a result of accelerated agricultural development and only a moderate increase in grain imports by the other developing countries. The unusually large grain imports by India in 1966 and 1967 which resulted from two successive and severe droughts are not reflected in table 5.

The projections to 1970 indicate an excess of exports over imports of 7.0 million metric tons (projection II). This can be interpreted as a small increase in world grain stocks. However, it is important to consider that harvested grain acreage in the United States is assumed at 158 million acres, up only 8 million acres from the 1964/65 level and 26 million acres below the average for the 1958-60 period. The projected excess of exports over imports under projection I is 5.7 million metric tons.

Levels of grain production in the less developed countries under projection II would result in some improvement in per capita consumption levels. But, increases in calories available per person would still fall short of recommended minimum levels (table 6). In terms of grain per person per year, consumption in India would fall short of recommended levels by 16 kilograms, Pakistan by 23 (see footnote 2, table 6), and other less developed grain importing countries by 14. As one would expect, the less developed grain exporters would have a level of grain availability in excess of minimum levels.

A significant proportion of the grain imports by the less developed countries is commercial. However, in 1964/65 these countries imported on a net basis 29.0 million metric tons of grain, of which 15.5 million metric tons were from the United States on concessional terms (table 7). Thus, 53.4 percent of total net grain imports by the less developed countries was in the form of food aid. This proportion was up significantly from the 1959-61 average of 33.3 percent.

This picture varies considerably among the developing countries. India and Pakistan accounted for 28.3 percent of total grain imports by the less developed countries, but for 52.2 percent of the food aid in 1964/65. Virtually all their grain imports were on a concessional basis whereas only 35.6 percent of the grain imports of the other less developed countries were on these terms.

It is difficult to project the distribution of total grain imports by the less developed countries between commercial and concessional.

In large measure this will depend upon food aid policies and the rates of economic growth[7] in the less developed countries, which in turn will depend heavily on the rate of growth of agricultural production.

The substantial commercial grain imports by the less developed countries result from the fact that many have reached a stage of development where they can afford to buy grain. Developing countries with limited potential for increased grain production but with sufficient growth in nonagricultural industries might be expected to increase their commercial purchase of grain in the future.

However, imports of less developed countries which are heavily dependent upon food aid will vary with the rate of progress in their own economic growth, agricultural development, and the availability of food aid. Higher rates of agricultural development would reduce the need for food aid and similarly, reduce the proportion of world trade in grains occurring on concessional terms.

PROJECTIONS TO 1980

Projections to 1980 of grain production, consumption, and trade are made for the less developed countries under four assumptions about rates of growth in grain production. Associated with each set of production projections are consistent sets of consumption and net trade projections.

The Four Assumptions

1. Historical trends I: The rate of growth of grain production during the 1970's is the same as in the 1954-66 period. The production growth rates are 2.5 percent per year for the grain importers, 3.1 percent per year for the grain exporters, and 2.6 percent per year for all less developed countries. These historical rates are applied to the 1970 production base for projection I, which does not imply an acceleration in the rate of growth of grain production in India and Pakistan during the late 1960's.

2. Historical trends II: The same historical rates of growth of production used in the historical trends I assumption are used. However, the historical rates of growth in production are applied to the base level of

production under projection II for 1970. These production bases for India and Pakistan are higher than those which would result from straight trend projections because of the weight given to accelerated agricultural development expected in the late 1960's.

3. Moderate improvement in production: It is assumed that the less developed countries will place greater emphasis on agricultural development in the future. But, it does not imply a "crash" program relative to the production capabilities of the developing countries, or to the capabilities of developed countries to provide assistance. For less developed grain importing countries the annual average rate of growth in grain production during the 1970's is assumed to be 2.9 percent, compared to 2.5 percent for the historical trends assumption. Production is projected to grow at 3.6 percent per year in the grain exporting countries and 3.1 percent per year for all the less developed countries.

7/ Arthur B. Mackie, Foreign Economic Growth and Market Potentials for U.S. Agricultural Products, FAER No. 24, Economic Research Service, U.S. Department of Agriculture, April 1965.

Table 7.--Grain imports on concessional terms relative to total
net grain imports for the grain importing less developed
countries of the free world, 1959-61 average and 1964/65

Country or region	Total net imports		Concessional imports 1/ from U.S.		Concessional imports as percent of total	
	1959-61 average	1964/65	1959-61 average	1964/65	1959-61 average	1964/65
	............Million metric tons....................				........Percent..........	
India	4.0	6.6	3.2	6.5	80.0	98.5
Pakistan	1.2	1.6	0.9	1.6	75.0	100.0
Other importing less developed countries	15.5	20.8	2.8	7.4	18.1	35.6
Total importing less developed countries	20.7	29.0	6.9	15.5	33.3	53.4

1/ Concessional imports include all imports from the United States on noncommercial terms. Some concessional imports came from non-U.S. sources, but the amount was small.

Table 8.--Annual rates of growth for less developed countries of the free world in 1970-80 decade implied in 1980 projections under several alternative assumptions

Country or region	Population	Historical trends			Moderate improvement in production 2/			Rapid improvement in production 3/		
		Pro-duction	Consumption 1/		Pro-duction	Consumption		Pro-duction	Consumption	
			Total	Per capita		Total	Per capita		Total	Per capita
					Percent					
India ....:	2.3	2.0	2.8	0.5	2.8	3.0	0.7	3.8	3.2	0.9
Pakistan ....:	2.4	2.9	3.0	0.6	3.2	3.1	.7	3.9	3.4	1.0
Other less developed countries excluding grain exporters ...:	2.7	2.7	2.9	.2	3.0	3.4	.7	3.9	3.6	.9
Subtotal ....:	2.5	2.5	2.9	.4	2.9	3.2	.7	3.9	3.4	.9
Net grain exporters ..:	2.7	3.1	3.1	.4	3.6	3.4	.7	3.6	3.4	.7
Total, all less developed import-ing countries ...:	2.6	2.6	3.0	.4	3.1	3.3	.7	3.9	3.5	.9

1/ Differences between growth rates in total production and total consumption reflect the influence of either imports or exports.

2/ Assumes that the strong pressures for more emphasis on agriculture in less developed countries will have positive effects on agricultural production and consumption.

3/ Rate of growth on production increases to 4 percent by 1975 and continues at that rate to 1980; rate of growth in per capita disappearance increases to 1 percent by 1975 and continues at that rate to 1980.

4. Rapid improvement in production: These assumptions imply a greatly accelerated program of agricultural development. The rate of growth in grain output in the developing grain importing countries would increase from 2.5 percent to 4 percent per year by 1975 and continue at that rate. The average for the 1970's would be 3.9 percent per year.

Projections to 1980 for the developed countries are made under only one assumption; i.e., the most likely levels of grain production, consumption, and trade assuming (a) grain prices in the world market remained at about the average of recent years and (b) that excesses of production over consumption would be withheld from markets; i.e., grain stocks would increase.

These assumptions led to unbalanced sets of world production and consumption estimates. These imbalances between total production and consumption of grains highlight a number of problem areas in world grain trade.

The analysis indicates that the world in the aggregate has more than ample capacity to supply grain needs by 1980 (tables 9 and 10). Even under the present relatively slow rate of growth in production in the developing countries there would be an excess production capacity in the world equivalent to 30.1 million metric tons under historical trends I assumption and 34.3 million metric tons under historical trends II assumption. However, the distribution of production is highly skewed in favor of the developed countries. Under the assumption of rapid improvement in grain production in the less developed importing countries, the distribution of production among regions would be less skewed, but there would be an excess grain production capacity in the world equivalent to 62.8 million metric tons of grain.

Historical Trends

With no acceleration in present rates of growth in grain production in the less developed grain importing countries, by 1980 they would require 58.5 million metric tons of total grain imports annually under historical trends I assumption, and 54.3 million metric tons under the historical trends II assumption. This is significantly above the 30.7 million metric tons estimated for 1970. India and Pakistan would account for from 20 to 24.0 million tons, or about two-fifths of the total imports of the group

Grain import needs in 1980 would be nearly double those for 1970 and more than double the level of imports in 1964/65, under both trend projections.

The less developed grain exporters are projected to increase their exports from 14.9 million tons in 1970 to 20.0 million tons in 1980. For all less developed countries together, net grain imports are projected to grow from 15.8 million tons in 1970 to 34.3 million tons in 1980 (historical trend II).

Per capita grain consumption for all the less developed countries would increase from 179 kilograms in 1970 to 185 in 1980--only 3.4 percent--under the historical trends II assumption. This means an annual average increase of just over 0.3 percent. Virtually all of the increase in per capita grain consumption would have to come from imports, since the rates of growth in population and grain production are equal. The rate of increase in per capita grain consumption under the historical trends I assumption would be even slower.

Per capita consumption of grains would fall short of the amount required to provide the minimum calories. The average for all the less developed countries would be 185 kilograms, 3 kilograms below the recommended level. However, India would fall short of its minimum needs by 7 kilograms per person, Pakistan by 12 (see footnot 2, table 6), and the other grain importing less developed countries by 10. The net grain exporters would exceed minimum per capita consumption levels by 34 kilograms. This would raise average consumption for all less developed countries to near an adequate level.

The developed countries could increase their net grain exports from 28.5 million tons in 1970 to 77.6 million tons in 1980. The increased exports from the United States and the other developed exporters, together with a decline in imports by Eastern Europe could more than offset the increase in imports projected for the other developed free world.

Moderate Improvement in Production

Moderate rates of growth in production in the less developed countries would result in an excess world grain production of 38.9 million metric tons annually by 1980.

Table 9.--World production and net trade for grains, by regions; projections to 1980 under alternative assumptions for growth in production in the less developed countries of the free world

Country or region	Historical trends I		Historical trends II		Moderate improvement in production 1/		Rapid improvement in production 2/	
	Pro-duction	Net imports	Pro-duction	Net imports	Pro-duction	Net imports	Pro-duction	Net imports
				Million metric tons				
Less developed countries:								
India ....:	100.0	20.0	106.1	16.5	114.7	10.3	126.3	1.1
Pakistan ....:	26.0	4.0	27.4	3.3	28.1	2.9	30.3	1.5
Other less developed countries, excluding grain exporters ....:	180.0	34.5	180.0	34.5	185.0	39.0	202.7	25.7
Subtotal ....:	306.0	58.5	313.5	54.3	327.8	52.2	359.3	28.3
Net grain exporters ....:	68.0	-20.0	68.0	-20.0	71.5	-22.5	71.5	-22.5
Total, less developed countries ....:	374.0	38.5	381.5	34.3	399.3	29.7	430.8	5.8
Developed countries:								
United States 3/ ....:	315.0	-109.5	315.0	-109.5	315.0	-109.5	315.0	-109.5
Developed exporters (less U.S.) ....:	115.0	-42.5	115.0	-42.5	115.0	-42.5	115.0	-42.5
Other developed free world ..:	106.8	73.2	106.8	73.2	106.8	73.2	106.8	73.2
Eastern Europe (incl. USSR) .:	230.2	1.2	230.2	1.2	230.2	1.2	230.2	1.2
Total developed countries ....:	767.0	-77.6	767.0	-77.6	767.0	-77.6	767.0	-77.6
Communist Asia ....:	183.5	9.0	183.5	9.0	183.5	9.0	183.5	9.0
World total ....:	1,324.5	-30.1	1,332.0	-34.3	1,349.8	-38.9	1,381.3	-62.8

1/ Assumes that the strong pressures for more emphasis on agriculture in less developed countries will have positive effects on agricultural production and consumption.

2/ Rate of growth on production increases to 4 percent by 1975 and continues at that rate to 1980; rate of growth in per capita disappearance increases to 1 percent by 1975 and continues at that rate to 1980.

3/ Grain production in the United States is based on 186 million harvested acres in 1980, 150 million in 1964, and 158 million in 1970.

Table 10.--World consumption of grains by regions; projections to 1980 under alternative assumptions for growth in production in the less developed countries of the free world

Country or region	Historical trends I		Historical trends II		Moderate improvement in production [1]		Rapid improvement in production [2]	
	Total consumption	Per capita consumption	Total consumption	Per capita consumption	Total consumption	Per capita consumption	Total consumption	Per capita consumption
	Mil. Metric tons	Kg.	Mil. Metric tons	Kg.	Mil. Metric tons	Kg.	Mil. Metric tons	Kg.
Less developed countries: [3]								
India ....:	120.0	175	122.6	179	125.0	182	127.4	186
Pakistan ....:	30.0	183	30.7	187	31.0	189	31.8	194
Other less developed countries,								
excluding grain exporters ..:	214.5	178	214.5	178	224.0	186	228.4	190
Subtotal ....:	364.5	177	367.8	179	380.0	185	387.6	189
Net grain exporters ....:	48.0	250	48.0	250	49.0	255	49.0	255
Total, less developed								
countries ....:	412.5	184	415.8	185	429.0	191	436.6	195
Developed countries:								
United States [4] ....:	205.5		205.5		205.5		205.5	
Developed exporters (less								
U.S.) ....:	72.5		72.5		72.5		72.5	
Other developed free world ...:	180.0		180.0		180.0		180.0	
Eastern Europe (incl. USSR) ..:	231.4		231.4		231.4		231.4	
Total developed countries :	689.4		689.4		689.4		689.4	
Communist Asia ....:	192.5		192.5		192.5		192.5	
World total ....:	1,294.4		1,297.7		1,310.9		1,318.5	

[1] Assumes that the strong pressures for more emphasis on agriculture in less developed countries will have positive effects on agricultural production and consumption.

[2] Rate of growth on production increases to 4 percent by 1975 and continues at that rate to 1980; rate of growth in per capita disappearance increases to 1 percent by 1975 and continues at that rate to 1980.

[3] Projected growth in grain consumption in the less developed countires does not take account of the income effect that may result from interaction between the rates of growth in the agricultural and industrial sectors.

[4] Grain production in the United States is based on 186 million harvested acres in 1980, 150 million in 1964, and 158 million in 1970.

Under this assumption, net grain imports by the less developed importing countries would be 52.2 million metric tons annually by 1980. This would be only 6.3 and 2.1 million below the amount projected under the historical trends I and II assumptions, and still well above the level of 30.7 million metric tons projected for 1970 (projection II). Grain exports by the less developed exporting countries would be 2.5 million metric tons higher than the tonnage under the previous assumptions. Thus, net grain imports by all less developed countries would be 29.7 million metric tons by 1980, or 8.8 million metric tons below the level projected under the historical trends I assumption, and 4.6 million metric tons below the level projected under historical trends II assumption.

Moderate improvement in production for India and Pakistan would not be sufficient to hold import needs at 1970 levels. The total of 13.2 million metric tons for the two countries would be 5.0 million metric tons above the tonnage projected for 1970 (projection II). For the other less developed grain importing countries, net grain imports would be 39.0 million metric tons, or 16.5 million metric tons above the level for 1970.

Average per capita grain consumption in all less · .veloped countries would be 191 kilograms, or 6.7 percent above the projection for 1970. This implies an annual increase in per capita consumption of 0.7 percent, of which 0.6 percent would be sustained by increased production and 0.1 percent by imports.

But even with the improved levels of production and consumption, per capita levels of grain consumption would still fall short of recommended amounts by 4 kilograms in India, 10 in Pakistan (see footnote 2, table 6), and 3 in the other grain importing less developed countries. Thus, there would still be a calorie gap.

The grain production, consumption, and trade picture for the develoّ ed countries is the same under this assumption as under the historical trends assumption.

Rapid Improvement in Production

The world grain production, consumption, and trade balance changes significantly if we assume rapid improvement in production in the less developed countries. By 1980 there could be a surplus of 62.8 million metric tons of grain produced annually. The increase over that under the previous assumptions results entirely from improved production in the developing countries.

Grain imports by the less developed importing countries are projected to be 29.3 million metric tons, only 5.8 million metric tons greater than exports from the less developed exporting countries and 2.4 million metric tons below the 1970 level (projection II).

A high proportion of these imports probably could be on commercial terms, reflecting (a) the increased ability to buy grain commercially that would come from rapid economic development either in agriculture or, for many countries, in nonagricultural industries, and (b) a sharp reduction in imports on concessional terms. Under these conditions, India and Pakistan would become negligible importers of grain.

Under the assumption of rapid improvement in production, per capita grain consumption in the less developed regions in 1980 would be 9 percent above that in 1970. Grain production in these regions would be sufficient for all of the increase in consumption. Grain imports would be reduced significantly.

The projected per capita levels of grain consumption would provide sufficient calories to meet the minimum recommended amounts in all countries used in the study. It should be noted, however, that the category of "other less developed countries, excluding grain exporters" includes over 70 countries. Although the average level of per capita grain consumption is adequate, some countries in this group may have substandard consumption levels.

The developed countries would have net exports of 77.6 million metric tons as under the previous assumptions.

IMPLICATIONS

This analysis points up several important economic issues related to the world food problem.

World Grain Production Capacity

The combined excess food production capacity of all of the developed countries in

1980 will be more than adequate to provide for the increased food import needs of the LDC's. This is likely even if the less developed countries do not improve their rates of growth in grain production. World surplus grain production capacity is projected to be about 30 and 34 million metric tons under historical trend assumptions I and II. The grain surplus could go even higher if the developing countries do a better job of increasing their food production.

Though the world has ample capacity for food production through 1980, the less developed countries will have to increase food output at significantly higher rates in the future to avoid rapidly rising dependence on food imports and food aid. A continuation of past growth rates for food production in the less developed importing countries would result in projected grain import requirements by 1980 of nearly 60 million metric tons, more than double the 1964/65 imports. Although food imports of this magnitude could be met through expanded production in the developed countries, ways to finance a large portion of them would have to be found. Furthermore, the LDC's would have to develop the capability to effectively import and distribute so much more grain.

Nature of the World Food Problem

The world food problem is basically one of disparity of food production and food availability between the developed and developing nations. It is inseparable from the problem of the development gap between rich and poor nations.

It is essential for the less developed countries to achieve marked improvements in their growth rates for agricultural production if they are to achieve higher rates of economic development and be able to provide people with a minimum average diet. A recent report of the President's Science Advisory Committee states:

> "The Panel is convinced from its study of the world food problem that food shortages and high rates of population growth in the developing countries are not primary problems. Rather, they are manifestations of a more fundamental difficulty, lagging economic development in the hungry countries. We find the prospects for the future both sobering and alarming." 8/

The report indicated that a 4-percent annual rate of growth in food production would be required to bring average diets up to presently established minimum levels of nutritional adequacy. At the other extreme, continuation of the 2.5 percent rate of growth would not permit the developing nations to make any contribution to improved diets from their own production.

A marked improvement in the food situation of the LDC's would be achieved if the less developed grain importing countries were to increase the annual rate of growth in grain production from the recent historical rate of 2.5 percent to between 3.0 and 4.0 percent by 1980.

This would be no mean achievement. It would require unprecedented rates of change and resource commitments in the less developed countries. It would require a massive effort by many developing nations and considerable assistance from developed countries. The resources that would be required are far in excess of present levels of investment in agricultural development.

Although it is not likely that all the LDC's could achieve an average annual rate of growth in production of 4 percent, some of them are capable of doing so. A recent study of 26 developing nations 9/ showed that between 1948 and 1963, 12 of the 26 developing nations had average annual rates of increase in crop production of more than 4 percent. These rates surpassed those ever achieved by now economically advanced nations during comparable periods of time. The 12 countries were Sudan, Mexico, Costa Rica, the Philippines, Tanganyika, Yugoslavia, Taiwan, Turkey, Venezuela, Thailand, Brazil and Israel.

8/ The World Food Problem; A Report of the President's Science Advisory Committee, Report of the Panel on the World Food Supply, Vol. I, The White House, May 1967.

9/ Changes in Agriculture in 26 Developing Nations; 1948 to 1963, FAER No. 27, Economic Research Service, U.S. Department of Agriculture, November 1965.

The 12 countries differ in many of the factors which influence agricultural production potentials including climate, rate of literacy, supply of land resources, cultural patterns, and governmental systems.

The rapid rates of increase in crop output achieved by the 12 countries did not just happen. Rather, they resulted from aggressive group action, generally national in scope, directed specifically to improving agricultural production.

The improvement of future rates of growth in food production in the less developed countries will depend primarily on the willingness of these nations to take the necessary steps. It will require extremely large increases in (a) the availability and use of a wide variety of such production inputs as fertilizer, water (irrigation), pesticides, machinery, and, where possible, land; (b) public and private investment in research and education to create the technology and trained personnel required to get the needed gains in agricultural productivity; and (c) investments to create the marketing, storage, and transportation systems required to support the desired agricultural production revolution and to provide the incentives to bring it about.

To illustrate the magnitude of the task for just one input, let us examine the prospective world fertilizer situation. Results of a recent TVA study 10/ on present and future fertilizer needs and production are summarized in tables 11 and 12. These data indicate that fertilizer production capacity is growing at very rapid rates commensurate with the growth in fertilizer needs.

World fertilizer requirements for 1970 are estimated to be about 80 percent above the 1964 level and almost 200 percent above in 1980. In 1970, it is estimated that net fertilizer production capacity will be nearly 86 million metric tons of nutrients, up 156 percent from production in 1963. However, production as a percent of capacity averages about 90 percent in the developed countries and 80 percent in the developing countries. Adjusting for this, the total production capacity would yield 75 million metric tons, well above the 67.5 million metric tons estimated to be needed.

10/ Estimated World Fertilizer Production Capacity as Related to Future Needs, TVA, Muscle Shoals, Alabama, February 1966.

However, the developing regions will not have produced an adequate amount to meet their needs by 1970. The developed countries will have either surplus fertilizer available for export or surplus production capacity.

The TVA study indicates that (1) the world fertilizer industry has the capacity to meet rapidly growing needs, and that (2) there is a maldistribution of fertilizer production capacity among the regions of the world. In the short -run, the distribution problem can be overcome through trade or aid assistance from developed to developing countries. In the long run this imbalance can be redressed by improving the general investment climate in the less developed countries.

The reader should not be misled about the relative ease of achieving more rapid agricultural development in the developing countries by the prospects for fertilizer. Fertilizer is only one of the needed inputs. It may be the most costly but the easiest to supply. Developing effective research programs and bringing about the required social and institutional changes may be much more difficult. All are necessary for sustained increases in production.

The Panel on the World Food Supply of the President's Science Advisory Committee has estimated 11/ that to double agricultural output in the less developed countries between 1965 and 1985 would require the following additional investments:

$17.0 billion for mining, manufacturing, and distribution of fertilizers.
$0.3 billion for production and processing of improved seed.
$1.9 billion for the production and distribution of pesticides.
$2.0 billion for the manufacture of farm machinery.

This makes $21.2 billion in total investments. These figures do not include the cost of obtaining improvements in water management; education and training of agricultural personnel; research; and marketing, storage, and transportation facilities.

11/ The World Food Problem: A Report of the President's Science Advisory Committee, Report of the Panel on the World Food Supply, Vol. II, The White House, May 1967, pp. 375-377.

Table 11.—Estimated world fertilizer requirements, by regions,
projections to 1970 and 1980

Region	Total plant nutrients (N, P_2O_5, and K_2O)			Compound annual increase	
	Consumption 1964	Requirements			
		1970	1980	1964-70	1970-80
	........Million metric tons..........			.....Percent.....	
Western Europe	12.3	16.2	22.7	4.7	3.4
Eastern Europe 1/	7.4	13.2	22.9	10.2	5.7
North America	9.8	15.5	25.0	7.9	4.9
Oceania	1.2	1.9	2.6	8.7	3.2
Asia 2/	4.7	13.4	25.5	19.0	6.7
Africa	0.9	3.8	6.8	27.4	6.0
Latin America	1.4	3.5	6.2	16.4	5.9
World total	37.7	3/ 67.5	3/ 111.7	10.2	5.1

1/ Including USSR.
2/ Including Mainland China.
3/ Does not take into account transfers of food from developed to developing
regions.
Source: Estimated World Fertilizer Production Capacity as Related to Future
Needs, Tennessee Valley Authority, Muscle Shoals, Ala., February 1966.

Table 12.--Growth in world capacity for production of fertilizers, by regions, 1970

Region	Production of ferti- lizers in 1963	Total nutrients (N, P_2O_5, and K_2O)				Increase of capacity for production of fertilizers over 1963 production	
		Total production capacity		Net production capacity for fertilizer 1/			
		1965	1970	1965	1970	1965	1970
	.... Thousand metric tons					...... Percent	
Western Europe	12,540	19,362	27,022	16,256	22,576	30	80
Eastern Europe	6,966	10,344	15,976	8,898	13,530	28	94
Africa 2/	444	1,016	3,733	891	3,326	101	649
Asia 3/	2,829	5,868	12,027	5,071	10,583	79	274
Oceania	907	1,133	1,773	928	1,448	2	60
Latin America	552	1,521	4,039	1,392	3,710	152	572
North America	9,224	18,997	35,595	16,125	30,395	75	230
Total	33,462	58,241	100,165	49,571	85,568	48	156

1/ Estimated that 10, 5, and 0 percent, respectively, of N, P_2O_5, and K_2O capacities will be used for industrial purposes by the developing countries of Africa (excluding South Africa and Egypt), Asia (excluding Japan), and Latin America, and that 20, 18, and 5 percent will be used by the rest of the world (including South Africa, Egypt, and Japan).

2/ South Africa and Egypt accounted for 76 percent of 1963 fertilizer production in Africa and will account for 33 percent in 1970.

3/ Japan accounted for 58 percent of 1963 fertilizer production in Asia and will account for 31 percent in 1970.

Source: Estimated World Fertilizer Production Capacity as Related to Future Needs, Tennessee Valley Authority, Muscle Shoals, Ala., February 1966.

In this study, grain production in the less developed countries is projected to increase between 1964/65 and 1980 by 50 percent under historical trends II assumption, by 57 percent under the moderate improvement in production assumption, and by 69 percent under the rapid improvement in production assumption. Under the last two assumptions, total additional investments of about $13 and $16 billion, respectively, would be required. The President's Science Advisory Committee estimated that an additional $21.2 billion would be needed. This is because the study covers a shorter time period (1980 compared with 1985), and uses a demand projection framework which results in lower consumption estimates.

Because it remains to be seen how much of the required investment will be forthcoming from the less developed countries themselves and from capital assistance from the developed countries, it is difficult to forecast which path will be taken. It will probably be somewhere between the two extremes.

On the one hand, available evidence indicates increased emphasis on agricultural development in the less developed countries. Thus, they are likely to do better than just continue historical trends. On the other hand, although some countries have had a growth rate in agriculture of 4 percent or more per year and others may achieve this rate it does not seem likely that the less developed countries as a whole can achieve this level of sustained agricultural development.

There is presently no indication that the developed nations are willing to provide the technical and capital inputs that would be required to attain a 4 percent growth in agricultural output and meet minimum nutritional standards by 1980. Further, it is questionable whether some of the developing nations could overcome the many social, political, and economic obstacles that stand in the way of such a rapid growth within this time period.

Future Problems in World Trade

Increasing grain production capacity in the less developed countries does not imply a corresponding reduction in the capacity to produce in the developed countries. The rate of improvement in agricultural production in Eastern Europe, the USSR, and other developed importing countries--particularly the countries of Western Europe which have highly protective agricultural policies--probably will not be influenced very much by what happens to food production in the developing world. Also, the probable growth in agricultural production potential in the developed grain exporting countries will continue to be affected little by the rate of growth in food production in the developing countries. Continued increase in the capacity of developed countries to produce food is an important element in the total world food picture.

The rates of agricultural development in both the less developed and the developed countries have very important implications for the pattern and level of world trade in grains. A balance of some sort will be achieved in world grain production, consumption, and trade. But there are many ways in which this balance can be achieved.

One way is by stimulating commercial trade in grains through the elimination or neutralization (for example, market access agreements) of trade barriers. This could insure a slower rate of growth in grain production and a higher rate of growth in grain imports by the developed importing countries that now have highly protective agricultural policies.

Another way would involve controls on the rate of growth of production to achieve the desired balance between quantities and prices. Who would pay the cost of supply management would be an important issue in this approach. The distribution of cost would be quite different, depending on whether only the developed exporters or all the developed world practices supply management.

If a balance were to be sought by decreasing output and increasing consumption by means of lower grain prices, the major impact of lower prices would fall on the grain exporters, both developed and developing. The aggregate demand for grain imports and the supply response are probably quite price inelastic. Thus, policies to maintain lower prices could still result in surpluses of a magnitude which, on world markets, would further seriously depress world grain prices. Undoubtedly some combination of the above approaches will be considered, so each is at best only a partial solution.

The pending International Grains Agreement represents a first step towards a multilateral approach to developing an equitable solution to the trade problems posed by the continuing surplus production capacity in the developed countries.

IMPLICATIONS FOR THE UNITED STATES

This analysis has important implications with respect to several interrelated goals. The United States seeks (a) adequate farm income for American producers, (b) expanding commercial exports of American farm products, and (c) increasing the rate of growth in food production in the developing countries to stimulate better rates of economic development and to reduce the need for food aid.

If acreage adjustment programs in the United States were discontinued, an additional 20 million acres over the 1967 level might be brought into production by 1980 at recent price levels. This acreage would give the United States an export capacity of 109.5 million metric tons. The projected increase in grain acreage could be achieved and still leave ample land for other crops.

If the United States were to assume the responsibility for all or a significant part of the balancing of world production and consumption of grains (at the price levels assumed in the study) that may be required by 1980, acreage harvested for grain would have to be held well below the 186 million acres assumed in the projections. An important consideration is whether the United States is the only nation pursuing supply management programs, or whether this function is distributed more broadly. Under the former assumption the United States could have grain exports that would (a) be a little above its historical share of about 50 percent of world trade, and (b) require harvested grain acreage of about 165 million (except for the rapid improvement in production alternative).

During the 1960's, U.S. grain exports are estimated to grow by 27.3 million metric tons,

or at an annual rate of 7.1 percent. During the 1970's they would increase by 24.6 million metric tons, or at an annual rate of 3.8 percent (historical trends I assumption).

The expansion in grain production in other developed countries at faster rates than the growth in demands means that these countries also are contributing to world surplus capacity.

The United States therefore has much to gain by getting other developed countries to share the supply management burden. For example, if the responsibility for supply management were distributed among the developed grain exporters in proportion to their projected 1980 production, grain exports by the United States under the assumption of moderate improvement in production would be 77.7 million tons. This would be 7.1 million tons above the level estimated for the United States when it has the sole responsibility for balancing world grain trade. If all the grain surplus were distributed among the developed exporting and importing countries in proportion to their production, U.S. grain exports by 1980 would be 84.5 million tons. This would be 13.9 million tons above the level estimated for 1980 if the United States alone were to pursue supply management programs.

The world food problem can be solved. This study indicates that a high level of international cooperation toward that goal will contribute to more effective growth in the developing countries and to a more equitable sharing of both the responsibilities and the gains to be expected from accelerated economic development.

APPENDIX A

A simple model is used in this study to link agricultural production to national income and consumption of agricultural output in the less developed countries. In these nations, agriculture is usually the dominant form of economic activity. Thus, a change in the rate of growth in agriculture has a significant impact on total income and, therefore, consumption of agricultural commodities. The application of the model requires a minimum amount of information about an economy.

Let

Y	=	total national income
ΔY	=	change in total national income
Y_a	=	income of the agricultural sector
ΔY_a	=	change in income in the agricultural sector
Y_{na}	=	income of the nonagricultural portion of the economy
ΔY_{na}	=	change in income of the nonagricultural portion of the economy
α	=	proportion of total national income coming from agriculture
$1-\alpha$	=	proportion of total national income coming from the nonagricultural sector
C_a	=	consumption of agricultural output
ΔC_a	=	change in consumption of agricultural output
β	=	income elasticity of demand for agricultural output
O_a	=	agricultural output
ΔO_a	=	change in agricultural output
γ	=	income elasticity of demand.

Real prices are assumed to be constant and, therefore, price changes do not appear in the model.

Total national income can be expressed as

$$(1) \qquad Y = Y_a + Y_{na}$$

The percentage change in total national income is a weighted average of the percentage change in income in the two sectors.

$$(2) \qquad \frac{\Delta Y}{Y} = \alpha \frac{\Delta Y_a}{Y_a} + (1-\alpha) \frac{\Delta Y_{na}}{Y_{na}}$$

Further, the change in consumption of agricultural output is a function of the change in income.

$$(3) \qquad \frac{\Delta C_a}{C_a} = \beta \frac{\Delta Y}{Y}$$

Finally, the percentage change in income in agriculture is expressed as a function of the percentage change in agricultural output.

$$(4) \qquad \frac{\Delta Y_a}{Y_a} = \gamma \frac{\Delta O_a}{O_a}$$

The relationship between alternative rates of growth in agricultural output and consumption of agricultural output, assuming a constant rate of growth, k, in the nonagricultural portion of the economy, is

$$(5) \qquad \frac{\Delta C_a}{C_a} = \beta \frac{\Delta Y}{Y}$$

$$= \beta \left[\alpha \frac{\Delta Y_a}{Y_a} + (1-\alpha)\, k \right]$$

$$= \beta \left[\alpha\gamma \frac{\Delta O_a}{O_a} + (1-\alpha)\, k \right]$$

This model assumes no change in population. The variables can, of course, be translated into per capita terms, thus removing the effects of population change, which can be accounted for separately.

The model also contains a number of oversimplifications. First, it is not necessary to assume that the change in agricultural income is a simple linear function of the change

in agricultural output. Alternative forms of this relationship could be employed. Second, as presented, the model does not allow for interdependence between the rates of growth in the agricultural and nonagricultural sectors. For any agriculture whose development in part depends on the use of inputs produced in the nonagricultural sector, and which purchases consumer goods from the nonagricultural sector, there probably exists an interdependence between the growth rates of the two sectors.

The model as presented is formulated in terms of total agricultural production. It is used in this study to analyze changes in the rate of growth of food production, as measured by the rate of growth in grain output. Production of nonfood crops is assumed to grow at the same rate as food production. This assumption could be dispensed with and production of nonfood crops treated as a separate sector of the economy.

In spite of these and other shortcomings, it is felt that this model more accurately reflects the relationship between agricultural production and consumption in the less developed countries than alternative models which do not take into account the income and consumption effects of changes in the rate of growth of agricultural output. The model is subject to considerable improvement and refinement.

Let us illustrate how the model is used in this study. A plausible set of values for a "typical" underdeveloped country whose economy is heavily based on agriculture might be:

$$\alpha = 0.6$$

$$1-\alpha = 0.4$$

$$\beta = 0.6$$

$$\gamma = 1.0$$

$$k = 5.0$$

$$\frac{\Delta O_a}{O_a} = 2.0$$

Then, from (5) income would grow by 3.2 percent and consumption by 1.9 percent.

Now, assume the rate of growth in agricultural output increased to 3 percent. Then, income would grow by 3.8 percent and consumption by 2.3 percent. The demand for agricultural output varies directly with changes in the rate of growth of agricultural output. As the rate of growth in output increases, so does demand, and vice versa.

This model illustrates an important economic aspect of agricultural development, and the need for agricultural imports in the less developed importing countries. As a predominantly agricultural, less developed country improves its rate of growth in agricultural output, its import requirements will decline by less than absolute increase in its own production. Conversely, if the rate of growth in agricultural output were to decline, the increase in import requirements would be less than the absolute decline in production.

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