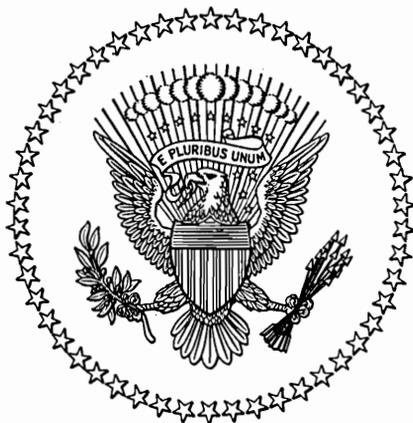


# THE WORLD FOOD PROBLEM



*A Report of the  
President's Science Advisory Committee*

VOLUME I

Report of the Panel on the  
World Food Supply

---

THE WHITE HOUSE

MAY 1967

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WASHINGTON

In all of recorded history, none have surpassed the American people in willingness to share their abundance with others. We have given unstintingly of our material wealth and our precious human resources to benefit the less fortunate of this earth. We have sought to restore those whom war has shattered. We have sought to provide assistance to the newly independent members of the family of nations who are making the effort to break the shackles of tradition and achieve a better life for their peoples.

But as success in programs to eradicate disease and to improve health have given more and more millions the opportunity to live out their natural span of life, the problem of hunger has lingered on and the shadow of starvation and impending famine has grown ever darker.

Hunger's unceasing anguish drains hope, crushes aspirations, and obstructs the generation of programs of self-help. The threat of starvation sets man against man and citizen against government, leading to civil strife and political unrest.

Our programs to help these new countries to increase food production have brought about striking improvement in a few instances. But in the total balance, food has not kept pace with population and the developing world continues to lose ground in this race.

The World Food Problem is one of the foremost challenges of mankind today. The dimension of the challenge will define the dimension of our response and the means for that response. We must join with others in a massive effort to help the less fortunate of the earth to help themselves. I am making this report public because of its significance for the American people and people all over the world.

A handwritten signature in black ink, appearing to read "Lyndon B. Johnson". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

*“... Feed Them Also and  
Lift Them Up ...”  
—Psalms 28:9*

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National Institutes of Health  
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Des Moines, Iowa

MILCO COX  
Rural Development Division  
Office of Institutional Development,  
Latin America  
Agency for International Development  
Washington, D.C.

HERBERT W. JOHNSON  
Head, Department of Agronomy and  
Plant Genetics  
University of Minnesota  
St. Paul, Minnesota

B. A. KRANTZ  
Extension Soils Specialist  
Department of Soils and Plant  
Nutrition  
University of California  
Davis, California

FRANCIS J. LEBEAU  
Agriculture Division  
Office of Institutional Development,  
Africa  
Agency for International Development  
Washington, D.C.

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Raleigh, North Carolina

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Agricultural Research Service  
U.S. Department of Agriculture  
Beltsville, Maryland

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MARTIN G. WEISS  
Agricultural Research Service  
U.S. Department of Agriculture  
Washington, D.C.

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Director for Agricultural Sciences  
The Rockefeller Foundation  
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Animal Health Division  
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Special Assistant for International  
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International Agricultural Develop-  
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Washington, D.C.

**M. L. ANSON**  
18 E. 81st Street  
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DeKalb, Illinois

**LEWIS B. NELSON**  
Manager  
Office of Agricultural and Chemical  
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**L. DALE NEWSOM**  
Professor of Entomology  
Louisiana State University  
Baton Rouge, Louisiana

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**JOHN R. DOUGLAS, JR.**  
Staff Economist  
Agricultural and Chemical  
Development  
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Muscle Shoals, Alabama

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Plant Physiologist  
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University of Illinois  
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Raleigh, North Carolina

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Gainesville, Florida

---

\*Deceased.

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---

\*Deceased.

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Harvard University  
Cambridge, Massachusetts

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Center for International Affairs  
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Agency for International Development  
Washington, D.C.

**ERIK THORBECKE**  
Chief, Sector and Market Analysis  
Division  
Office of Program Coordination  
Agency for International Development  
Washington, D.C.

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# THE WORLD FOOD PROBLEM

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## 1.0 THE ASSIGNMENT

... and lo a black horse; and he that sat on him had a pair of balances in his hand. And I heard a voice say, A measure of wheat for a penny, and three measures of barley for a penny; and see thou hurt not the oil and the wine.

REVELATION 6: 5, 6

In his Message on Food for Freedom, February 10, 1966, President Johnson directed his Science Advisory Committee:

- to search out new ways to:
  - develop inexpensive, high-quality synthetic foods as dietary supplements
  - improve the quality and nutritional content of food crops
  - apply all of the resources of technology to increasing food production

When we first met as a Panel, we were inclined toward a narrow view of the task before us. Preliminary discussions and deliberations, however, quickly convinced us to alter this initial position. It became evident that a study of food production would be meaningful only if it included an examination of broad scope which would place the problem of food in the context of the more general questions of economic development and foreign assistance.

The situation as the Panel now views it, after nearly a year of study, is that hunger and malnutrition are not primary “diseases” of the last half of the 20th century. Rather, along with the so-called population explosion, they are symptoms of a deeper malady—lagging economic development of the countries of Latin America, Asia, and Africa, in which nearly two-thirds of the people of the earth now live. While our deliberations have centered on the specific problem of the food supply, we have attempted to consider it in appropriate context.

In the State of the Union Message, January 10, 1967, President Johnson said:

Next to the pursuit of peace, the really greatest challenge to the human family is the race between food supply and population increase. That race tonight is being lost.

The time for rhetoric has clearly passed. The time for concerted action is here and we must get on with the job.

This succinct statement summarizes the problem as we have found it. This report defines the job that “we must get on with” and recommends some approaches for action.

## 2.0 THE PANEL'S APPROACH

### 2.1.0 *The General Problem*

We have been unable to devise any new or original statement of the world food problem. The subject has been treated so thoroughly in orations and editorials during the past two decades that both its size and significance tend to be obscured by rhetorical overkill. All has been said before and said extremely well; all has been repeated, reiterated, and rephrased. The stark misery of hunger, the ravages of malnutrition, the threats of civil strife, social unrest, and political upheaval posed by food shortages, and the shadow cast by impending famine have all been portrayed in urgent and compelling terms. The need for the United States, other developed nations, international agencies, and voluntary institutions to help the hungry nations has been pointed out time after time. Insofar as the citizens of the developed countries of the West are concerned, this obligation to aid the less fortunate of the earth has been accepted without argument and they seem to assume that they are already supporting effective programs which will finally alleviate the problem. So repetitively has the problem been brought to the attention of the American public during the past several years that they seem almost to have lost the ability to respond to the stimulus; they are aware of the existence of the problem, they converse about it from time to time, but there is no longer any depth of understanding or concern. The situation has been aptly put:

A nation conditioned by affluence might possibly be suffering from compassion fatigue, or from conscience sickness, the peril of narrowing our field of vision to leave out the unpleasant view of life disfigured by hunger.<sup>1</sup>

Despite expenditures of billions of dollars for foreign aid; despite donations and concessional sales of millions of tons of food to developing nations; despite herculean efforts by numerous voluntary groups; despite examples of highly productive technical assistance programs by foundations; and despite years of activity by international organizations such as International Bank for Reconstruction and Development (IBRD), Food and Agriculture Organization (FAO), World Health Organization (WHO), United Nations Educational, Scientific and Cultural Organization (UNESCO), and United Nations

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<sup>1</sup> Cousins, Norman ; *Saturday Review*, March 25, 1961.

International Children's Emergency Fund (UNICEF), there are more hungry mouths in the world today than ever before in history.

Throughout our deliberations and our efforts to respond to the President's directive, we have continually asked ourselves, "Why is the race between food and population being lost?"

Several factors have contributed:

1. The overall problem of the world food supply is so large and so extremely complex that it is almost impossible for the casual or even the moderately concerned observer to comprehend its true dimensions or to grasp its intricate interrelationships with the many other aspects of economic growth and development.

2. Despite its true complexity, the problem, at first glance, seems deceptively straightforward and is, therefore, unusually susceptible to oversimplification. Because eating and even farming seem readily understandable to the average citizen in a developed country such as the United States, the temptation to act on the basis of superficial or incomplete information is almost irresistible. This leads to seizure and overemphasis upon panaceas and piecemeal "solutions" which are inapplicable, ineffectual, or inadequate. The cumulative delays engendered by false starts and stop-gap measures mask the requirement for broad and effective programs, tailored to the demands and dimensions of the overall problem.

3. The details of the task involved in increasing food production to meet world needs have never been charted with the clarity and exactness that the available information will permit. The problem has been treated dramatically but incompletely—usually to incite short-term action for humanitarian reasons. A wholehearted response to an *incomplete proposal*, however, lulls the participants into an unjustified feeling of security that the problem is coming under control.

4. Food shortage and rapid population growth are separate, but interrelated problems. The solutions, likewise, are separate, but related. The choice is not to solve one or the other; to solve both is an absolute necessity. The current tendency to think of food production and fertility control as alternative solutions to a common problem is dangerously misleading.

5. The twin problems of food and population imbalance have one feature in common that adds immeasurably to the difficulties of achieving control. Their eventual solution is crucially dependent upon success in convincing millions of citizens in the developing nations to take *individual* action. Fertility control cannot be achieved by declarations of government policy or by executive decree although adoption of a policy and the provision of information, instruction, and materials are obviously needed and are helpful. Similarly, political declarations concerning agricultural productivity are ineffective unless individual farmers can be convinced to adopt the necessary improved practices.

The provision of these personal incentives is a task that encompasses a vast array of social, economic, and political considerations which differ between countries and within countries. Indeed, the very fabric of traditional societies must be rewoven if the situation is to change permanently.

6. The eventual alleviation of world hunger will require many years. It is dependent on far-reaching social reforms and long-range programs of hard work which offer no promises of quick and dramatic results of the type so helpful in maintaining enthusiasm for a concerted, difficult undertaking. The results cannot be seen as a dedication of new buildings, as a successful launching into space, or as other spectacular, "newsworthy" events to punctuate the year in and year out toil.

7. The problem of food production is but one part, albeit a very important part of the enormous problem of economic development in the poor nations. As the years have passed, the great expectations which ushered in our foreign assistance programs, fresh on the heels of the heady successes of the Marshall Plan, have not been realized. Domestic political constraints have so eroded the program and the agency responsible for it that there remains virtually no possibility of commitment to long-range, coordinated action, dedicated to the systematic solution of a series of interrelated problems, none of which can be solved in isolation from its fellows. The original emphasis upon technical assistance has been so diluted that it is almost correct to say that this form of aid, indispensable to the accomplishment of increases in food production, now receives little more than lip service. Despite chronic reiterations of the need to involve private industry in economic assistance, no significant progress in engaging this rich reservoir of resources and skills can be reported at this time.

The chief handicap faced by all is the impatience of the modern fast moving world . . . expressed in the desire of philanthropists (individual, foundation, national, and international) for concrete evidence of good they are doing; expressed in the hope of the specialist during a tour of 1½ or 2 years, to leave a permanent mark upon the culture that has been evolving for 1½ or 2 millennia.<sup>2</sup>

## 2.2.0 *Technology and Agricultural Development*

The establishment of modern agricultural practices has succeeded in increasing the indigenous production of food crops in several developing countries; in a few, such as Mexico, Taiwan, and Israel, the results have been spectacular. The true significance of these very conclusive demonstrations of what agricultural science and technology can accomplish is largely misunderstood by the vast majority of

<sup>2</sup> Thomas, H. E., Cultural control of water development; role of science and technology in African development, N.A.S. Panel Meeting, San Francisco 1968.

Americans, including many officials and legislators with major interests in and responsibilities for this country's program of foreign assistance. It also is not properly understood by many government officials in the developing countries or by many administrators of international agencies.

Given the opportunity, agricultural scientists and technologists can apply existing principles and concepts to find answers to problems of expanding agricultural productivity in another country or region of the world.

This *ability to find answers* through basic and adaptive research and through technological innovation within a country is distinctly different from *already knowing the answers*. The adaptation of existing methods and techniques to indigenous needs is not the same as transplanting existing American agricultural techniques, unmodified, to another country. The hard lessons learned by American specialists in the school of experience which are now accepted as basic tenets by agriculturists throughout the world, have made curiously little impression upon the public. Through some almost inexplicable twist in communications, there is a persistent impression that agricultural science already has the answers to the problems of increasing food production in the developing countries. This misunderstanding has given rise to the "know-how, show-how" fallacy, the idea that practices responsible for our own outstanding agricultural success can be applied with equal effectiveness in far different climes and cultures. Insofar as the problem of the world food supply is concerned, this view, which is as erroneous as it is entrenched, looks on the solution to the problem as a matter of logistics. In actuality, it is a scientific and technological problem of the first magnitude, in addition to a logistical one.

While, at first glance, the difference in knowing how to find answers and in already having answers may seem to be a minor one, it has major implications in planning for the inclusion of technical assistance in foreign aid. The initial need for adaptive research in the developing country itself and the continuing need for research on new varieties and practices are *basic* to modern agricultural production and an understanding of these needs is fundamental to planning a successful program of agricultural development overseas. The notion that farmers from the developed countries can contribute substantially to food-production programs in foreign nations without suitable resources and technological information is a misconception which sorely needs correction. In the United States, we tend to take many things for granted and, of these, the scientific and technological basis for modern agriculture leads the list. An understanding of the remarkable differences between traditional subsistence farming and modern commercial agriculture is the first step toward comprehending the magnitude of

the problem of the world food supply and the absolute essentiality of technical assistance as opposed to "practical" assistance, to the solution of the problem.

The steadily diminishing role that true technical assistance has played in the foreign aid program of the United States is a trend which must be reversed if the program is to be expected to contribute significantly to the long-term amelioration of the increasingly serious food shortages in the developing countries.

### *2.3.0 Other Considerations*

In agricultural development as well as in other areas of assistance to a developing country, the political stability and predominant attitudes of the recipient government are of crucial importance. Most American citizens are thoroughly familiar with the constraints and disruptions that domestic political conditions within a developing country can create for aid programs. Recent history is replete with episodes which try our patience and frustrate our good intentions.

In contrast to these more obvious and better publicized difficulties at the political level, the obstacles posed by traditional culture, social structure, religious beliefs, and the long-established habits and customs of many developing countries are rarely considered in truly realistic terms. To understand, much less to accept these constraints is particularly difficult for Americans who remain among the citizens of Western Nations the least cosmopolitan and least tolerant of delay. The problem of ethnological differences has been epitomized:

In one country, steel plows are introduced where previously a pointed stick had served. The farmers accepted them with polite gratitude and use them as ornaments but not for plowing. Why? These plows require two hands and the farmers are accustomed to using only one, the other being used to guide the bullock. A more productive variety of rice cannot be introduced in part of Nepal, where it is needed and very well suited to climate and soil, because the grains cling a bit more to the stalk and a new threshing technique would be used. But threshing is a family or community undertaking involving social and ritual as well as mechanical activities. Running water in peoples' houses is not accepted because the village well is a social center, as well as source of water . . . It would not be difficult to put together a large list of such minor failures nor to include in it some major ones. If these seem improbable or easily overcome, the reader might review the introduction of an innovation, say the fluoridation of water, into our own technologically highly sophisticated society. He might also consider the willingness with which Christians, out of Christian motives, will help to reduce infant mortality and disease in a distant, non-Christian country and how unwilling they may then be to help control the population explosion that inevitably results.<sup>3</sup>

Developed nations are characterized by low rates of population growth and adequate food supplies. This implies that the eventual

<sup>3</sup> Dart, Francis E., *The rub of cultures*, Foreign Affairs, January 1963, p. 365.

solution to both food and population problems will be one and the same and that the solution will be primarily a matter of economic improvement.

This view, however, oversimplifies the situation. Hunger, "the eternal involuntary fast," as Mahatma Gandhi termed it, and malnutrition, its physiological result, impair productivity and slow economic development. A fact of overriding importance is that the cornerstone of economic progress is the development of *resources*. Most developing nations must look to the land and to agriculture for the resources with which to build self-sustaining, productive national economies. This hard, mundane, and unexciting fact has yet to be accepted as it must be by the political authorities in most of these countries. Indeed, it is not well enough understood by the developed countries which offer foreign assistance. Agricultural development has never been a particularly appealing or inspiring national goal; it is politically unglamorous, unrecognized, and unrewarding. It does not raise visions of the 20th century, the age of technological revolution, in the minds of most people.

Until agricultural development is accorded its rightful place by both donors and recipients of foreign aid, the imbalance between the world's food supply and its population will continue to outpace our efforts to meet the increasing need no matter how well-intentioned they may be.

#### ***2.4.0 The Form of the Report***

This report, which we had originally hoped would be a blueprint that would enable the United States to translate its concern into action is more of a sketch than a set of working drawings. Our greatest difficulty has been to offer a descriptive analysis which avoids undue emphasis upon single segments of a complex problem. We have discovered few new facts, but information from many scattered and diffuse sources has been brought together and has been correlated in new ways.

While global averages and general world estimates portray the total size of the problem and, hence, have some usefulness, they cannot serve as a basis for specific action or even for specific planning for the needs of a given country or region within a country. Consequently, wherever possible, we have given actual examples of action programs, emphasizing India, Pakistan, Brazil, and other Latin American countries as prototype areas. Throughout, we have been faced with the need to adapt a larger mass of highly technical material into a form that will be understandable to nontechnical readers.

The Panel's initial view (in retrospect, a rather simplistic one) of determining program requirements and costs has been modified as the food problem has been unveiled in its complexity and we have lost

much of our original naivete concerning the economic implications of alternative approaches to the problem. Certain estimates of manpower requirements and capital expenditures in the area of food production can be made rather accurately. We have emphasized throughout the interdependence of the development of food resources and other phases of economic development. This recognition, however, has not enabled us to grapple directly and specifically with problems concerning the allocation of limited capital, the assignment of priorities within a given country, and other factors of economic development.

With the help of economists, we have been able to establish some guidelines for the specific economic analysis that should precede implementation of any of our proposals in any single country. To have gone beyond this would have changed the character of the study by expanding its scope to include the total economies of all of the developing countries.

The Panel enlisted for its work on the world food problem authorities from universities, private industries, foundations, and Federal agencies, and their expertise was utilized in specific studies by subpanels, each directed by a member of the Panel. More than one hundred individuals contributed to this effort. The material relating to this study is compiled in three volumes.

Volume I is a concise summary of the world food problem, including a description of the nature of modern agriculture. The Panel's general recommendations for policy and detailed recommendations for actions to be taken or encouraged by the United States in the near-term and long-term are given, and also included are summaries of the subpanel reports. Areas demanding further study are noted.

Volume II consists of a series of reports prepared by the several subpanels which are presented in 14 chapters. These are intended to document and to explain some of the assertions contained in Volume I and to provide interested readers with further detailed information on specific subjects. There are two chapters in which data from the subpanel reports have been synthesized. One is devoted to economic implications of the world food problem and the other is a 20-year projection of India's foodgrain problem. Collectively, Volume II can be looked on as a disaggregation of the world food problem into its various components. The reports of the subpanels are not entirely uniform, having been prepared independently, and some of the data and opinions contained within them are at slight variance. These, where of major import, have been discussed in Volume I.

Volume III contains technical and other special papers. In the course of deliberations by the Panel and subpanels, detailed analyses of existing or new data were prepared by members and consultants.

Several of these represent original research and all contain information that should be of unusual value in planning. Most will be of primary interest to specialists but each is sufficiently important to deserve perusal by anyone with serious interest in or responsibility for the problem of food for developing countries or economic development in general.

## 3.1 PRINCIPAL FINDINGS AND CONCLUSIONS

This report defines and directs attention to a threatening problem of the global environment in which the United States and all nations must dwell together—the declining condition of more than two-thirds of the human race.

The Panel's detailed analysis of the world food problem has led to four basic conclusions:

1. The scale, severity, and duration of the world food problem are so great that a massive, long-range, innovative effort unprecedented in human history will be required to master it.

2. The solution of the problem that will exist after about 1985 *demands* that programs of population control be initiated now. For the immediate future, the food supply is critical.

3. Food supply is directly related to agricultural development and, in turn, agricultural development and overall economic development are critically interdependent in the hungry countries.

4. A strategy for attacking the world food problem will, of necessity, encompass the entire foreign economic assistance effort of the United States in concert with other developed countries, voluntary institutions, and international organizations.

### 3.1.0 *The Nature of the World Food Problem*

The world's increasingly serious nutritional problem arises from the *uneven distribution* of the food supply among countries, within countries, and among families with different levels of income. Global statistical surveys, based upon total food produced per person, suggest that there is no world-wide shortage of food in terms of quantity (calories) or quality (protein) at the moment. But in the developing countries, where two-thirds of the world's population live, there is overwhelming clinical evidence of undernutrition (too few calories) and malnutrition (particularly, lack of protein) among the people. Clearly, millions of individuals are *not* receiving the amounts of food suggested by average figures.

Many South Asian and Latin American countries, for example, have average diets which are nutritionally inadequate according to minimum standards of the United Nations Food and Agriculture Organization (FAO). In these regions, surveys show that the poorest 25 percent of the people consume diets with caloric and protein contents that are only about three-fourths of the country average and fall far

below calculated nutritional requirements. It is in these low income groups that overt malnutrition is found, particularly among the most susceptible groups: infants and preschool children, pregnant women, and nursing mothers.

### 3.2.0 Population Growth and Food Needs

If the world population continues to increase at 1965 rates, 52 percent more calories will be required in 1985. This estimate is based on calories actually consumed and does not consider production, losses, quality, and wastage of food. If, as a result of family planning programs during 1965-85, one optimistically assumes a progressive decrease to 30 percent in the probability that a woman of given age will bear a child (fertility rate<sup>1</sup>), the caloric requirements will still be 43 percent higher by 1985.

These projections of *world* food requirements, however, fail to depict the plight of the developing countries. India, at her present population growth rate, will require 108 percent more calories by 1985; with a 30 percent reduction in fertility, the increased nutritional requirement will be 88 percent. The corresponding figures for Pakistan's increased caloric needs in 1985, allowing for the same reduction in fertility, are 146 percent and 118 percent, and for Brazil, 104 percent and 91 percent (Figure 3-1).

These estimates portray two of the most crucial aspects of the relationship between population growth and food needs:

1. Population and food problems center directly in the already poor, already diet-deficient countries where food production is low and population growth rates are high. In these developing nations, under the best of circumstances, food needs will at least double within the next two decades.

2. The disproportionate additional need for food in the developing countries cannot be solved by successful programs of family planning alone during the next 20 years. This mathematically demonstrable fact of demography *must not* be interpreted to indicate that population control measures are inherently ineffective or in any way secondary in importance to increasing food production. On the contrary, the Panel's estimates simply show that the impact of successful family planning is cumulative and makes itself felt in the size of the next generation.

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<sup>1</sup>The demographic techniques utilized by the Panel in projecting population growth are described in detail in Chapter I, Volume II. Assumptions concerning future effectiveness of family planning were not made on the basis of an estimated reduction in *birth rate* (births per 1000 total population). Rather, a reduction in the *age-specific fertility rate* was assumed. Age-specific fertility is a more accurate reflection of success in family planning than is birth rate alone.

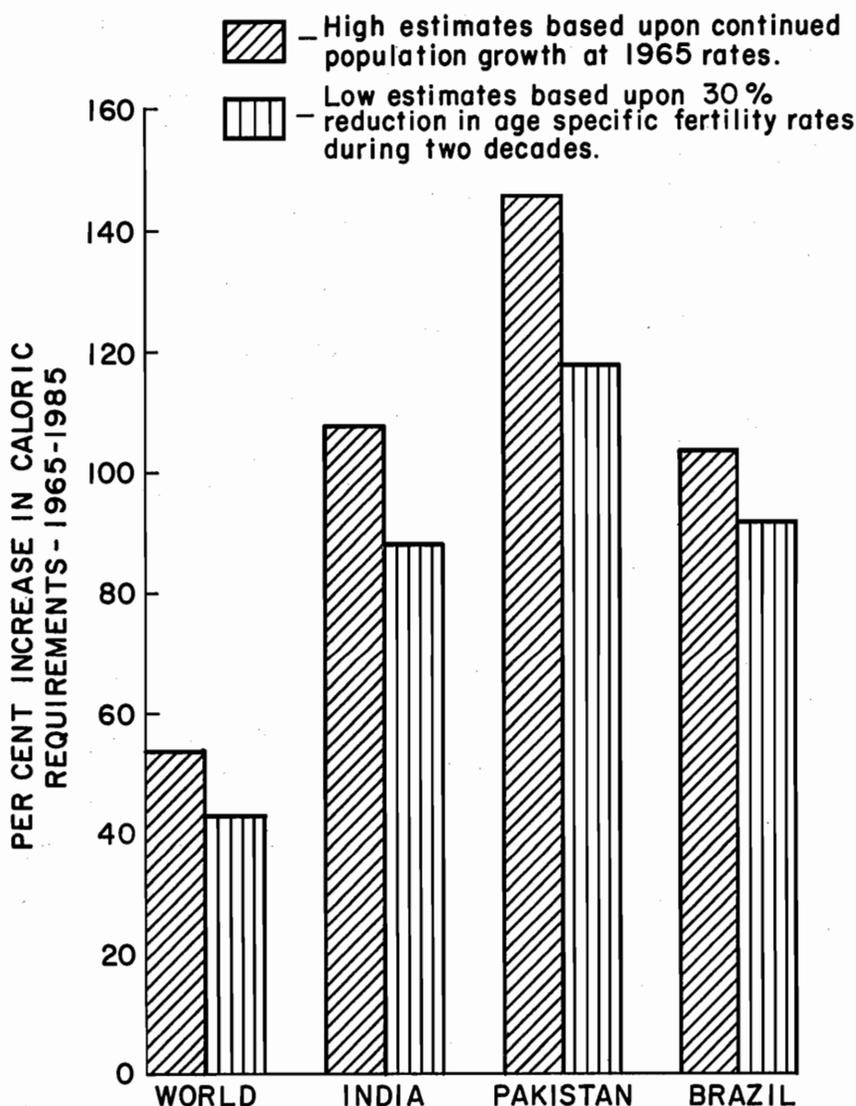


FIGURE 1-1.—Projection of caloric requirements for the world, India, Pakistan and Brazil.

For example, the difference in our high and low estimates for world population in 1985 is only 385 million (5.03 billion and 4.65 billion). The difference is greater in later decades and is 1.15 billion in the year 2000 (7.15 billion and 6.0 billion).

To avoid a continued worsening of the population-food situation during the years beyond 1985, that may even reach an economically or ecologically irreversible state of imbalance, *it is imperative to institute intensive programs of family planning now.*

The Panel is unanimous in supporting and urging, in the strongest terms, continuing and increasing emphasis upon research, technical assistance, and capital funding in family planning. Only by such continuing emphasis and effort can the outpacing of food production by population growth be avoided as a problem that might continue well into the next century. The long lag-period that necessarily precedes the main effect of programs of family planning adds to the urgency of the need for action now.

The world food problem is not a future threat. It is here now and it must be solved within the next two decades. If it is solved during this time, it will be manageable for the years thereafter.

*This report, then, is addressed to the grim reality of the food shortage that will occur during the next 20 years (actually 1965/66 to 1985/86) before programs of family planning can be expected to bring about long-term amelioration of the problem by reducing world population growth.*

### **3.3.0 Nutrition, Infant Mortality, and Family Planning**

That reduction of population growth is essential to achieving a balance between food supply and food need is an obvious, easily understood, and widely appreciated fact.

There is, however, another more complex, less well-known, and crucially important relationship between nutritional needs and family planning. Surveys of the attitudes of married couples in developing countries show that the numbers of children desired are higher than in the developed nations. Furthermore, the average number of live births per woman in the developing countries is 30 percent greater than the desired number of children.

Emphasis on the desire for heirs leads to large families. Only one son may be needed for ritual or economic purposes but it is common to want two sons to insure against the death or incapacity of one. Couples must average four children to obtain two sons.

Availability and efficacy of pills, intra-uterine devices and other technical means for birth control are largely irrelevant until couples have secured the desired number of living children.

If we assume the necessary preconditions for reducing fertility rates in the developing countries are low infant and child mortality and a public awareness that mortality is low, then *we have the apparent paradox that a reduction in childhood mortality will reduce rather than raise the rate of population growth.*

In the United States, approximately 25 of every 1,000 liveborn infants fail to survive to the age of one year and most of the deaths result from prematurity or congenital defects. In the poor countries of Asia, Africa, and Latin America, published infant mortality rates

range from 100 to nearly 200 per 1,000 live births. *Much of the higher death rate is the direct or indirect result of protein-calorie malnutrition.*

Protein-calorie deficiency, in the form of a disease called *kwashiorkor*, is a great killer. Acute diarrhea can be a dangerous illness for a well-nourished American baby; in the malnourished infants of the developing countries, it has an appalling mortality. Common childhood diseases are catastrophic in protein-deficient children. In 1960, for example, the fatality rate from ordinary measles was more than 100 times greater in Chile than in the United States.

If lowered infant and child mortality is a precondition to acceptance of family planning, and the major underlying cause of excessive childhood deaths in the developing nations is malnutrition, it follows that an increase in both quantity and quality of food in these countries is essential to achieving stability of population growth.

*Viewed in this light, alleviation of the world food problem must be accorded the highest priority in planning for the developing nations.*

### **3.4.0 Subsistence Farming and Commercial Agriculture**

In countries where, for centuries, farming has been traditionally at a *subsistence* level, intended to produce food and fiber only for family or local needs, the urgent problem of converting individual farmers to a *commercial* system in which production is primarily for markets at a distance from the farming area has been superimposed upon the other demands of modernization. The cornerstone of economic progress of any nation is the development of its natural resources and manpower. Many of the developing nations must concentrate on agricultural resources as the foundation for building self-sustaining, productive national economies. Conversely, the growth of the entire national economy will be essential in the future to increase agricultural production, which will depend critically on the farmer's ability to purchase fertilizers, tools, high-yielding seeds, pest controls, and irrigation water. To be able to purchase the required materials, farmers will need to sell a major portion of their harvests, which means that there must be increasingly prosperous customers who can buy farm products.

To persuade farmers to accept the techniques and methods of modern agriculture is a formidable and complex undertaking. Farmers in traditional subsistence economies are understandably wary of assuming new risks because they are so close to the margin of survival. If a farmer is to invest in the modern inputs of improved seeds, fertilizers, and pesticides that are essential to increasing the output of his land, these resources must be easily available to him, a system of farm credit must be established so that he can afford to purchase them, he must be instructed in the proper and economic utilization of these materials,

he must be reassured that he will be compensated for possible losses incurred in the process of innovation, and, above all, he must be shown that the potential payoff is worth the risk. Land tenure policies should not be such that his landlord will profit and he will not. Government pricing policies should not favor the consumer at the expense of the producer.

*All of these factors enter into the vital matter of providing incentives to the farmer to increase production for the market. Fundamentally, it appears that many nations are under-utilizing the power of the market economy.* Needed inputs for modern agricultural production are scarce, unreliable in availability, and expensive in relation to the prices of farm products. For example, a bushel of rice will pay for four times as much fertilizer in the United States as it will in Egypt and more than twice as much as it will in Thailand or India.

Both producers *and* consumers are responsive to prices and to income if governments will recognize and use the market mechanism. The Mexican government has recognized this fact in pricing policies and this is a major reason for the growing promise of the Mexican agricultural development program.

To induce farmers to change, the potential payoff must be high—not 5 to 10 percent but 50 to 100 percent. Adoption of deep wells for supplemental irrigation in West Pakistan is an example. In five years, nearly 32 thousand private “tube” wells were installed, at a cost of \$1,000 to \$2,500 each, on farms no larger than 25 acres in the cotton and rice regions of the former Punjab. A private investment of \$50 million was made by traditional farmers without government subsidy. Why? The wells typically paid for themselves in two years. If the payoff is large enough, farmers will change.

### ***3.5.0 The Effects of Urbanization***

The enormous increase in nonfarm population in the diet-deficient countries has aggravated the food problem further by making it necessary to develop distribution systems to move more and more food into the cities from the producing areas. This requires the establishment of transportation, storage, processing, and marketing facilities on an unprecedented scale in economies which are already stretched to their limits.

The growth of large cities is a well-recognized characteristic of developed nations but it is not generally realized that the trend toward urbanization is fully as strong in the developing countries. As early as 1950, more than one-third of the world's cities with populations exceeding 100 thousand were in Asia and the exodus from rural areas has accelerated each year since.

The shift of people from farms to cities in the United States and Western Europe has resulted primarily from the reduction in rural labor requirements brought about by advances in modern agricultural technology and increased labor requirements of industry. In the developing countries population growth alone has heightened the frequency with which families leave the overcrowded, poverty-stricken countryside, hoping to find a livelihood in the city. The results in most developing nations have been growing slums and unemployment since unskilled labor is overabundant in both rural and urban areas.

### **3.6.0 Food Customs and Taboos**

Dietary habits are established early in life and, in the highly traditional cultures of the developing countries, food selection and diet more often reflect religious and social beliefs than they do the principles of human nutrition. During the past several years, there have been many commercial programs intended to make unfamiliar new food products available to low-income groups in the developing countries. It has become abundantly clear that it is extremely difficult to change fixed food habits. Market research and feasibility studies must give proper attention both to family income and to existing habits and taboos. It has been demonstrated that dietary customs *can* be changed (e.g., people whose dietary staple has been rice have been persuaded to accept wheat as a supplement or substitute) but success in any such undertaking requires time and a carefully prepared program of consumer education. In summary, *any program to remedy malnutrition which involves changing traditional food habits is highly likely to be ineffective in the short-run and even a long-range plan must be carefully programed for the specific local situation.*

### **3.7.0 Meeting the Need for More Food**

For the next several years, any major expansion of the world food supply will be dependent on increased production from conventional sources and upon more efficient utilization of available foodstuffs through reduction of waste and spoilage. *The vast majority of the increased production must take place within the developing countries themselves.*

#### **3.7.1 There is No Panacea**

Periodically, the news media draw attention to ongoing research on systems which offer possibilities as new sources of human food. Because there is a strong tendency to portray these as possible "solutions" to the world food problem and because the public is drawn understandably to such panaceas, this publicity undoubtedly lessens

concern about the seriousness of the food supply in the developing nations.

The Panel has examined carefully and in detail the several new processes which are under current study. "Single cell protein" derived from fermentation by yeasts or bacteria of carbohydrates, hydrocarbons, or cellulose is particularly promising. A great advantage of single-cell protein is that it can be produced independently of agriculture or climatic conditions. However, there are major unsolved problems of scale of production, processing characteristics, nutritive quality, consumer acceptance, and cost which remain to be worked out. It will be several years, *at least*, before even a decision concerning the possible usefulness of such materials in the food supply can be made.

Methods for extraction of protein directly from green leaves have been devised and deserve careful consideration and further research since the materials utilized are frequently wasted or are fed to animals. Again, many problems of nutritive quality, scale, cost, and acceptability must be solved before evaluation of the usefulness of this material will be possible.

Investigations of the processing of algae as human food have been unrewarding thus far because of the excessive cost of deriving a product that is safe for human consumption. It now appears that the usefulness of algal materials economically derived as a by-product of reclaiming sewage and other waste waters will be as a feed for livestock.

In summary, some nonconventional sources of food appear to offer great potential for the long-term but in the judgment of the Panel none of these can be expected to lessen the problem of increasing food production from conventional sources during the next two decades.

Furthermore, the magnitude of the world's food problem is so great that nonconventional sources, when and if they become available, may be needed to supplement rather than supplant modernized agriculture. The problem will be with us for so long, however, that every effort must be made now to invent new processes and develop known ones to produce novel foodstuffs. In order to provide a reasonable probability that the long-range potential of unconventional food sources may be realized within two decades, we must accelerate research on these methods now.

### *3.7.2 Animal Sources*

There are good opportunities for improved production of livestock and increased utilization of fishery resources, including fish farming (aquiculture), in the developing countries. These deserve emphasis and exploitation because animals are capable of converting to food dif-

ferent types of by-products and forages that cannot be consumed directly by people and for the significant contribution that they can make to improving the quality of protein in diets and earning foreign exchange. A process of producing fish protein concentrate (FPC) appears to hold promise for the future although major problems of scale, technologies for different species, and consumer acceptability must be solved before its usefulness can be evaluated.

### 3.7.3 Agricultural Production

It is, therefore, evident that the *bulk of the increase in food supply must come from increased production of farm crops*. There are two ways in which agricultural production can be increased: by bringing more land under cultivation or by increasing yields of land under cultivation.

Until the present time, most of the increase in food production in the developing countries has been achieved by extending traditional farming methods over a larger area of cropland. Substantial opportunities remain to bring additional land under cultivation in the less densely populated areas of Latin America and of Africa, but the vast majority of arable land in Asia is already in use. While there are marginal possibilities for using small additional areas, it is clear that as the population continues to grow, the amount of cropland per person in the Asian countries will diminish progressively.

*In Asia, a shift to increasing crop production by intensifying agriculture and using modern methods to improve annual yields on land under cultivation will be mandatory*. Even in Latin America and Africa, the increasing cost of clearing additional land may well make it more economical in many regions to concentrate on elevating yields rather than expanding cultivated areas.

To increase yields, a major expansion of irrigation facilities will be necessary to make multiple cropping possible independent of wide variations in seasonal rainfall. It also will be necessary to develop and utilize new, high-yielding varieties of plants, to develop and utilize plants with a higher quality of protein, to increase the use of fertilizers and pesticides, and to employ improved farm machinery. Increased capital investments and increased expenditure on the part of farmers will be required to make these tools of modern agricultural technology available. These are the techniques that have been employed so successfully in the developed countries to transform farming into a *business*.

*The transition from traditional farming to modern agriculture will be difficult and expensive for the hungry nations but it is absolutely essential if their food needs are to be met. There is no alternative.*

### 3.8.0 *The Need for Technical Assistance*

The modernization of agriculture in the developing countries will involve capital investment, provision of inputs in the form of seeds, fertilizers, pesticides, water, and machinery, organization of distribution and marketing systems, education of agricultural specialists and extension workers, provision of production incentives for individual farmers in the form of land-reform and pricing policies, and other changes in social and economic structures.

*Critical to the success of all of these measures, however, is the necessity for adaptive research needed to gain an understanding of the principles governing plant and animal production under the conditions, soils, and climates existing in the developing countries.*

#### 3.8.1 *Agricultural Technology is Not Transferable*

Modern scientific agriculture has been brought to flower in the temperate regions of the developed world. In the tropical climates where the bulk of the world's low-income people live, scientific agricultural efforts have been concentrated on the traditional tropical export crops: sugar, tea, coffee, cocoa, bananas, and rubber. Only recently have food crops received serious attention.

*The products of technology and "know-how" cannot be transferred directly to the developing nations.* Many plant varieties transferred to different climates fail to flower or set seed if, indeed, they survive at all. Livestock may become non-productive or die. Adaptive research must be accomplished within the developing countries. A blueprint for a bicycle or a steel mill can be shipped overseas and utilized without alteration but the blueprints and architecture for a food crop must be developed overseas. There, as in the United States, new plant varieties, each better than the last, must be produced frequently to increase plant resistance to insects and disease.

There is an urgent need to carry out this adaptive research, to establish strong indigenous institutions, and develop the manpower that will enable the poor, food-deficit nations to carry out the self-sustaining, continuing programs of research and development that are essential to modern food production.

#### 3.8.2 *The Task of Technical Assistance*

Increasingly, United States foreign assistance should take the form of knowledge, technical aid, adaptive research, education, and institution building.

*The scarcest and most needed resource in the developing countries is the scientific, technical, and managerial skill needed for systematic, orderly decision-making and implementation.* Through technical assistance programs, the United States should emphasize guidance,

education, and the development of indigenous capabilities—for the long term—because the task in the developing nations has only just begun and will continue for many decades to come.

In recent years, United States programs of technical assistance have largely given way to capital assistance and the purpose and value of each has become blurred. The important distinction between these two instrumentalities of aid should be recognized and each should be employed sharply and effectively to reinforce the other in helping those developing countries that are willing to make the effort to solve the complex problems of feeding their people and improving the quality of their lives.

### ***3.9.0 Nutritional Need and Economic Demand***

The Panel's approach to the world food problem has been almost the opposite of that employed by economists. It costs money to produce food, however, and someone must pay the bill. Therefore, no matter what the physiological *need* may be, the production of food is controlled by effective market *demand*.

Economists tend to relate income and food demand in a causal fashion. The Panel, of necessity, has quite literally reversed the usual economic approach by first estimating the food shortage and setting a future goal for food production. The next step was to calculate the rate of change in income that will be required to generate the effective market demand for the targeted nutritional needs.

There are certain relationships between the demand for foodstuffs and the overall demand for goods and services in any economy. In order for "effective demand" for food to exist, the means of buying the food—purchasing power—must be available. In other words, aggregate income must grow at a rate which permits consumers to purchase the projected food requirements.

Likewise, on the production or supply side, there are relationships which link agricultural food production to overall production. The production of food crops requires manufactured inputs such as fertilizers, pesticides, and machinery which must be imported or produced domestically. If they are imported, the overall economy must generate sufficient exports or must rely on a net inflow of foreign assistance or private capital to pay for the imports. If these inputs are to be produced domestically, or paid for by industrial exports, the non-agricultural sectors must expand at rates consistent with the need of the agricultural sector. Similarly, various nonagricultural sectors are dependent on agricultural raw materials and, in some case, food products.

Because of the interdependence which exists among food need, food demand, overall income, agricultural (food) output, and total output

(GNP), it is meaningless to consider a nation's demand and supply of foodstuffs independently from overall economic growth.

### 3.9.1 Tentative Economic Implications

The Panel's analysis of the overall problem indicates that the required compound annual growth rates (1965/66–1985/86) for the developing countries in aggregate will be:

	Percent
Increase in food demand .....	4.0
Increase in food production.....	4.0
Increase in gross national income.....	5.5

The achievement of such growth rates will require massive efforts which must be more successful than history has recorded in any previous 20-year period. Now the developing countries, in aggregate, are increasing their compound annual growth rates approximately as follows:

	Percent
Increase in food demand.....	3.0
Increase in food production.....	2.7
Increase in gross national income.....	4.5

Only countries such as Mexico and Taiwan are achieving growth rates of the order deemed necessary.

Additional investments for acceleration of agricultural output in the developing countries as a whole have been analyzed but not verified by detailed country studies. The direct capital requirement for fertilizers, seeds, mechanization, and pesticides for a 4.0 percent growth rate in agricultural output approximates \$300 million annually in the early years, increasing to almost \$4 billion per year by 1985. This estimate does not include direct investments in land and water resources nor does it include the necessary direct "infrastructure" investments in power, transportation, marketing, credit, food processing, storage, and distribution. It is estimated that *to achieve a 4.0 percent annual growth rate in food demand and supply, capital investments will have to increase from the current 15 percent to 19 percent of the gross national products of the developing countries. This would be equivalent to a \$12 billion increase in investment above the 1965 base. To achieve such a feat will require capital and technical involvement of developed and developing nations alike on a scale unparalleled in the peacetime history of man.*

### 3.9.2 A Framework for Further Study

Because of the inherent limitations of the Panel's aggregative approach which consisted essentially of estimating direct input requirements on a global scale, it is imperative that a country by country intersectorial economic analysis be undertaken. Input-output analyses should be developed so that estimates can be made of the *direct* and

*indirect* investment requirements needed to achieve the food targets that have been set by the Panel. Explicit attention should be given to the several institutional, policy, and technical considerations at the micro-economic level which are eclipsed in the aggregate global approach used by the Panel.

### 3.10.0 *The Task Ahead*

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.

As we now view the situation, the United States faces two choices:

1. The first is for the United States to continue to provide technical and capital assistance and private investment to poor countries willing to make the self-help effort to achieve self-sustaining growth. Our foreign assistance program would then continue to be largely an American effort with coordinating relationships with the United Nations organizations and other international institutions. While this course might lead to some improvement over the status quo, it would not suffice to meet the food problem because, for all of its economic resources, the United States cannot possibly accomplish the immense task of alleviating the world food problem alone. *This course would be unsuccessful in halting or reversing the rapid deterioration of the population-food situation in the developing countries and the world would continue to lose ground.*

2. *The other alternative is for the United States to take the lead in mounting a global effort, in concert with other developed nations and with international organizations, that will bring to bear the technical skills and capital resources needed to reverse the downward course of the developing countries and to restore the chance of their peoples for a better life.*

We are unanimous in the belief that, at this point in history, a new long-term policy direction is indicated urgently—a policy that deals massively, directly, and effectively with this central problem of today's world.

We are unanimous, also, in the belief *that the United States must assume leadership of the free world and all of its international institutions in a coordinated, long-range development strategy for raising the economic level of the poor nations, thereby meeting the threat of hunger, increasing the volume of world trade and economic activity, and contributing to the achievement of the goal of ultimate importance, a lasting peace.*

### 3.10.1 Why?

In the Panel's view, the concern of this country for the hungry nations is threefold:

1. *Humanitarian*—We should help the less fortunate simply because they need help and we are able to help them. The benefits of altruism are by no means unilateral. The challenge of a difficult task and the moral uplift that comes only from doing for others are needed to temper and balance the leisure and affluence of American life. The real successes of the Peace Corps center in the fundamentally inspired, collective aim that is exemplified in the late Albert Schweitzer's dictum, "It is only giving that stimulates."

2. *Security*—Populations in the developing countries double in 18 to 27 years; 55 to 88 years are required for populations to double in the developed countries. By the year 2000, if present rates of growth continue, there will be more than four times as many people in the developing countries as are in the developed nations. To avoid a threat to the peace of the world as well as to our own national security, we cannot afford to be too little and too late with our development assistance. The expectations of the poor are demanding fulfillment. It is to be hoped that some measure of their ambitions can be realized by peaceful means.

3. *A Better Tomorrow for Us, Too*—This is a long-range goal, an economic reason for investment. An important way to expand our own economy in the future will be through further specialization and trade. As nations develop they become trading nations and through trade, both parties to a transaction benefit. Trading partners are likely to be peaceful protagonists.

### 3.10.2 How?

If the United States is to deal seriously and productively with international development:

1. The American public must be convinced that the efforts merit investment of their taxes and that the efforts will be effective in meeting the overall problem.

2. The American public must have confidence in the substance of the programs which are implemented and in the arm of the government which is responsible for administration of those programs.

3. Funding and programs must be placed on a long-range basis, not budgeted and funded hand-to-mouth, from year to year. Foreign economic assistance is doomed to frustration and failure if the responsible agency is forced to deal only with quick payoff projects and to show results tomorrow in order to survive the next budget cycle.

## 4.0 RECOMMENDATIONS

### *A. Population and Family Planning*

#### **PROGRAMS OF FAMILY PLANNING SHOULD BE AN INTEGRAL PART OF TECHNICAL AND ECONOMIC ASSISTANCE**

This policy has been stated forcefully and adequately in recent messages by the President and the Panel strongly endorses these statements. Family planning should be encouraged because of the long-range need to decrease the rate of population growth and because of its value in improving economic benefits per capita. The Panel cautions, however, that family planning will not in itself be a solution to the world food problem, and that family planning alone will probably not significantly reduce the problem of the food needs within the next 20 years in the developing countries. Population numbers in the developing countries will continue to increase rapidly during the next 20 years because nearly half of the present population is less than 15 years old. In spite of the fact that population control is one of the greatest problems facing mankind, there is an immediate need for increased supplies of food and better nutrition. (See Vol. II, Chapter 1)\*

### *B. Food Production and Nutrition*

The foremost problems for improved nutrition are how to provide adequate calories and proteins. Increasing domestic animal production, food from the sea, various forms of aquiculture, and the harvest of wild animals will make important contributions, but these measures will not meet increased caloric requirements in the developing countries which in the next 20 years will double due to an increase of about 4 percent per year. By the end of the next two decades, requirements for calories and proteins are estimated to be about 100 percent greater in India and Brazil, and in Pakistan from 120 to 150 percent greater—the lower need is based on an optimistic estimate of the effect of family planning. (See Vol. II, Chapters 1, 4, and 5)

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\*These references indicate the locations in Volume II of this report where the topic is discussed in greater detail.

**B1. THE MAIN GOAL FOR IMPROVING THE WORLD FOOD SUPPLY MUST BE THAT OF INCREASING CROP YIELDS IN THE DEVELOPING COUNTRIES, ESPECIALLY IN ASIA—MANY DEVELOPING COUNTRIES MUST ESTABLISH AGRICULTURAL DEVELOPMENT AS A NATIONAL GOAL WITH RELEVANT RESEARCH, EDUCATION, AND EXTENSION PROGRAMS TO ADAPT THE PRINCIPLES OF PLANT AND ANIMAL PRODUCTION TO LOCAL CONDITIONS.**

Major attention must be directed to a wide range of research on problems of crops and soils of the developing nations and highest priority needs to be given to this objective by both the developed nations helping with technical assistance and the recipient countries. Adopting agricultural production as a national goal would give agriculture a favorable image and attract competent and dedicated people into the profession. (See Vol. II, Chapters 3, 4, 7, 8, and 12)

**B2. THE DEVELOPING COUNTRIES SHOULD BE ENCOURAGED AND ASSISTED IN INCREASING AND IMPROVING PROTEIN SUPPLIES IN THE FOLLOWING WAYS IF THE SPECIFIC COUNTRY HAS THE REQUIRED NATURAL RESOURCES AND ECONOMIC MEANS (See Vol. II, Chapters 3, 4, and 5)**

**a. DEVELOP HIGH PROTEIN FOODS, ESPECIALLY FOR PRESCHOOL CHILDREN, FROM INDIGENOUS PRODUCTS.**

**b. INCREASE THE PRODUCTION AND USE OF PULSES AND OIL SEEDS SUCH AS SOYBEANS, PEANUTS, AND COTTONSEED.**

**c. INCREASE AND IMPROVE DOMESTIC ANIMAL PRODUCTION, ESPECIALLY TYPES THAT ARE NOT COMPETITIVE FOR FOOD USED BY HUMAN BEINGS.**

**d. UTILIZE POND CULTURE OF FISH, BOTH BY ITSELF AND IN COMBINATION WITH AGRICULTURAL PRACTICES SUCH AS RICE CULTURE AND IRRIGATION PROJECTS.**

**e. INCREASE CATCH OF SEA FOODS.**

**f. DEVELOP AND UTILIZE NEW GENETIC STRAINS OF PLANTS THAT PROVIDE PROTEIN WITH A HIGHER NUTRITIONAL VALUE.**

**g. EXPAND AND INTENSIFY RESEARCH AND DEVELOPMENT RELATED TO FISH PROTEIN CONCENTRATE (FPC).**

**B3. THERE SHOULD BE MORE EMPHASIS ON THE NUTRITIONAL NEEDS OF THE POPULATION IN NATIONAL FOOD AND AGRICULTURAL PROGRAMS.**

For each developing country or region, the extent and causes of protein-calorie malnutrition, the extent of deficiency of vitamins and minerals, the etiology of malnutrition, the relationships of nutrition to health and mental development, and the factors affecting acceptability of foods and food habits, will have to be determined. Mothers and housewives in developing areas should be taught how to feed children and other members of their families to obtain maximum benefit from available food supplies. In many instances, supplementary

high quality protein foods will be needed and their use should be demonstrated. Methods of avoiding food waste, better conservation techniques, and food preservation must be emphasized. (See Vol. II, Chapters 1 and 5)

***B4. RESEARCH ON PROTEIN FROM LEAVES, SINGLE-CELL MICROORGANISMS GROWN ON SUBSTRATES SUCH AS PETROLEUM, AND MICROSCOPIC ALGAE SHOULD BE CONTINUED.***

While these processes are at such a preliminary stage of development that they are unlikely to make any significant impact upon the problem of the next two decades, they possess considerable promise for the long-term as sources of high-quality protein and may be important before the end of the century. (See Vol. II, Chapter 5)

***C. Increasing Agricultural Productivity***

***C1. MAJOR EMPHASIS MUST BE GIVEN TO INCREASING PRODUCTIVITY PER UNIT OF LAND IF THE WORLD FOOD NEEDS ARE TO BE MET IN THE IMMEDIATE FUTURE.***

In the areas of the world, such as Asia, where the shortage of food is severest, there is also a scarcity of potentially arable land which indicates that increased production must come from lands that are already being farmed. *Annual yields* must be increased by making sufficient water available to increase productivity, by utilizing improved farming practices, and by multiple cropping. Attention should be given to plant nutrition, pest control, and genetic improvement. (See Vol. II, Chapters 3, 4, 6, and 7)

***C2. SINCE CONVENTIONAL CROP PLANTS ARE LIKELY TO BE THE CHIEF SOURCE OF FOOD FOR MEETING THE IMMEDIATE WORLD NEEDS, ALL POSSIBLE EMPHASIS MUST BE DIRECTED TOWARD IMPROVEMENT OF STRAINS AND VARIETIES.***

Developing nations should have major breeding programs for developing high-yielding, well-adapted crops that are resistant to pests and diseases; and personnel, programs, and institutions from the developed nations should be enlisted to assist with these efforts. All developments should be oriented toward production practices that will result in maximum yields. (See Vol. II, Chapters 3 and 12)

***C3. HIGH PRIORITY SHOULD BE GIVEN TO PROVIDING PRODUCTION INPUTS ESSENTIAL TO ACCELERATING AGRICULTURAL PRODUCTIVITY IN THE DEVELOPING WORLD.***

Technical assistance and financing from the developed nations will be necessary to provide these production inputs on the scale needed. Private industry as well as government must participate in this effort. Financing facilities for producing fertilizers, seeds, pesticides, and machinery through grants or long-term interest loans is urged in preference to providing direct food aid under concessional terms. This procedure lays the groundwork for continuing progress in agricul-

tural production and does not have a depressing effect on farm product prices that is likely to accompany food aid at concessional prices. (See Vol. II, Chapter 6)

***CA. COUNTRIES SHOULD BE ENCOURAGED TO CONCENTRATE THEIR PRODUCTION EFFORTS ON CROPS THAT ARE WELL ADAPTED TO THEIR SOILS AND CLIMATE.***

The United States and other developed nations should not provide technical assistance for programs of the developing countries that are aimed at self-sufficiency which involves producing poorly adapted crops. (See Vol. II, Chapter 3)

***C5. THE PLANNING, AUTHORIZATION, AND OPERATION OF IRRIGATION PROJECTS SHOULD REFLECT THE NECESSITY FOR PROVIDING NOT ONLY WATER BUT ALL THE INPUTS AND PROCESSES THAT ARE REQUIRED IF THE HIGH COSTS OF IRRIGATION PROJECTS ARE TO BE OPTIMIZED IN INCREASING AGRICULTURAL PRODUCTIVITY.***

Whenever irrigation removes the moisture ceiling on crop yield, other management practices such as fertilization, liming, improved seeds, and insect and disease control become more critical. Failure to follow through with all required practices can easily offset the advantages of irrigation. Irrigation development from either surface or ground water supplies or both is essential to increase agricultural production in arid and semiarid regions, but the greatest possibilities exist in those subtropical and tropical areas which have alternating wet and dry seasons. This is because of the greater availability of water supplies and the potentialities for intensified farming through year-round cropping. Irrigation development should be given especially high priority in such regions and special attention should be paid to increasing the ability of the farmers to manage water supplies most effectively in combination with other production inputs. In the Indian subcontinent and probably in Southwest Asia, the needed level of capital expenditure for irrigation development over the next 20 years will be greater than for all other production inputs. Although the most immediate increases in production can be obtained through use of fertilizer and higher yielding seeds, the times required for irrigation development are so long that surveys and engineering planning should be accelerated now on an urgent basis. United States assistance agencies should greatly increase their level of pre-investment technical assistance for irrigation development. In irrigation development more emphasis needs to be given to the relatively inexpensive ground water resources and their use, particularly in the Indian subcontinent. A test of the effectiveness of ground water development in the Gangetic Plain of northern India should be given high priority. (See Vol. II, Chapter 7)

***C6. COUNTRIES SHOULD DEVELOP LONG-RANGE PLANS OF LIVESTOCK PRODUCTION BASED UPON OPTIMUM UTILIZATION OF TOTAL AGRICULTURAL RESOURCES.***

The potential for animal production can be increased through genetic stocks of livestock resistant to local diseases and adverse environmental conditions, increases in forage production, improvements in range and water management, better livestock nutrition, and programs for disease and pest control. The unique abilities of animals to convert forages, by-products, and waste materials to high quality food, as well as the advantages of combining animal and plant production should be recognized and should be considered in national programs to expand food production. Steps should be taken immediately to control the world's major epizootic diseases of livestock which constitute one of the most important limiting factors in animal production in the developing countries. (See Vol. II, Chapters 4 and 5)

***C7. THE AGRICULTURAL POTENTIAL OF VAST AREAS OF UN-CULTIVATED LANDS, PARTICULARLY IN THE TROPICAL AREAS OF LATIN AMERICA AND AFRICA, SHOULD BE THOROUGHLY EVALUATED.***

Research projects should be initiated and expanded to develop soil and crop management practices and systems for sustained food production in these areas. Basic information already available on tropical soils such as the World Soil Map and supporting descriptions should be published forthwith. (See Vol. II, Chapters 8 and 12)

***C8. THE WORLD METEOROLOGICAL ORGANIZATIONS AND THE UNITED STATES ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION SHOULD PROVIDE TECHNICAL ASSISTANCE TO THE COUNTRIES OF SOUTH AND SOUTHEAST ASIA IN APPLIED METEOROLOGICAL AND OCEANOGRAPHIC RESEARCH TO IMPROVE LONG-RANGE FORECASTING OF THE MONSOON RAINS AND EXPLORE THE POSSIBILITIES OF PRECIPITATION ENHANCEMENT.***

The past two years of partial crop failure in India were due to abnormal and unpredicted behavior of the monsoon. The effects could have been partly alleviated if the farmers had been able to time their operations in accordance with the beginning of steady monsoon rainfall. Advance planning for food aid could have been improved if seasonal monsoon forecasts had been available.

***C9. IN EACH DEVELOPING COUNTRY ANALYSES SHOULD BE MADE OF THE COST EFFECTIVENESS, NEEDED LEVEL, AND OPTIMUM SEQUENCE OF EXPENDITURES FOR INCREASING AGRICULTURAL PRODUCTION IN ALTERNATIVE WAYS.***

The analyses should consider:

- a. Use of fertilizers and other inputs on presently cultivated land where there is already an assured water supply;

b. Development of irrigation to provide more adequate, timely, and assured water supplies for single or multiple cropping at present levels of cropping intensity, plus the use of other inputs;

c. Irrigation development, plus use of other inputs, to increase cropping intensity (reduction of fallow and extension of double or triple cropping) on presently cultivated land;

d. Extension of the cultivated area by putting potentially arable but presently uncultivated land under cultivation.

Specialists from each developing country should have a major role in the analysis for that country but in most cases they will need technical assistance for foreign specialists in many disciplines through multi-lateral or bilateral assistance agencies. To make these recommended analyses more useful and specific and to serve as a basis for engineering design of water and land development, detailed topographic and soil surveys must be made in most countries, together with extensive measurement of the quantity and quality of surface and underground water supplies. Both the developing countries and the assistance agencies of the advanced countries should very considerably increase the level of effort and expenditures going into such surveys, including the training of soil scientists and technicians and hydrologists. (See Vol. II, Chapters 6, 7, and 8)

#### **D. Food Aid**

##### ***D1. FOOD AID SHOULD BE ADMINISTERED TO STIMULATE AGRICULTURAL AND ECONOMIC DEVELOPMENT AND TO IMPROVE THE FOOD PRODUCING CAPABILITY OF RECIPIENT NATIONS.***

Food aid can be justified only for humanitarian reasons and should be conditioned by requirements for self-help. In the future, it is likely that no one nation will be able to assume the responsibility for food aid. Even though most food aid may be bilateral, planning and cooperation for organization and financing should take place within a multi-lateral framework. One essential condition to satisfy requirements for future food aid will be the provision of storage facilities so buffer reserve stocks can be built up in the less developed countries. (See Vol. II, Chapter 2)

##### ***D2. IF THE FORTIFICATION OF WHEAT WITH LYSINE BEING STUDIED ON A LARGE SCALE IS FOUND TO BE FEASIBLE AND EFFECTIVE AS A MEANS OF IMPROVING THE PROTEIN SUPPLY TO THE TARGET AREA, CONSIDERATION SHOULD BE GIVEN TO FORTIFICATION OF ALL CEREAL GRAINS AND FLOURS SHIPPED FROM THE UNITED STATES.***

If the effectiveness of this program can be demonstrated, then the United States should assist developing countries with programs for centralization of domestic grain processing and fortification. (See Vol. II, Chapter 5)

### ***E. Production Incentives for Farmers*<sup>1</sup>**

#### ***E1. ATTENTION SHOULD BE FOCUSED ON THE ENTIRE RANGE OF PROBLEMS AFFECTING PRODUCTION INCENTIVES OF FARMERS.***

Production incentives include the influences imposed by the cultural environment and the viable production opportunities available in each region of substantial agricultural potential. Reliance must not be placed solely on price and tax policies, or on the educational and persuasive powers of extension workers, or on land ownership and tenure arrangements. Each of these is an important part of the whole and *all* must be emphasized.

#### ***E2. SPECIAL EFFORTS MUST BE MADE TO PROVIDE OPPORTUNITIES THAT ARE NECESSARY BOTH TO ALLOW AND TO INDUCE FARMERS TO MAKE PRODUCTION-INCREASING CHANGES.***

These efforts should include locally verified new technology (verified both with respect to physical response and economic validity), farm supplies and equipment needed to put the new technology into practice, efficient market institutions to handle farm products, transportation links to major market centers, production credit, and extension workers to teach and encourage farmers to use new practices.

#### ***E3. IMAGINATIVE EXPERIMENTATION IS NEEDED ON WAYS TO REDUCE THE RISKS AND UNCERTAINTY FACING FARMERS IN THEIR DECISION-MAKING AND ON WAYS TO PROVIDE GREATER PRODUCTION INCENTIVES.***

Increased attention should be paid to training rural social scientists in each country so local ability can be brought to bear on the problem of production incentives.

In the final analysis, the incentives for farmers will be sufficient if there are assurances that income will be attractively greater than costs of production.

### ***F. Transportation*<sup>2</sup>**

#### ***F1. EXTERNAL AID AGENCIES SHOULD COUPLE ANY ECONOMIC AID TO TRANSPORTATION PROGRAMS WITH INSISTENCE ON EXPERIMENTAL AND DEMONSTRATIONAL DEVELOPMENT OF TOTAL TRANSPORT SYSTEMS TO SERVE SELECTED REGIONS OF HIGH AGRICULTURAL POTENTIAL.***

Such a total system must include adequate access and intercity roads, highways (or railways), vehicles, market-town handling facilities,

<sup>1</sup> See Vol. II, Chapter 9.

<sup>2</sup> See Vol. II, Chapter 11.

and systems of intermarket communications for commodity movements. External aid agencies might well undertake or participate in local programs of research to determine the transportation requirements, in quantitative terms, for different rates of growth in food production in major agricultural regions. External aid agencies should also be prepared to offer both financial aid and technical assistance to increase the efficiency of trunk transportation connecting the experimental projects.

***F2. MAJOR ATTENTION NEEDS TO BE GIVEN TO MODERNIZING AND INCREASING THE CAPACITY OF PORT FACILITIES IN MANY COUNTRIES.***

Rolling stock for both trunk railways and long-distance truck haulage should be designed to be compatible with rapid handling at modernized port facilities, thereby minimizing transshipment costs.

***F3. THE DEVELOPED NATIONS SHOULD HELP WITH PLANS FOR BUILDING RURAL ROADS WHICH CAN BE IMPLEMENTED WITH WAGE SUPPLEMENTS FROM FUNDS DERIVED FROM FOOD AID.***

The crucial role of the transportation system in moving food from the farms to the consumer and farm supplies from distribution points to the farms is sometimes neglected. An effective and efficient transportation system must be present or planned in programs for agricultural development.

***G. Marketing, Processing, and Distribution of Farm Products***<sup>3</sup>

***G1. THE GOVERNMENTS OF THE DEVELOPING NATIONS SHOULD GIVE SPECIAL ATTENTION TO THE MARKETING SERVICES AND DISTRIBUTION SYSTEMS THAT ARE REQUIRED TO ENCOURAGE ECONOMIC DEVELOPMENT, INCLUDING AN INFORMATION SERVICE FOR ADVISING FARMERS, PROCESSORS AND DISTRIBUTORS ON THE NEEDS AND AVAILABILITY OF PRODUCTS.***

External agencies can provide assistance and private enterprise must be encouraged to actively participate.

***G2. PRIVATE INDUSTRY SHOULD BE ENCOURAGED TO DEVELOP AND EXPAND FOOD PROCESSING, PRESERVATION, AND DISTRIBUTION INDUSTRIES.***

Private industry and governmental agencies should cooperate in developing and marketing the equipment needed by producers and consumers that will enable more effective conservation and protection of foods.

<sup>3</sup> See Vol. II, Chapter 10.

**G3. MAJOR EMPHASIS SHOULD BE GIVEN TO THE REDUCTION OF FOOD LOSSES FROM RODENTS, MICROORGANISMS, INSECTS, AND MECHANICAL DAMAGE TO INCREASE AVAILABILITY OF FOOD.**

## **H. Agricultural and Trade Policies<sup>4</sup>**

**H1. COUNTRIES AND AREAS SHOULD BE ENCOURAGED TO DEVELOP POLICIES FOR FREER TRADE, NOT FOR NARROW NATIONAL SELF-SUFFICIENCY OR TIGHTLY PROTECTED REGIONAL TRADING BLOCS.**

Common markets should be encouraged to the extent that they are a step toward freer trade with the world, as well as with their members. The developing countries should be encouraged to expand their food trade with one another as well as with the developed world in emphasizing the self-help policies advocated by the United States and other developed nations. Reductions in barriers to the movement of food and inputs for agricultural production will encourage production, will lower costs, and will stimulate expansion in line with comparative advantage.

**H2. INTERNATIONAL COMMODITY ORGANIZATIONS SHOULD MAINTAIN AND INTENSIFY THEIR EFFORTS TO FORECAST SUPPLY AND DEMAND CONDITIONS FOR THEIR COMMODITIES AND DEVELOPED NATIONS SHOULD PROVIDE TECHNICAL ASSISTANCE IN EFFORTS TO SHIFT PRODUCTION TO ITEMS PRESENTLY OR PROSPECTIVELY IN SHORT SUPPLY.**

Means must be developed for improving international intelligence concerning crop conditions and plans to buy and sell. Such intelligence is needed to make complex international marketing less erratic and more predictable, particularly in view of increasing East-West trade.

**H3. WORLD PRICE POLICIES ON WHEAT SHOULD BE SUCH THAT WHEAT CAN BE COMPETITIVE WITH FEED GRAINS.**

The world capacity to produce wheat may again in the future exceed the economic demand for the crop. If Canada, Australia, and Argentina continue to expand their wheat exports, these exports will probably have to be partly on a concessional basis. The United States should not withdraw and leave the commercial markets to competitors while we provide most of the food aid.

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<sup>4</sup> See Vol. II, Chapter 2.

**14. UNITED STATES TRADE AND AGRICULTURAL POLICIES MUST BE SUCH THAT THE UNITED STATES REMAINS AGGRESSIVE IN THE EXPANDING COMMERCIAL MARKETS OF THE WORLD.**

*a. AS AN INCENTIVE TO CONTINUE GROWTH IN EFFICIENCY AND PRODUCTIVITY IN THE UNITED STATES.*

*b. TO OBTAIN THE FOREIGN EXCHANGE WITH WHICH TO BUY COMMODITIES FOR WHICH FOREIGN PRODUCERS HAVE GREATER COMPARATIVE ADVANTAGE.*

American producers of major commodities have an important stake in the viable commercial world market for those products in which the United States can meet international competition. Among these products are the coarse grains, wheat, cotton, and sources of plant proteins, especially soybeans.

**I. Research and Education <sup>5</sup>**

**11. THE CENTRAL OBJECTIVE OF THE EXTERNALLY SUPPORTED PROGRAMS OF EDUCATION AND RESEARCH FOR THE DEVELOPING COUNTRIES SHOULD BE ACQUISITION OF KNOWLEDGE AND SKILLS THAT WILL BE APPLICABLE TO AND USEFUL IN ADVANCING ECONOMIC DEVELOPMENT.**

It is imperative that education and technology be emphasized in technical assistance due to their importance in the economic development of the recipient nations. Insistence on this emphasis by the donor nation is considered appropriate and necessary to insure most effective results.

**12. VERY HIGH PRIORITY MUST BE GIVEN TO RESEARCH AND EDUCATION RELATED TO FOOD SUPPLY AND NUTRITION IN THE DEVELOPING NATIONS.**

The agricultural development that is so desperately needed is dependent upon an informed people and a vigorous, dynamic effort to gain information on the applied problems of nutrition and food production.

**13. ACADEMIC PROGRAMS OF THE INDIGENOUS AGRICULTURAL UNIVERSITIES MUST BE STRENGTHENED AND IN SOME CASES REORIENTED TO INSURE THAT THEY HAVE A MORE SIGNIFICANT ROLE IN INCREASING THE WORLD FOOD SUPPLY.**

Salaries, support, and working conditions for educators must be improved to levels that will attract young graduates with superior intellect. The emphasis needs to be reoriented to prepare students for solving practical problems of food supply and nutrition.

<sup>5</sup> See Vol. II, Chapter 12.

**14. SPECIAL VOCATIONAL TRAINING PROGRAMS SHOULD BE INNOVATED AND EXPANDED TO PROVIDE MANPOWER TRAINED IN SPECIFIC TECHNICAL SKILLS THROUGH ORGANIZED VOCATIONAL SCHOOLS OR THROUGH ON-THE-JOB TRAINING IN INDUSTRY AND AGRICULTURE.**

Occupational and vocational education of the type provided in post high school technical institutes in this country should be considered as a means of meeting the immediate needs for trained manpower of the developing nations. Assistance in organizing and staffing these programs may have to be provided by the developed nations.

**15. INNOVATIVE EDUCATIONAL TECHNIQUES, SUCH AS TELEVISION, TRANSISTOR RADIO, AND MOVIES SHOULD BE EMPLOYED ON A MASSIVE SCALE TO DECREASE ILLITERACY, IMPROVE EXTENSION EDUCATION, AND INCREASE OPPORTUNITIES FOR COMMUNICATION OF INFORMATION ON FAMILY PLANNING, NUTRITION, FOOD PRODUCTION, FOOD PRESERVATION, AND FOR GENERALLY INCREASING THE EDUCATIONAL LEVEL OF THE POPULATION.**

Mass communication methods and techniques should be utilized to the fullest possible extent in transmission of information to the people of developing nations and in providing general education. Social and economic change is often highly dependent upon the effectiveness of mass media of communication. The only prospect for upgrading the education of most of the present inhabitants of many developing nations is through adult and extension education programs on radio and television.

**16. THE UNITED STATES GOVERNMENT AND UNIVERSITIES MUST DEVELOP POLICIES AND PROGRAMS TO CARRY OUT LONG-TERM COMMITMENTS FOR OVERSEAS RESEARCH AND EDUCATIONAL ASSISTANCE.**

The universities of the United States must be encouraged to develop competence among their faculties, construct the necessary facilities, and develop their curricula in ways that will enable them to better participate in international education and research of importance in population control, food, and nutrition of developing nations. Long-range financial commitments, staffing, and program orientation are necessary at the United States universities to accomplish this objective. Funds should be provided for use in research and training in nutrition and the agricultural sciences in order that future manpower requirements may be met.

**17. UNIVERSITY-TO-UNIVERSITY CONTRACTS TO ASSIST IN OVERSEAS AGRICULTURAL DEVELOPMENT SHOULD BE CONTINUED AND EXPANDED, PROVIDED GREATER CONTINUITY OF STAFF AND PROGRAM CAN BE OBTAINED.**

Programs in the developed countries should be structured to most effectively use interested, competent faculty of the university. This

may involve only individual departments at some institutions. Methods should be found to enable universities to staff with scientists and educators whose principal careers will be in service abroad in developing nations.

**18. INTERNATIONAL RESEARCH INSTITUTES SHOULD BE DEVELOPED TO FOCUS ON FOOD, NUTRITIONAL AND AGRICULTURAL PROBLEMS OF THE DEVELOPING COUNTRIES.**

These "Centers of Specialization" (of which the International Rice Research Institute is an example) should concentrate on problems of international importance and provide for graduate education as well as research wherever possible. Multilateral financing of these institutes should be encouraged and methods found to provide for participation by the cooperating nations in the program development and its administration.

**19. PRIVATE INDUSTRY OF THE UNITED STATES AND OF THE DEVELOPING COUNTRIES MUST BE ENCOURAGED TO PARTICIPATE IN OVERSEAS RESEARCH, DEVELOPMENT, AND TRAINING RELATED TO FOOD SUPPLY AND NUTRITION.**

**J. Private Sector**

**PRIVATE INDUSTRY AND THE REST OF THE PRIVATE SECTOR MUST BE ENLISTED IN THE ECONOMIC DEVELOPMENT EFFORT ON A MASSIVE, EFFECTIVE, AND LASTING SCALE.**

Private industry's vast resources of capital, technical know-how, trained manpower and managerial capability are seriously underemployed in the economic development effort.

To ensure deployment of these vital resources on the scale required, policies and programs must be devised:

a. To provide the operating climate and the economic incentives to justify the allocation of private resources to areas that are unattractive for conventional investment.

b. To utilize private industry's analytical and planning skills in preparing country by country analyses of cost effectiveness, needed level, and optimum sequence of expenditures for increasing agricultural production.

c. To enable private industry to create new profitable business combinations that will provide the full range of material inputs in the minimum time required for increased agricultural production.

d. To enable private industry to create complementary profitable business combinations designed to carry the farmer's increased output to the consumer with maximum economy and dispatch. (See pages 99-103.)

**K. Economic Implications**

**DETAILED INTERSECTORIAL ECONOMIC ANALYSES SHOULD BE CARRIED OUT FOR THE MAJOR DEVELOPING COUNTRIES**

The studies should be undertaken immediately and should include input-output information to estimate the *direct* and *indirect* input and

investment requirements necessary to achieve the food targets in each country. Explicit attention must be paid to institutional policy and technical considerations at the microeconomic level. (See Vol. II, Chapter 13.)

#### ***L. Organization and Policy***<sup>6</sup>

***L1. THE UNITED STATES SHOULD TAKE THE LEAD IN CONCERT WITH THE FREE WORLD AND ITS INTERNATIONAL INSTITUTIONS IN A COORDINATED LONG-TERM, STRATEGIC PLAN FOR RAISING THE ECONOMIC LEVEL OF THE DEVELOPING COUNTRIES.***

Through the use of a long-range plan, supported by detailed country-by-country economic analysis, the United States should make every effort to persuade the members of the OECD and the other developed countries to join in an international program of dimension and scope to match the problem. Attempts should be made to enlist the cooperation of the Eastern Bloc of nations. "Humanitarian" pleas should be backed by hard facts. The United States should be willing to provide necessary guidance during the period of program establishment.

***L2. IF THE PRESENT TREND TOWARD MULTILATERAL ADMINISTRATION OF ECONOMIC ASSISTANCE IS TO ACCELERATE, THE UNITED STATES MUST TAKE POSITIVE ACTION IN STRENGTHENING EXISTING INTERNATIONAL INSTITUTIONS UNTIL THEIR POLICIES AND CRITERIA MAKE THEM ABLE TO OPERATE EFFECTIVELY AND UNDER CONDITIONS ACCEPTABLE TO THE UNITED STATES AND OTHER MAJOR DONOR COUNTRIES.***

They should emphasize long-term programs of major significance rather than a miscellany of small projects. The multilateral agencies must be empowered to operate with consistent policy and management, not subject to arbitrary pressures favoring specific national interests or viewpoints of donors or recipients. There must be full authority to select and to remunerate staff on the basis of competence rather than national origin or representation. The United States should be prepared to take a leading role in fostering coordination among the programs of multilateral agencies. The hope is, of course, that the international program could and would be self-governing and self-coordinating, but realistically, the United States must be willing to assume responsibility for the next crucial 10 to 20 years.

***L3. THE UNITED STATES SHOULD RETAIN BILATERAL PROGRAMS OF CAPITAL AND TECHNICAL ASSISTANCE TO ASSURE FULL PARTICIPATION OF OUR PERSONNEL, INDUSTRY, UNIVERSITIES, AND GOVERNMENT AGENCIES.***

Capital assistance and food aid (a form of capital assistance) should be clearly distinguished from technical assistance. Programs, agency responsibilities, and accountability for results of programs should

<sup>6</sup> See Chapter 14.0 of this volume.

be based upon a clear definition of purpose and appropriate criteria of accomplishment. This separation of programs and responsibilities will clarify the overall endeavor, will make possible specific commitments with specific purposes, and will not cause the whole program to suffer because of the shortcomings of a small part of it.

***LA. THE UNITED STATES ECONOMIC ASSISTANCE EFFORT SHOULD INCLUDE IN-HOUSE OR THROUGH CONTRACT OR INTERAGENCY AGREEMENT, THE CAPABILITY FOR PRE-INVESTMENT RESEARCH, ANALYSIS, MEASUREMENT, APPRAISAL, PLANNING, AND MONITORING OF ECONOMIC DEVELOPMENT ON A SCALE AND WITH AN ACCURACY FAR EXCEEDING ANYTHING IN THE PAST. EVENTUALLY, THIS TASK MAY BE ASSIGNED INTERNATIONALLY BUT INITIALLY, THE UNITED STATES MUST CARRY IT FORWARD.***

Unless economic aid to developing countries, whether bilaterally or multilaterally administered, is contingent upon long-range, carefully planned programs, the developing countries will continue to request aid only to meet crisis situations and will ignore the need for long-term integrated programs.

***L5. UNITED STATES TECHNICAL ASSISTANCE SHOULD BE MADE AN EQUAL PARTNER WITH CAPITAL ASSISTANCE AND THE STRUCTURE OF THE FOREIGN ASSISTANCE ORGANIZATION SHOULD REFLECT THIS EMPHASIS.***

Appropriation authorization should be at least on a 5-year basis and, insofar as possible, should be considered and evaluated separately from capital assistance. The goal of United States technical assistance should be more than imparting specialized knowledge. It should include creation of indigenous professional manpower and permanent, independent, institutions able to sustain themselves for the future; as well as data collection, research and information, and analysis of county problems. Present tours of duty for technical assistance personnel should be lengthened, as the experience of two decades has shown. The recommendations of the Gardner report, "A.I.D. and the Universities," concerning personnel, career opportunities in development, and long-term engagement of universities and government agencies should be implemented as soon as possible.

***L6. EACH EXECUTIVE AGENCY SHOULD BE GIVEN AN ADMINISTRATIVE AND CONGRESSIONAL MANDATE TO "MAN FOR" LONG-TERM FOREIGN ASSISTANCE, RATHER THAN "SQUEEZING OUT" PROJECTS FROM DOMESTIC PERSONNEL.***

The dichotomy of "domestic" vs. "foreign" interest is no longer tenable and must be eliminated as a short-term view so that the technical expertise and manpower of the entire Federal establishment can be made directly available for foreign aid, as needed, without subterfuge or indirection.

## 5.0 BACKGROUND FOR CRISIS

For several years following World War II, the developing countries of the free world<sup>1</sup> improved the per capita nutrition of their citizens despite a very rapid rate of population growth.

Food supplies were increased by :

1. Importation of more grain from the developed nations, especially Canada, Australia, and the United States.
2. Expansion of the land area under cultivation.
3. Improvements in crop yields.

While food production within these countries has continued to increase annually, the rate of increase has dropped to an average of only 1.6 percent per year since 1961/62 as compared with a compound growth rate of about 2.5 percent for the past decade.<sup>2</sup> Concomitant with this slowing of indigenous production of food, there has been a decrease in the per capita production of food in the developing countries. The Department of Agriculture estimates that the amount of food produced per person declined by 4 percent in Asia and 6 percent in Latin America between 1961 and 1965.

### *5.1.0 Increased Trade*

Until 1954, the developing countries of the free world were net suppliers of grain to world markets, exporting nearly 4 million metric tons in that year. Since 1955, the internal food deficit of these nations has grown rapidly and they have become importers, the amount reaching 16.5 million metric tons in 1965. As the major supplier of these imports, the United States has now expended its large surplus, mostly through concessional sales, outside of commercial channels. For example, in 1966, the wheat shipped to India was equivalent to one-fourth of the total crop in the United States. Obviously, the capacity of the major exporting nations is limited and, furthermore, grain is needed for the commercial markets of the developed world where population and demand are also increasing annually. The domestic requirements of the United States are also a new concern to be

<sup>1</sup> Latin America, Africa, and Asia, except Japan and Communist China.

<sup>2</sup> The Department of Agriculture estimates that food production in Latin America, Africa, and Asia, except Japan and Communist China, increased 27 percent during the period 1951/55 to 1961/65. This corresponds to a compound growth rate of 2.4 percent per year. According to the FAO, food production in these areas increased every year except one from 1958/59 to 1965/66. The compound rate of growth for these years corresponds to 2.8 percent per year. Most of the increase occurred early in this period and the average rate for the last four years is only 1.6 percent.

reckoned with by planners. The problems of allocating grain for food aid and for commercial trade on the basis of year-to-year production projections rather than, as in the past, on the basis of an already available reserve, are exceedingly complex and are just being faced by the United States.

### *5.2.0 Increased Cropland*

Most of the increases in food production during the past decade in the developing countries have come from expanding the area under cultivation rather than intensifying yields on cultivated land. In Asia, where essentially all available land has been utilized, there is no longer the option of adding cropland. Substantial opportunities remain for bringing new lands under cultivation in both Latin America and Africa but the low fertility and difficulty of cultivation of many of their soils means that the cost-benefits of required capital investment must be weighed against those of the alternative of yield increases.

We have carefully considered the basic question of whether the developing world can continue to attempt to meet food needs largely through extension of traditional agriculture and increasing imports or whether it will be necessary to shift to the far more difficult method of increasing production by intensifying agriculture and improving yields. Our analysis indicates that future food needs cannot be provided by imports, either concessional or commercial and at least in Asia, not by cultivation of new lands. They must, of necessity, be provided by increased yields in the developing countries.

### *5.3.0 Increased Yields*

Yields per unit area have not risen very rapidly in most of the developing countries. An examination of the yields of the three major grains (wheat, rice, and corn) from 1935 to 1962 showed an increase in 21 cases and either no change or a decrease in 12 instances. The *average* rate of increase for the 21 developing countries surveyed was only 0.3 percent per year.

It seems clear that the developing nations, particularly those in Asia, must emphasize yield improvement during the coming decades. The requirements for this increase in yields have been described in detail in Volume II of this report. It will necessitate the provision of vast amounts of capital for fertilizers, pesticides, improved seeds, machinery, and water for irrigation. An even more difficult problem, perhaps, will be the vast educational and training programs required to create, distribute, and properly use modern crop production inputs and the transportation to distribute, process, and market the outputs of farms.

It is by no means certain that this task can be accomplished to the extent or at the rate needed to meet food requirements during the next two decades, even with a "war-like" mobilization of the developed countries.

A maximum effort will be required from all nations, developing and developed alike, if the pangs of hunger are to be alleviated, if the irreparable damages of infant and childhood malnutrition are to be prevented, and if the growing threat of outright mass starvation is to be turned aside.

## 6.0 THE NEED FOR FOOD

The prevention of malnutrition throughout the world by providing adequate diets for the rapidly expanding population is a task of staggering proportions. FAO has estimated that at least 20 percent of the population in the developing countries is undernourished (receive too few calories) and about 60 percent receive diets that are inadequate in nutritional quality (commonly a deficiency of protein). Protein-calorie malnutrition, which takes the form of a disease called *kwashiorkor* when severe, is the most widespread deficiency affecting preschool children, the most vulnerable group in the population. Childhood malnutrition causes retardation of physical growth and development and recent evidence suggests that mental development may be impaired also. In malnourished preschool children, mortality and morbidity are extremely high and the common infectious diseases of childhood are catastrophic.

Nutrition has a vital role in the health of adults, also, and influences socio-economic and cultural development profoundly. Malnutrition leads to deterioration of physical fitness and mental efficiency, to emotional and personality disturbances, and to reduction in the capacity to perform work.

In the developing countries, increased supplies of calories and high quality protein<sup>1</sup> are needed urgently. In many areas, vitamin and mineral deficiencies are prevalent and foods furnishing these specific nutrients must be made available. Anemias, endemic goiter (iodine deficiency), and xerophthalmia (vitamin A deficiency) are frequently encountered and beriberi (thiamine deficiency) and ariboflavinosis are observed in some countries.

### 6.1.0 The Growth of Population<sup>2</sup>

The technological revolution, which has enabled rapid and self-sustaining economic growth to occur in the developed countries, has had one critically important effect in the developing countries—a marked reduction in death rates. This decrease in mortality has not,

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<sup>1</sup> A *high quality protein*, is defined as one which supplies all the essential amino acids (lysine, histidine, tryptophan, methionine, threonine, leucine, isoleucine, valine, phenylalanine) in near-optimal proportions. This misleading term, "*animal protein*," is often used to refer to such materials, because proteins from animal sources are usually complete, not because proteins with the full complement of amino acids are derived exclusively from animal sources.

<sup>2</sup> See Vol. II, Chapter 1.5.0.

as yet, been followed by a decline in birth rates, and, consequently, it has created something unprecedented in the history of mankind—very high rates of population growth over areas of ancient settlements. The times required to double the population in most developing countries are 18 to 27 years; they are 55 to 88 years in most developed ones. The developing regions now contain about two-thirds of the world's human beings. By the year 2000, if present rates of population growth continue, there will be more than four times as many people in the developing countries as in the developed ones.

If fertility does not change, and mortality continues to decline, the population of the world will increase from 3.3 billion in 1965 to 5.0 billion in 1985, or by 52 percent. With a 30 percent decrease in fertility over the next 20 years, the world population would be 4.65 billion by 1985, an increase of about 40 percent above 1965. The difference between the high and the low figures is only 385 million persons, about the same as the probable range of the uncertainty in the projected 1985 population of Mainland China. The difference, however, would be greater in later decades. By the year 2000, the high projection would give a world population of 7.15 billion persons, and the low projection would give 6.0 billion. Figure 6-1 shows projections for the World, India, Pakistan, and Brazil.

By the year 2000, the population of India will have increased to such an extent, even if fertility declines, that the present area harvested for food crops would provide only about three-tenths of an acre per person, about the same as in Egypt today. The most critical situation will occur around 1980, long before any decrease in the rate of population growth can have a substantial effect.

A reduction in the rate of population increase may be necessary to increase food production in the developing countries. Economic growth and social development have been impeded by a high birth rate, which has resulted in a very high proportion of children in the population, approximately 45 percent under 15 years old, and, hence, a high dependency burden on the producing adults in the society. Even when overall economic growth is taking place, a rapid increase in population allows very little improvement in per capita income, and, therefore, little increase in the ability to save for needed capital investment.

### **6.2.0 Population Control <sup>3</sup>**

Unless the rate of population increase can be sharply diminished, all the efforts to augment agricultural production will merely postpone the time of mass starvation, and increase its agony when it inevitably occurs.

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<sup>3</sup> *Ibid.*

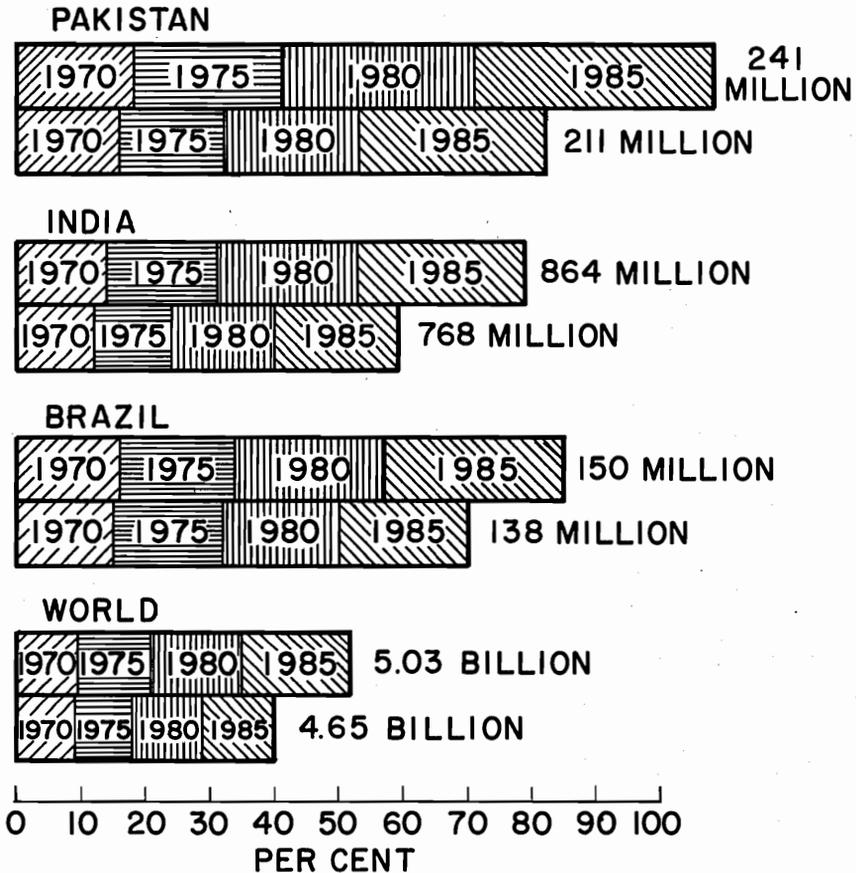


FIGURE 6-1.—Cumulative increases in population for the Pakistan, India, Brazil and the World based on high and low projections for 1970 to 1985.

Values are percent increases over population in 1965. The population projections for 1985 are given with each bar.

There are good reasons for believing that human fertility in most of the developing countries will decrease during the next few decades, but when and how much cannot be predicted. Surveys of the attitudes of husbands and wives clearly indicate the existence of a desire to limit family size. Many couples want no more children than they already have, and would like to know better ways of preventing further births.

Parents in the developing countries desire greater numbers of children than parents in the developed countries. The desired number of children averages four per couple which, with present and prospective levels of mortality, would double the population every 30 to 35 years. The large number of children desired probably reflects an adjustment

to high and unpredictable child mortality, a traditional community life built on family and kinship ties, and the need for "insurance" in later years of life.

Favorable attitudes to family limitation in the developing countries are much more common among couples who already have three or four living children. Availability of birth control means may thus be unimportant until the desired number of living children is secured. Low infant and child mortality and public awareness that mortality is low may be one of the necessary pre-conditions for reducing fertility.

*We are faced with the apparent paradox that a reduction in mortality should reduce rather than raise the rate of population growth. If this is the case, reduction of malnutrition among children, by increasing the quantity and quality of food supplies, may be a key factor in solving the population problem of our time.*

The transition from high to relatively low fertility rates in the developed countries occurred in a much less favorable atmosphere for family planning than exists throughout the world today. The governments of most of the developing countries are now endorsing population control policies at a rate and in a climate of world approval that would have been unimaginable even a few years ago. The role of government in reducing fertility is to exhort, inform, and provide; decisions and actions must be taken by individual couples acting in accordance with their perceived interests. Even so, the governmental task is large and difficult, requiring a high degree of organization, adequate financial and logistical support, great flexibility in meeting changing conditions, and continuing objective evaluation of results. Only a small proportion of people in the developing countries have even moderately good understanding of family planning. The poor and the uneducated need to learn what the well-to-do and the educated already know—that there are a number of safe, reliable, and simple methods of limiting the number of births. Although the efforts to promote family planning cannot replace the effort to increase food production, they are of coordinate importance; unless both programs are successful, the world faces catastrophe.

### 6.3.0 Caloric Needs for the Future <sup>4</sup>

In computing the nutritional requirements of a population, consideration must be given to the distribution by age and sex and the average body size of males and females at different ages in addition to the number of individuals in the population. There are marked variations in average body weights among different peoples. Data for seven Asian and seven Latin American countries show that the average Indian weighs nearly 15 percent less than the average Malayan; the East

<sup>4</sup> See Vol. II, Chapter 1.6.0.

Pakistanian weighs about 20 percent less than the West Pakistanian; the range between the relatively small Indians and Vietnamese at one extreme, and Uruguayans and Chileans at the other, is approximately 40 percent. The differences in body weight between the peoples of the Asian and the Latin American countries are probably partly genetic, but several lines of evidence suggest that nutrition can be a determining factor in fulfilling genetic potential. Hence, a sustained improvement in the nutrition of children in poor countries can be expected to increase the average body weight of adults 10 percent or more during the next two decades, with a corresponding increase in food needs.

There are more females than males in the developed countries, while the reverse is often true in the developing ones. This difference in sex ratios would raise the per capita nutritional requirements of the developing countries except that they also have a larger proportion of children under 15, whose nutritional requirements are much less than those of adults.

The most serious nutrition problem of the developing countries arises from the uneven distribution of food, both in quantity and quality, among families with different levels of income. In India and South America, surveys show that the poorest 25 percent obtain a diet with an energy and protein content that is usually less than 75 percent of the average for the population, and is considerably below the calculated nutritional requirements. Among these low income groups, there is clear clinical evidence of malnutrition, particularly among the children.

Caloric needs of the World and of India, Pakistan, and Brazil were estimated from caloric requirements listed by the Food and Agriculture Organization (FAO) of the United Nations. In applying these standards, it was apparent that the average body sizes of children and adults were less than those suggested by FAO. Accordingly, current estimates of caloric needs were calculated at two levels, one for the FAO reference body weights, and the other, for the current body weights. Lack of satisfactory data on body weight in these countries introduces uncertainties as to accuracy. In projecting caloric demands for the future, it was assumed that children would receive sufficient calories to achieve normal growth to age 14 (FAO reference child weights) and that, because of better nutrition during childhood, the body weight of the adult population would increase three kilograms per decade.

Caloric needs for the world for 1965, based on FAO standard body weights, were 7,787 billion kilocalories, or 2,354 kilocalories per caput, per day. In 1985, the estimated caloric needs of the world will increase 23 percent or 43 percent above 1965, to 11,823 billion kilocalories, or 2,350 kilocalories per caput, per day, if fertility rates remain unchanged and 11,118 billion kilocalories, or 2,393 kilocalories per caput,

per day, if fertility rates *decrease* by 30 percent. Current estimates of caloric needs are probably high since the scanty information available indicates that many population groups are of smaller body size than FAO standards. Projections based on these standards (see Figure 6-2) seem justified as much of the world population is suffering from impairment of physical growth due to inadequate caloric and protein intake.

In 1965, estimates of caloric needs for India were 1,138 billion kilocalories per day or 2,352 kilocalories per caput for FAO body weights and were 937 billion kilocalories per day or 1,936 kilocalories per caput for the average body weights recorded in India. The lower estimate is in close agreement with caloric availability calculated by FAO in recent years for Far Eastern countries. In 1985, the needs will be 108 percent more than present at the higher projection and will be 88 percent more than the present at the lower projection.

In Pakistan, if present fertility rates continue, the population will more than double in 1985 and current caloric needs of 212 billion kilocalories per day will be increased by 146 percent. If fertility declines, needs will still be 118 percent more than estimates of current needs.

In Brazil, the lower level of estimated caloric needs in 1965 was 2,164 kilocalories per caput per day. A recent estimate of caloric availability for that country as a whole is 2,650 kilocalories per caput per day. This emphasizes the importance of food distribution as a factor in caloric availability since undernutrition is common in some parts of Brazil. Assuming no change in fertility, caloric needs for Brazil will increase 104 percent between 1965 and 1985, from 176 to 360 billion kilocalories per day. With some decline in fertility, the increase will be 92 percent. If needs are to be met, a more equitable distribution of calories within the country must be achieved.

#### **6.4.0 Protein Needs for the Future<sup>5</sup>**

In estimating protein requirements, the procedures utilized were those proposed by the Joint FAO-WHO Expert Group on Protein Requirements. Protein needs were estimated in terms of FAO "reference" protein.<sup>6</sup> These values were then converted to an intake of protein from food sources in proportion to the amounts available in the national food supply of the population in question. This was done by estimating the net protein utilization (NPU) of these diets. NPU affords an index of digestibility of protein and of the biological values of the amino acid mixture absorbed from the intestine. Protein requirements were expressed as grams per kilogram of body weight for various age groups.

<sup>5</sup> *Ibid.*

<sup>6</sup> Defined as protein that is completely utilized for anabolic purposes, i.e., protein that has an NPU of 100.

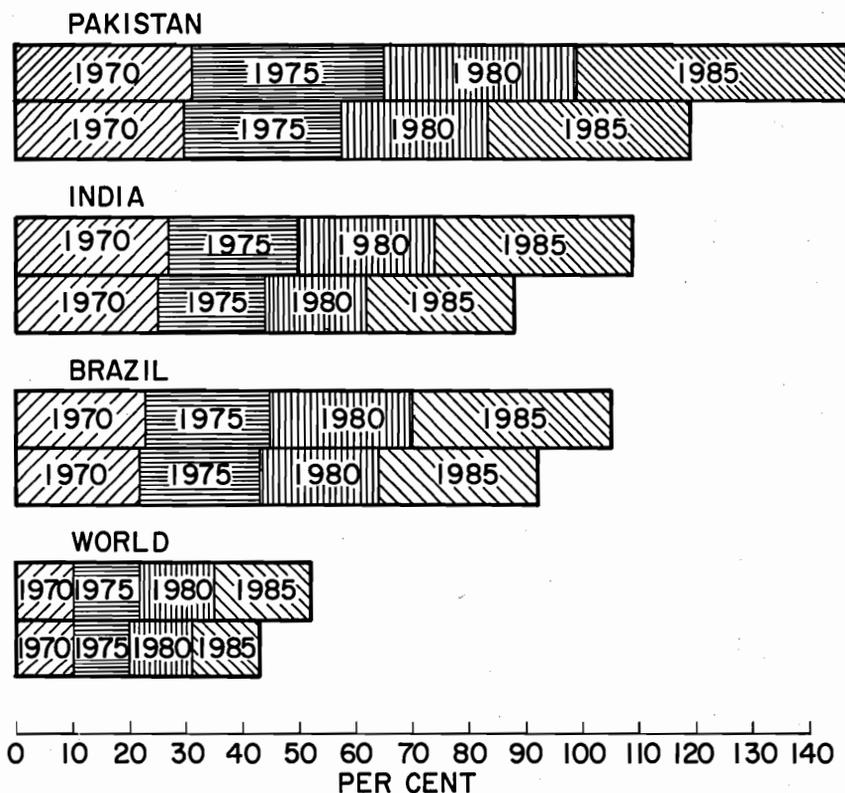


FIGURE 6-2.—Cumulative increases in annual caloric requirements of Pakistan, India, Brazil, and the World based on high and low population projections for 1970 to 1985. Values are percent increases over 1965 requirements for consumption (not production) and assume equitable distribution.

The estimated caloric and protein requirements for India, Pakistan, Brazil, and the World in 1985, relative to the needs for 1965, are summarized in Table 6-1.

TABLE 6-1.—Needs for calories and proteins in 1985 expressed as percent increase over needs estimated for 1965

Needs	Population estimate	World	India <sup>2</sup>	Pakistan <sup>2</sup>	Brazil <sup>2</sup>
Calories-----	High-----	52	108	146	104
	Low-----	43	88	118	92
Protein <sup>1</sup> -----	High-----	52	110	145	109
	Low-----	45	93	121	98

<sup>1</sup> Protein needs are for FAO "reference" protein.

<sup>2</sup> Based on estimated body weights in 1965.

The Panel has translated the calculated requirements for calories and protein into foods and commodities that will be needed to provide food for the world and the three selected countries. It should be emphasized that these requirements are for food that is consumed and not for food that is produced, which must be much greater to allow for various types of losses and for an even distribution among and within households.

Special problems exist in meeting protein needs in countries where single foods provide most of the food energy, or where food resources are not equitably distributed. Attention must be given to mechanisms of food distribution within a country and within households to assure adequate intake of protein of young and growing children and other groups that are vulnerable to malnutrition. When food supplies are limited in quantity or variety, it may be necessary to provide additional protein to meet the requirements of vulnerable groups in the population.

#### 6.5.0 *Future Needs for Other Nutrients*<sup>7</sup>

The needs for *thiamine*, *riboflavin*, and *niacin* are related to caloric intake. Accordingly, the relative increase in needs for the next 20 years will be about the same as indicated for calories. The Panel used the recommended intakes of these three vitamins suggested by the Joint Expert Committee of FAO-WHO. In many of the developing countries, cereal grain furnishes a large percentage of the diet. The thiamine and riboflavin content of grains is markedly reduced by milling. Since there is little reason to believe that food patterns will change, consideration should be given to the enrichment of cereal products with thiamine and riboflavin. The latter vitamin appears to be in short supply in many parts of the world. The niacin requirement can be met in two ways, by the vitamin itself and by conversion of the amino acid tryptophan to niacin in the body. This makes calculation of niacin availability and requirements difficult because of a paucity of information on the tryptophan content of many foods and because there are uncertainties about the efficiency of the biological conversion process. If protein needs are met by good quality protein, it can be assumed that niacin needs will be fulfilled also.

The world needs for *vitamin A*, if it is obtained largely (90 percent) in the form of carotene, will increase 50 percent between 1965 and 1985. In India, Pakistan, and Brazil, requirements will almost double during this period at the higher population projection and will increase by 80 percent or more at the lower projection. Since there are areas in these and other developing countries in which vitamin A-containing foods are not widely used, ways in which this vitamin can be added to existing foods must be considered.

<sup>7</sup> *Ibid.*

Estimation of *calcium* requirements is difficult and uncertain. Based on conservative estimates, the needs for calcium in India, Pakistan, and Brazil will double or more than double by 1985. On a world basis, requirements will increase 50 percent at the high population projection and about 40 percent at the low projection. Where milk and milk products are not available, careful selection of foods is necessary to meet even minimal allowances for calcium.

Numerous limitations exist in interpreting projections of food and population need. There are uncertainties in population numbers and characteristics, uncertainties in estimating caloric and protein requirements, inadequate information on home food production and consumption, and insufficient knowledge of food losses and nutrient composition of foods. Furthermore, averages should be interpreted cautiously in judging adequate and inadequate diets. Averages do not reflect inequities in distribution, the incidence of malnutrition, lack of food availability or purchasing power, local customs or ignorance.

#### 6.6.0 *The General Protein Problem*<sup>8</sup>

Statistical surveys, notwithstanding, there is abundant and unequivocal clinical evidence that large numbers of the world's people suffer from protein malnutrition. Clearly, these malnourished individuals are not getting the amounts of protein suggested by surveys. The reason for this apparent discrepancy is that the "average" daily per capita ration of protein does not quantitatively and qualitatively consider the requirement of three groups: *preschool children, pregnant women, and nursing mothers*. The protein needs of children of weaning age are particularly high in relation to caloric requirements, and unless these are satisfied, physical development and growth are impaired. Aggregate surveys of a global type also fail to consider the many individuals in different regions who are under nutritional stress due to crop failure, sickness, or natural catastrophe.

Supplying adequate nutrition to a developing area is not an isolated problem of providing adequate amounts of protein. Each region of the world has available to it certain foodstuffs; the people who live in each region have specific food habits and taboos. The choice of corrective action for a "target" population is dependent upon assessing local production and distribution and pinpointing the requirements for the specific acceptability patterns of the population. It is imperative that programs to alleviate protein deficiency be designed to produce results in a relatively short time. Since even the most vigorous efforts probably will fall short of the goal, consideration should be given to any program which shows promise of achieving significant results. Nutritional programs, however, differ greatly in the speed with which

<sup>8</sup> See Vol., II., Chapter 5.0.

they can be initiated and developed as well as in their ultimate impacts. Present donations of grain and mixtures of protein (weaning foods) to the developing countries have an immediate but small-scale effect on protein malnutrition.

### 6.6.1 *Protein Needs of Grain and Non-Grain Regions*

Proper protein nutrition involves the provision of adequate calories and an adequate amount of protein of suitable *quality*. The mass of the population in developing countries gets most of its protein and most of its calories from grain. For these people, more protein can be provided *by increasing agricultural production and by reducing waste* through better distribution and storage. It also may be possible to provide more protein *by improving the nutritional quality* of grain proteins by genetic means or by fortifying cereal grains with the essential amino acid, lysine (which is low in all major grains), or with protein concentrates from oil seeds and fish. In many areas, considerable potential exists for increasing protein from animal sources, including fish. A minor proportion of the peoples in developing countries, certain Latin American and African countries, obtain most of their calories from cassava and other starchy roots which are low in protein. In these non-grain regions, there is no alternative to the production of additional foodstuffs that contain high quality protein.

### 6.6.2 *Future Needs and Possibilities for Protein*

The Panel evaluation of the potential for synthetic foods or for new sources of foods has made it clear that there is no panacea for the world food problem or for the problem of protein malnutrition. Products such as the proteins of yeasts, bacteria, or fungi grown on hydrocarbons (petroleum), carbohydrates, or cellulose; protein extracted directly from green leaves that are now wasted; algae produced under a variety of conditions; and the much publicized fish protein concentrate (FPC) all have potential for the future. They can have little immediate effect, however, because a great deal of additional research and development must be carried out before their usefulness can be assessed and production and distribution mechanisms established. There are a number of problems which must be considered before any of these can have a significant impact, including: the cost and availability of the products; the cost of these proteins relative to other sources of protein; the effect of large scale processing; nutritive quality; and the question of how the product will be used. The latter is important because, to be effective, the product must be accepted and consumed by those members of the population who are most susceptible to protein malnutrition.

Protein supplies can be increased locally from domestic animal production, pond and other aquiculture of fishes and invertebrates, catches

of sea foods, and harvest of wild animals. Lack of purchasing power and absence of processing and storage facilities, markets, transportation, and distribution systems have prevented most of these resources from being utilized fully in the developing countries. As an example, the world fisheries catch has increased at a rate of 7 percent per year for more than a decade but little or none of the catch has been used to improve protein malnutrition in the developing countries.

There is now hope that FPC will provide the means of utilizing fish to combat protein malnutrition throughout the developing countries. Implementation of a program to use FPC will require time, because the United States is only now planning construction of its first FPC plant which is to have a capacity of 50 tons per day, has FDA approval only to use hake-like fishes for FPC, has not had the opportunity to test the process for hake-like fishes on a commercial scale, has yet to adapt the process to other types of fishes, and there is little information or experience on how FPC can be used as a *food* for people in the developing countries.

We believe that a considerable acceleration in the rate of development of this potentially valuable product should be undertaken, but we also conclude that *it is fully as important to plan* for the long-range development of fishery resources as it is to promote FPC. If FPC should prove to be the best means of using the fishery potential, we will be well along the way to harnessing the food potential of the oceans. If it develops that FPC is not the best means, then fishery resources can be utilized in other ways. In any case, the essential need is to learn how to obtain the maximum nutritional benefit from the oceans and to assure that man's use will increase and preserve their food potential.

At the present time, the protein problem can be attacked in a non-specific manner by fortification of cereals, the major staple in diets, with the amino acid, lysine. Since most grains are deficient in lysine, an essential amino acid, fortification will improve the nutritional quality of the protein. How much such a program will affect the problem of protein malnutrition cannot be predicted but it will improve the supplies of protein. It can be implemented *immediately* because synthetic lysine and the techniques for fortification are available. At present, flour but not whole grain, can be fortified with protein concentrates such as FPC or soybean.

Cost estimates indicate that lysine, which is available at about \$1.25 a pound, would be cheaper to use as a lysine source for enrichment of grain than FPC which costs \$.25 a pound but contains only about 8 percent lysine. (If FPC were used only for its lysine, the cost would be about \$3.00 per pound of lysine and it would have to be used at a level of about 1 percent). Even if cereals are fortified with threonine and tryptophan (essential amino acids present in limited amounts in

cereal proteins), in addition to lysine, the estimated costs indicate that amino acids would be cheaper than FPC, but only by about 10 percent. On the other hand, the value of lysine that can be produced by introducing genes for high lysine in corn should be considered. The world corn production is about 165 million metric tons annually which represents about 430 thousand tons of lysine. If the genes opaque-2 or floury-2 could be incorporated into corn produced in the world, the lysine content would be doubled or would be increased by about 900 million pounds.

Unfortunately, the improvement of the nutritional quality of cereal proteins by fortification may not be the most economical way to provide adequate dietary protein. For example, at the level at which FPC and amino acids are competitive in fortification, about 3 percent FPC, the concentration of protein that could be supplied daily is not significant for small children. A pound (454 grams) of fortified wheat would contain only about 11 grams of fish protein ( $454 \times .03 \times .80 = 10.9$  grams), a minimum amount needed to improve protein nutrition. Post-weaning and preschool children probably would not eat a pound of wheat daily, the equivalent of about 1500 kilocalories, so they would benefit little. In addition, this type of program is not an economical way to utilize protein because the entire population is eating food which has a higher nutritional quality than is necessary for adults.

Because protein malnutrition is most serious among preschool children, it seems logical that high protein foods will be needed, especially for pregnant women, nursing mothers, and post-weaning children. The main source of protein for these foods in the developing countries will likely be indigenous plant products such as oil seeds and legumes. Single cell protein, leaf protein, and FPC have potential but intensive research is needed if they are to be of real use in the future.

In the past decades, the chemical industry has accomplished miracles in reducing the cost of synthesis of complex organic compounds, and in reducing the cost of processing vast amounts of raw materials. Research should be directed toward practical synthesis of amino acids, (e.g., tryptophan), toward effective processing of protein from leaves and algae, toward converting wood-pulp to edible carbohydrates and large scale manufacture of edible fats from petroleum. Although such research, even if successful, would not help in the immediate future, the long-term prospects of these and other novel processes are not likely to be realized unless investigation is intensified now. Furthermore, an intensive research program on the chemical manufacture and modification of foodstuffs may develop unexpected and unforeseen approaches that can help alleviate the food shortage of the next generation. The time to amplify such long-term research is now.

## 7.0 TRENDS IN TRADE IN AGRICULTURAL PRODUCTS <sup>1</sup>

In the developed parts of the world, incomes, agricultural production, food consumption, and trade in agricultural products are all rising. Most of the developing countries also have scored at least slight improvements in agricultural production. Food consumption in these countries, however, is increasing more rapidly than food production. This has been made possible by rising net imports from developed countries, largely on the basis of concessional sales.

If per capita food consumption and the quality of human nutrition in the developing free world are to improve more rapidly than at present, a combination of the following, all of which are difficult but all of which appear to be possible, must occur:

1. Decrease population growth rates.
2. Accelerate agricultural and related production and productivity.
3. Accelerate increase in per capita income.
4. Accelerate concessional and commercial trade.

Analysis of trade and agricultural policies of developed and developing countries suggests that economic and technical assistance from developed countries to support more rapid economic development is an essential pre-condition to improvement in human nutrition and living standards.

Countries and areas should concentrate on products in which they have or can develop a comparative advantage if they are to improve efficiency in agricultural production. This requires freer trade and discouragement of narrow national self-sufficiency or tightly protected regional trading blocs. Specifically, the United States should further liberalize its own tariff and quota policies on agricultural products and should continue to press for freer access by nonmembers to EEC and other regional trading blocs. To the extent that common markets are a step toward freer trade to the world as well as to their members, they are to be encouraged.

Since food exports to developing countries on concessional terms will be required for some years to come to accelerate growth, *food aid* should be:

1. The joint responsibility of the developed nations, not primarily the task of the United States. Most actual food aid will be bilateral

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<sup>1</sup> See Vol. II, Chapter 2.0.

in the near-term but discussions and planning should take place in more nearly a multilateral framework.

2. So administered as to provide maximum incentives for increased investment by the developing countries in their own agriculture.

(This often means higher, not lower food prices in recipient countries. Food aid should *not* be used to depress prices received by producers which detracts from the farmer's incentive for increased production.)

Storage of reserve stocks of key food crops should be the joint responsibility of developing and developed nations—not primarily the task of the United States. Greater international planning and cooperation in the organization and financing of concessional sales of food and fiber should be developed. Trade, consultation, and information exchange among developing as well as developed nations should be materially increased since these are in the interests of specialization, comparative, advantage, and use of resources. International commodity organizations should maintain and intensify their efforts to forecast supply and demand conditions for their commodities; foreign aid should provide technical help for shifts in production to items presently or prospectively in short supply.

United States concessional trade (food aid) should:

1. Be conditioned on implementation of broad self-help requirements.

2. Encourage reduction or removal of export taxes on agricultural products and taxes on imports of agricultural inputs in recipient countries.

3. Not be motivated by the objectives of disposing of surpluses which reduces United States leverage to bring about improved production in recipient countries.

In the United States and in other countries, emphasis should be given to the production of those commodities which are or can be competitive in world markets without protection from tariffs and subsidies. Individual countries should reduce their emphasis on those commodities which can be supplied more economically by other countries. The United States and other developed countries should review carefully their import policies with respect to potential export commodities of developing countries and reduce impediments to increased consumption and imports. Preferential trading arrangements, however, should be avoided.

East-West trade appears to be increasing. The ability of the developed to help the developing countries will be conditioned by the Eastern World. If the Eastern World is active in the commercial market, its purchases will likely take priority over concessional sales. Therefore, improved international intelligence, knowledge of crop

conditions, and of plans to buy and sell would make complex international marketing less erratic and less uncertain.

*Continued indefinite expansion of concessional sales by the United States is not in the best interest of either the donor or recipient nations.* It does not establish long-term, hard bases of trade. Production capability of donor nations is expanded at the donor nation's expense, *not* on the basis of comparative advantage or viable markets. Recipient nations may use such imports as a crutch to avoid the consequences of unchecked population growth, an unproductive agriculture, and irresponsibility in accelerating domestic economic growth.

Grains are not complete substitutes for one another. If in the future wheat is not priced so that it is used as a feed crop in the developed world, supplies may again become burdensome because of lack of commercial markets. Soon the only major international commercial markets may be Japan and Communist China. China's ability to pay is uncertain. If Canada, Australia, and Argentina continue to expand their wheat exports, these exports will have to move on a concessional basis—unless the United States is willing to withdraw from commercial markets and leave them to competitors while we assume the entire burden of food aid for the poor nations.

Producers of major commodities in the United States have an important role in the viable commercial world markets for those products in which we can meet international competition. Among these products are the coarse grains, wheat, cotton, and plant proteins, especially soybeans. Our trade and agricultural policies must be such that the United States remains aggressive in the expanding commercial markets of the world: (1) as an incentive to continued growth in efficiency and productivity in the United States, and (2) as allies in trade so that we can obtain the foreign exchange to buy commodities for which other nations have greater comparative advantage.

## 8.0 FOOD SUPPLY, AGRICULTURE, AND ECONOMIC DEVELOPMENT

If the world's supply of food is to grow substantially, there must be general economic development in the developing nations and not just a change in farming itself. It is not *need* for food but *economic demand* for it that can induce greater production. Many types of investment throughout each national economy are required to create this demand and to make possible the production of the inputs essential to farming.

Stated differently, current justifiable concern about food supplies does not constitute a crisis that should cause us to put general economic, social, and political development aside to make way for a crash food production program. The need for more food should cause a re-examination of programs for general economic development, in order that both the magnitude and the characteristics of policies and programs be consistent with food needs arising from current malnutrition and rapidly increasing numbers of people to be fed. The discussion to follow examines the nature of interrelationships between food supplies, agriculture, and economic development.

### 8.1.0 *Economic Demand, Investment and Development*

The world needs more food, but increased supplies will be forthcoming only in response to an increased economic demand for food. Farming is a business whose functions include the production of food and involves costs which someone must pay. Either the prices paid for farm products by consumers must be high enough to make it profitable for farmers to increase production or some third party must pay these costs. This holds true for international concessional sales just as it does for normal commercial operations either within or between countries.

One of the most difficult problems encountered in meeting the world's need for more food arises from the fact that in most of the countries where this need is most urgent, a high percentage of the labor force is engaged in farming. This situation is likely to change only slowly, even where the most strenuous efforts are made to industrialize and to increase off-farm employment opportunities. Yet it is off-farm employment, either domestic or foreign, that creates the market demand for farm products.

A second important dimension of the problem of increasing the world's supply of food is the necessity of capital investments of almost

staggering proportions. Some of these investments are needed on farms. Even more are needed elsewhere in each economy, partly to make greater agricultural production possible and partly to increase non-agricultural production. The latter is important because the people of each country want products in addition to food and because the increased economic demand for food created by non-agricultural production calls for more farm production.

These investments are needed on a continuing basis, year after year. Thus, part of the task of increasing food production is management of each total economy in such a way that investment is kept at the highest possible level and allocated most advantageously among all investment needs.

For the reasons given above, overall economic development in each country is essential to increasing the world's supply of food. The demand generated by total economic development, if appropriate measures are taken, may call forth increased domestic food production from regions within the country that have substantial agricultural potential. If a country does not have such agricultural potential, the demand for food generated by its economic development will stimulate production in other countries and its income from non-farm production can pay for food imports.

Food production is not a separate industry but an integral part of an agriculture that produces other materials also. In many instances the most profitable combination of enterprises for a single farm business is one which produces both food and non-food products. In other circumstances, the production of food and the production of industrial raw materials such as fibers, rubber or oils must compete for the use of the same land resources.

Two points deserve emphasis here. The first is that stimulating greater food production must take the form of stimulating general agricultural development because of the complementary relationships between food and non-food products on each of many farms. Second, increasing the farm production of non-food products frequently plays an important role in general economic development. Under such circumstances, it is often a mistake to force a shift to food crops.

### ***8.2.0 What is Agriculture?***

The simple, common-sense definition of agriculture is that it is the cultivation of crops and the tending of livestock. A more useful definition says that "agriculture is the utilization of biological processes, on farms, to produce food and other products useful to man." This describes the nature of the production process and introduces the

idea of the farm as the unit within which the process is carried out. A third definition, popular in the United States today, broadens the definition much further to include economic activities classified as "agri-business." This includes as a part of agriculture all non-farm activities that provide farms with production inputs and those industries that market, process, and distribute farm products. The method used here to discuss the role of agriculture in a national economy is to outline the relationships involved in an expanding agriculture that give rise to these differing definitions.

This discussion is organized, therefore, into three components, depicted graphically in Figure 8-1. These three components are

1. Agri-culture
2. Agri-support
3. Agri-climate

This chart may constitute a useful reference point for this discussion.

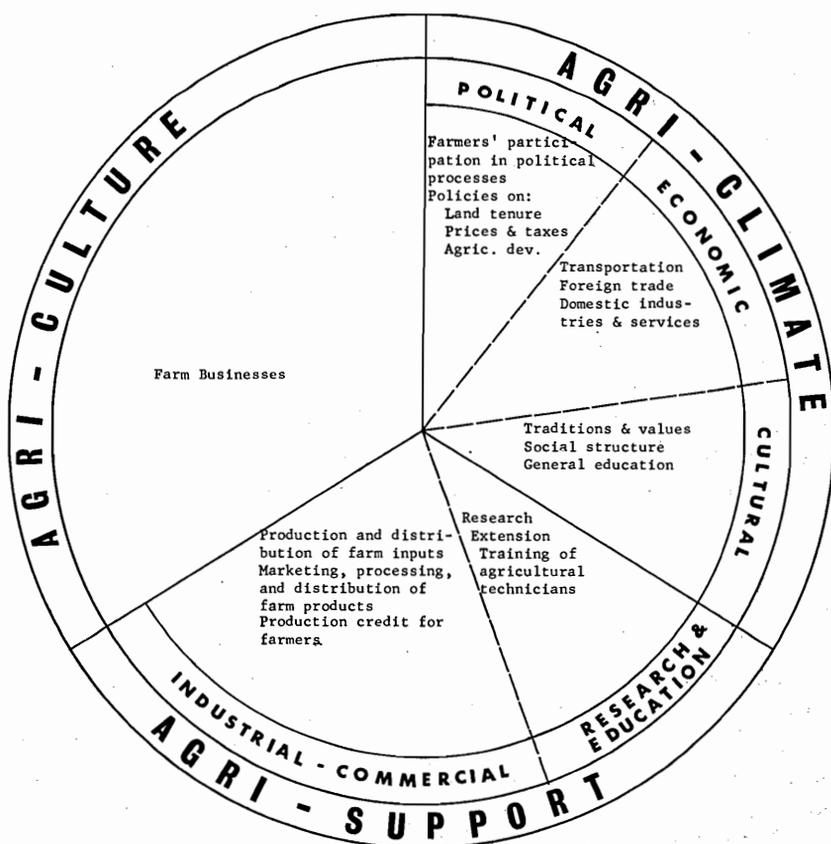


FIGURE 8-1.—Major factors in agricultural production

### 8.3.0 *Agri-Culture: The Nature of Farming*

Basically, farm production is based upon the growth processes of plants that utilize solar energy through photosynthesis. Man can exercise considerable control over these growth processes, but he cannot regulate them completely. The amount of solar energy available varies from place to place, air and soil temperatures vary with climate and weather, available soil moisture varies enormously with rainfall. The structure, texture, and plant food nutrients of the soil vary likewise. Man can modify these, and he can change the character of the plants themselves through systematic breeding, but farming still depends on the biological processes of plant growth and on the energy of the sun.

Because the basic process of farming depends on solar energy, it must always remain widely distributed over the face of the earth so the sunlight can be utilized where it falls. No other fact has greater significance for agricultural development. On the one hand, it requires an extensive and well-articulated transportation system to move the production inputs which a progressive agriculture needs from distant points of manufacture to each farm and to move farm products to ultimate consumers. Furthermore, it denies to farming two opportunities that are available to many other industries. One of these is the opportunity to concentrate activities in order that industries geographically adjacent can exchange products, avoiding major transportation costs or time-lags. The other is the opportunity to create favorable working conditions without transforming an entire society. A steel or textile mill can establish working conditions in a plant which, during working hours, will separate laborers from the demands, customs, and traditions of their families. Agriculture cannot do this since farming must be carried on in widely dispersed village settings, in the midst of family influences and traditional social pressures. Agriculture development, by virtue of this inherent dispersal, requires a major social transformation. It cannot create in part-time oases the new sets of working conditions appropriate to its production needs.

#### 8.3.1 *Seasons and Crop Cycles*

One of the favorable circumstances for increasing the world supply of food lies in the fact that long growing seasons characterize most of the agricultural regions of the developing countries. In many regions, crops can be raised throughout most of the year. In most agricultural regions, however, there are seasonal variations with differing combinations of temperature and moisture suitable for different crops at different times of each year. Most food crops have growing periods shorter than a year, and this makes "multiple cropping" feasible—a different crop occupying each field in different seasons or with the

same crop grown two or three times each year. Frequently, a plant breeding program to shorten the growing period of a crop becomes an essential prerequisite to multiple cropping in a particular region.

### *8.3.2 Intermittent Labor Requirements*

Another distinctive feature of crop production is that the labor requirement is intermittent. Seedbed preparation and planting require labor. Thereafter, until harvest, labor is required only intermittently for weed and pest control or for irrigation. Labor is again required for harvesting, threshing, and otherwise preparing the crop for market.

This intermittent need for labor in farming poses a special problem that can be solved in one of two ways. One is to combine, in the same farm business, crop and livestock enterprises in such a way that work peaks fall at different times, thereby evening out the labor requirements during the year. The other is to combine farming with non-agricultural employment in the off-season. Japanese agriculture furnishes an excellent example of both types of adjustment to the intermittent labor needs of crop production.

This intermittent need for labor provides a resource at the same time that it poses problems. There are many countries where, at present stages of development, labor is available for activities other than farming during substantial portions of each year at very low cost since alternative employment is scarce or absent. Meanwhile, several enterprises that can raise future productivity have labor as their chief requirement and they can be worked on intermittently without impairing progress. Examples are grading fields to improve irrigation or to control erosion; installing drainage lines; building fences; improving farm buildings; constructing farm-to-market roads; building schools; and erecting local storage facilities for farm products, supplies, and equipment.

### *8.3.3 Subsistence Farming: Production and Consumption on the Farm*

The frequency with which we use the term "subsistence farming" testifies to the closeness of consumption and production in much of the world's agriculture. Millions of farm families produce food, and sometimes fiber, not primarily for exchange in any market, but for their own consumption. This is another way in which agricultural production stands in stark contrast to industrial production which is always for the market.

This virtual identity of production and consumption on many farms in developing countries has major consequences for agricultural development. Prices can become operative as regulators of production only where some of the products of farms are sold in the market. A major transformation in the traditional thought patterns of subsist-

ence farmers is required to persuade them to shift from making production decisions on the basis of family consumption needs to making these decisions on the basis of market prices. Yet this transformation is essential if agriculture is to progress.

### *8.3.4 Farming as the Residual Employer of Labor*

The fact that farm production includes food, the basic requirement for subsistence, means that family members who may not be needed on the farm, but who cannot find employment in the cities, frequently remain at home and are fed. This, in large measure, accounts for the fact that farming is forced to absorb the residual labor supply for which urban (i.e., non-farm) employment is unavailable. Factories can discharge and stop paying workers for whom they no longer have work. Farmers can hardly stop feeding family members whose labor is unneeded but who cannot find other jobs.

### *8.3.5 Farm Capacity is Largely Man-Made*

An important way in which farming is very similar to other industries, though it is widely presumed to be different, is that the productive capacity of a farm is largely man-made. It is a cumulative result of what has been done to the land in the past and is largely the result of investment.

Farms, of course, commence with an initial productive capacity provided by exposure to solar energy, rainfall, and plant-food nutrients naturally present in the soil. The ceiling which these set for production, however, is wholly inadequate for progress in agriculture. The more progressive agriculture becomes, the smaller is its dependency on the natural endowments for achieving total productive capacity of the farm and the greater the proportion of these imports that is man-made, the result of investment.

### *8.3.6 Economies of Scale in Farming*

Unlike industrial production where, generally speaking, firms grow more efficient as they grow larger, small farms can be efficient and highly productive. Particularly where there is a large agricultural labor force without access to alternative employment and where nearly all good agricultural land is occupied, annual yield on the existing cropland is more important than output per worker. In such a situation, the land can be farmed intensively, raising crops that require a relatively large amount of labor per unit of land. The fact that the tending of plants and animals is improved when it is possible to give close and continuous attention to detecting infestations by disease or attack by pests and to counter these dangers quickly also helps to explain the widely verified fact that a farm need not be large in order to be efficient.

This does not mean that farms cannot be too small or too large for efficient operation. The range of efficient sizes of farms varies from region-to-region with available technology, with the man-land ratio, and with the relative local prices of land, labor and capital. Farms are too small when the families cultivating them cannot make a decent living from their farm efforts coupled with non-agricultural employment nearby. This holds true only if off-farm employment is available; if not, cultivating a farm that is "too small" is better than total unemployment. Large farms are more efficient when labor is expensive relative to the costs of land and capital (a situation seldom encountered in Asia, Africa, or Latin America) or where the most profitable use of the land is for a single crop such as wheat, sugarcane or the grazing of livestock. Farms are too large to be efficient if the size of the farm removes the incentive to increase productivity per acre, or where complexity of the management problem exceeds the technological means for meeting it or proves to be more costly than on smaller farms.

Economies of scale within farming are associated primarily with specific operations such as plowing and harvesting and can be achieved through cooperation among a group of farmers or by having these operations performed on contract. More of the operations in which economies of scale are important are to be found in the production and distribution of farm supplies and equipment and in the marketing, transportation and processing of farm products to which we shall turn in a later section entitled "Agri-Support: Servicing Farm Needs".

### *8.3.7 Farming as an Assembly-Line Operation*

One of the basic changes that characterizes a developing agriculture as it grows in productivity is that the farm comes to resemble the assembly-line in factory manufacturing enterprises. Each farm depends less and less on the resources inherent in the land and more and more on production inputs provided by and purchased from other sectors of the economy. Farming is serviced, more and more, by "agri-support" activities, and it is carried on under political and economic rules of the game determined by the "agri-climate."

### *8.40 Agri-Support: Servicing Farm Needs*

Only in a primitive agriculture do farmers utilize only those resources that are found "naturally" on the farm itself; that is, the plant nutrients naturally occurring in the soil, locally adapted plant varieties that have been grown for a long period, and home-made tools and implements.

In any advancing agriculture, farmers are dependent on many off-farm enterprises to service their production and marketing needs.

Some of these provide farm inputs for which farmers normally pay and are discussed below as meeting "industrial and commercial" needs. Others are usually provided by the government without direct repayment by individual farm-businesses. In fact, it is precisely because so many of these operations must be carried on by activities serving farm-businesses but not part of them, that relatively small operations can be highly efficient. Economies of scale differ among the services discussed below. Because each of these activities is carried on by a different set of industrial and commercial firms and cooperative and governmental agencies, it is possible for each to organize on the most efficient scale. Being separately organized and administered, however, makes it easy for them to get "out of phase" and thereby reduce the adequacy with which they serve the needs of farm businesses. Some of the adjustments needed to keep them in phase can be achieved by market prices while others depend upon appropriate governmental action.

#### *8.4.1 Industrial and Commercial Activities*

Seed production and processing are extremely important in development of commercial agriculture. Whereas in subsistence agriculture each farmer saves some of the harvest as seed for the next year, progressive farming requires the purchase of seeds. In the case of hybrids, new seed must be purchased every year. Other seeds must be purchased at frequent intervals, if not annually, either to maintain their "purity," to secure strains resistant to new diseases or to obtain optimum response to improved cultural practices.

Seed production involves highly specialized types of on-farm operations whereas seed processing which consists of cleaning, treating, storing, and packaging, involves many non-farm activities.

The production of fertilizers, pesticides and farm equipment is normally economical only when conducted on a very large scale in plants requiring heavy capital investment. The manufacture of fertilizers, particularly, requires large amounts of power. All fertilizers entail heavy expenditures for transportation, especially those for which raw materials are found only in a few parts of the world.

Formulating livestock feeds becomes an increasingly important industry as agriculture progresses. Industry can utilize by-products of other industrial processes for enrichment and betterment of animal nutrition and health in ways that farmers cannot duplicate by mixing their own feeds.

The distribution of farm inputs is, of course, as important as their production. These inputs are produced only at a few places in each country and may have to be imported from abroad. Farms, however, are widely scattered and cannot be individually served by manufacturing plants or from seaport importers. A network of local outlets, within reach of individual farmers, is essential.

Marketing farm products is another major type of agri-business. Each farmer has only a relatively small amount of each product to sell, and he may live at a considerable distance from ultimate consumers. Since few farmers are in a position to do their own marketing, they must rely on dealers to collect the products at or near each farm, to store and protect these products, and to move them to marketing centers and to consumers. Operating the transportation network is another essential agri-support activity. Farmers can transport products to the nearest market town, but the major transportation network serving agriculture is a separate industry.

Few products leave the farm in the form in which they are finally used. The processing of farm products may be as simple as milling rice or wheat; it may involve preservation; or it may entail combining different farm products into manufactured foods. With increasing urbanization and rises in urban incomes, food processing becomes important at early stages of agricultural development both to substitute for imported processed foods and because it extends the use of perishable foods beyond the seasons in which they are grown.

Providing farm credit becomes increasingly important as agriculture becomes more progressive. Contrary to popular belief, it is not the poverty of farmers but the length of farm production cycles, from sowing to harvest or from the birth of livestock until market time, that makes an efficient farm production credit system a necessity. Whether credit is provided by private banks, cooperative societies, or governmental agencies, it is a large operation and an important part of agri-business.

#### *8.4.2 Research and Education*

The second set of activities that must be carried on for the specific purpose of serving the needs of farm-business consists of research and education that are normally not paid for directly by farmers but are made available to all through appropriate governmental programs.

Research is essential to the successful economic development of agriculture. Farming can become more efficient and increase its output only when it can employ constantly changing technology. The activities of seedsmen, manufacturers, and merchants providing farm supplies and equipment must be backed by research that is continually developing improved technology that can be embodied in farm supplies and equipment. This research must take three forms:

1. Finding new technical measures for raising farm productivity. Such research involves plant breeding, soil management, disease and pest control, animal breeding and nutrition, irrigation practices, and engineering research to develop the equipment and power sources needed to use new means of increasing farm output.

2. Examination of the costs and returns of each new technical possibility and of the "package" of practices in which it might be employed. New farming technology will be adopted by farm businesses only to the extent that it pays to do so.
3. Continued search for ways of improving the efficiency of each of the off-farm industrial and commercial services to farmers.

As agriculture becomes more progressive, much of the research for improving the efficiency of off-farm services to farming can be, and often is, conducted by the firms engaged in these activities. Such firms also frequently finance research to improve farm technology itself. It is important to emphasize, however, that *no significant agricultural development has been achieved by any country without very substantial publicly financed and administered programs of agricultural research.*

There must be extension and continuing education for farmers. If on-farm technology is to change in ways that increase output and efficiency, farmers must learn how to apply the new methods developed from research and how to utilize the farm supplies and equipment made available. In addition, even the wise use of production credit requires considerable learning on the part of farmers. Farmers are not wholly dependent for information on a publicly financed extension service. They learn from each other and from local representatives of suppliers of farm inputs, banks, and other credit agencies. The acceleration of agricultural development to the extent required by the world's rapidly expanding need for more food will necessitate a network of extension education for farmers that is as wide as the distribution of farms in regions of agricultural potential.

Training of specialists for agricultural education and services is vital. It is clear that establishment, expansion, and improvement of each of the activities discussed above calls for training considerable numbers of these specialists. If the bulk of the training of farmers is to be accomplished through extension education, this service must be carried on by persons who combine competence in improved farm technology and farm management on the one hand and abilities to effectively transmit the information through the extension education on the other hand. Research requires trained workers of many types, each of whom is expert in a particular field and adept at working cooperatively with research specialists in other fields. Managers and field workers in credit, marketing farm products and distributing farm inputs are required as are specialists in seed production and distribution.

The primary instrumentalities for meeting the need for trained agricultural technicians are (1) agricultural colleges; and (2) continuous in-service or on-the-job training. Continuous in-service training is important partly because most present staffs of each activity

serving agriculture have had inadequate training in the past and partly because the continuously changing technology that is essential to agricultural development requires that each technician keep abreast of new knowledge.

### 8.5.0 *Agri-Climate*

The activities that have been presented up until now in this discussion are *specific* to agriculture in any economy no matter what definition of agriculture may be adopted. As mentioned earlier, one definition of agriculture is that it is "the utilization of biologic processes, on farms, to produce food and other products useful to man." A second definition expands this to include the industrial and commercial activities by which farm production inputs are manufactured and distributed to farms and by which farm products are marketed, processed, and distributed to ultimate consumers. This latter definition makes agriculture identical with what is frequently called "agri-business." Some people prefer to expand the definition of agriculture still further to include agriculture research and education, since these have significance only because of a nation's farming activities.

Beyond all of these, however, there is another dimension of each national economy that must be taken into account in any effort to increase the world's supply of food. This is the general climate of opportunity, inhibition, inducement, and "rules of the game" set for agriculture by each nation's culture and government.

#### 8.5.1 *Economic Climate*

Little agricultural development, and hence little increase in food supply, is possible in a subsistence agriculture. Agricultural development is possible only within an exchange economy where there is a substantial market demand for farm products coming from non-farm consumers with purchasing power. Consequently, a domestic demand for farm products is largely dependent upon the level of industrialization of the economy. Industrialization provides an expanding market for farm products. It increases non-farm employment opportunities without which even a redundant farm labor supply must continue to be supported within a subsistence agriculture. Some of this industrialization can and should take the form of activities that provide farmers with production inputs and utilize farm products as raw materials. Industries based on raw materials from minerals, petrochemical industries, and secondary and tertiary industries producing general consumer goods and services all increase the market demand for farm products and provide additional forms of non-farm employment. The ready availability in local rural markets of types of consumer goods attractive to farm families provides an additional important incentive to increase their sales of farm products so that enhanced farm incomes may allow them to purchase these products.

The relationship between domestic industrialization and agricultural development is, therefore, truly symbiotic. Agriculture needs both the products and the demand for farm products provided by industry. Industry needs the food and raw materials of agriculture and it also needs the broadened demand for its own products that only rising farm incomes and increasing demands for farm production inputs can provide. This interdependence of domestic industry and agricultural development is particularly strong where most of the employed labor force is in agriculture.

For the immediate future, at least, progressive agricultural development in much of Asia, Africa, and Latin America is heavily dependent upon opportunities to export raw or processed farm products. Many of these countries include tropical regions that produce such crops as coffee, cocoa, coconuts, rubber, and palm oil that are much in demand in more highly developed economies in the Temperate Zone. This external demand for farm products can play a key role in the general economic development of tropical regions by supplementing the generally low domestic demand pending domestic industrialization and by providing foreign exchange needed to purchase industrial equipment and to support the importation of production inputs for agriculture.

An exchange economy relies heavily on efficient transportation. Agricultural production is particularly dependent upon transportation because of its geographic dispersal. In addition, many agricultural products are bulky or perishable, and some of its inputs, especially fertilizers, are heavy. While transportation facilities are not built in any country solely to serve agriculture unless its importance to agriculture and the broadening domestic market for consumer goods is realized by planners, the widespread network of rural roads that is needed is likely to be neglected. The existing transportation system is an important part of the economic climate within which farming and agri-support operations must be carried on in a country.

### *8.5.2 Political Climate*

The political situation in a country affects the development of agriculture in several ways. It determines the extent to which law and order enhance future expectations of stability throughout the economy and it determines the emphasis that is given both to general economic development and to agriculture's role in development. It influences significantly the extent to which long-standing traditions and values are to be supported or are to be challenged in the interest of progress. Finally, it determines the extent to which farmers may participate in or are excluded from participating in these political decisions. In summary, the political climate sets the boundaries within which agriculture can develop.

The systems of land tenure prevailing in a region determine what share of the harvest the farm-operator may retain and is, therefore, an important determinant of his incentive to increase production. It determines whether decision-making is concentrated in the farm operator or divided between the tenant-operator and the landowner. It determines, to a large extent, where political power lies among rural citizens. In a country where most of the land is owned by a very few, the landowners usually dominate political decisions and governmental actions involving agriculture favor their interests at the expense of those of other farm-operators.

Few prices in today's world are uninfluenced by governmental policies. All too frequently, the government of a developing country takes measures to hold down the cost of food for urban industrial workers and government employees by placing a ceiling on prices, thus reducing one of the prime incentives for farmers to increase production. Similarly, the prices of farm production inputs are often set well above the import price to encourage domestic manufacture or to conserve foreign exchange. Farm products frequently are purchased by a government at a fixed low price and then exported at a profit to augment general governmental revenues.

Tax policies, likewise, can have a substantial influence on agriculture. Low land taxes may stimulate increased farm production where farms are small and cultivation can be intensive. In the case of very large farms which are operated in a non-intensive manner, however, low land taxes may inhibit optimum cultivation if landowners feel their incomes are already "high enough." Import duties may discourage the importation of needed farm production inputs.

Agriculture prospers or languishes along with other sectors of an economy in response to governmental policies and initiatives. Public policies that influence agriculture and are determined by the power structure of a country have the following characteristics: 1) favor or require substantial savings out of the national product, 2) encourage current consumption, 3) encourage or discourage both domestic and foreign private investment, 4) stabilize prices or allow inflation, and 5) favor or discourage appropriate domestic industrialization.

Whether or not political decisions have a greater influence on agriculture than on other sectors of an economy may be open to question, but the diversity of the influences of public policy on agriculture is beyond dispute. It is not enough, in order for agriculture to develop, that the government be on record as favoring agricultural growth. Precise governmental participation in agricultural development is a necessity because of the important effect of public policies on farmer's incentives, the need for governmental agri-support activities of research and education for which farmers do not pay directly, and the influence of government on agri-support industrial and commercial

activities. Positive government action is important for research and education, rural transportation, price, land tenure, and tax policies. Agricultural development can be retarded if a government tries to do too much in the form of state operation of agri-support industrial and commercial enterprises, or of overly-detailed regulation of these.

Since national political decisions have such a large role in agricultural development, it is important that *farmers*, and not just large *landowners*, have a full share in the political process by which these decisions are reached. One avenue for this is participation in national elections and another is the creation of farmer organizations that can wield effective political influence.

Another important type of political participation by farmers is representation in decentralized local units of government. While decisions affecting agriculture are made at a national level, many public activities might develop more rapidly if local units had more autonomy, responsibility, and taxing power. Local governments can give farmers control over some of the public activities that affect them most immediately and active participation by the farmer is good training in the nature of citizenship in a free society.

### 8.5.3 *Cultural Climate*

Political action can change certain of the "rules of the game" quickly but a culture's traditions and values have a tenacious hold on the minds and attitudes of its people. These give way only slowly wherever there seems to be significant conflict between the old and the new. In most of the countries where food production needs to be increased rapidly, these traditions and values have developed in an era when technology changed slowly, margin above subsistence was narrow, and protection against the disaster of total crop failure and starvation was far more important than any effort to increase production through experimentation. Until these attitudes change, they are part of the climate within which farming must be carried on.

The social structure of each culture is a product of its traditions and values. The solidarity of tribes and clans, extended family systems, and patterns of village influence and adjudication were largely forms of adjustment to isolation. They occurred in times of slow and expensive transport, non-exchange economies, and in relatively closed village economies, where food supplies were not much above the subsistence need of each community. As the transportation, market economies, and technology capable of supporting higher levels of production, all of which are inherent in raising levels of production, become available, they threaten and make obsolete many of these forms of social organization. Yet loyalty to the old social structure, and the integrity of "their way of living" remains strong. People resist changes until they can visualize or conceive a new order that can acceptably replace the

old. Farming cannot move away from or disregard the influences of social structure as can a large urban factory. It must modernize within this climate, changing gradually while honoring the necessities out of which the old forms arose.

Yield-increasing agricultural development is always associated with a rising level of general education. The ability of farm operators to receive and use myriad forms of information concerning new farm practices and respond to current and prospective prices is heavily dependent on literacy, and it increases with each increment in pertinent general education. Similarly, with respect to the needs of agri-support activities and of policy and program formulation within the general economy, general education is of major importance.

The content of general education is fully as important as its amount or its distribution from primary school through the university. Probably the most significant feature of the United States system of land-grant colleges has been that, from the beginning, these colleges were based on the premise that it is appropriate for colleges and universities to teach whatever it is useful for citizens to learn. Studying "agriculture and the mechanical arts" has dominated the college education of hundreds of thousands of young Americans for the past one hundred years and this has played a major role in the technological progress of this country.

### *8.6.0 The Role of Agriculture in a National Economy*

When we speak of the role of agriculture in a national economy, therefore, we are *not* talking about the relationship between a "sector" that is homogeneous in its character and neatly separated from other sectors but about an activity that has its roots in many activities, both off and on farm and with many types of mutual interdependence.

The assembly-line of agriculture is made up of farm-businesses of many sizes and types. These farm-businesses are widely dispersed to utilize sunlight where it falls and where soil and moisture conditions are favorable, and they are obliged to develop within the cultural climate which, in many places, is determined by previous low-technology modes of living. This assembly line must be serviced by two sets of agri-support activities: (1) industrial and commercial enterprises to provide farm production inputs and to market, process and distribute farm products; and (2) programs of research and education related to the needs of farmers.

Agri-support activities are strongly influenced in what they can do by the general agri-climate of the total economy and by the degree of non-agricultural industrial development as it determines the economic demand for agricultural products, including food. They are affected by political policies and programs, by the degree of farmer participa-

tion in political decisions, and by the traditions, values, and social organization of the total culture.

Most discussions of the role of agriculture in a national economy make five points:

- (1) Agriculture is the basic industry on which any economy must be built since it provides the food everyone must have;
- (2) Agriculture must provide employment for a high proportion of the workers of a country in the beginning, and for a decreasing proportion of the total working force as economic development and industrialization proceed;
- (3) In order for industrialization to occur, agriculture must progress in such a way that it needs progressively fewer workers so that some workers can be released to man non-agricultural industries;
- (4) Agriculture must provide the capital to meet the need for investment in non-agricultural industries and in general economic and social infrastructure;
- (5) Countries that are dominantly agricultural need to export agricultural commodities in order to provide the foreign exchange with which to purchase needed capital equipment.

We believe it is both more accurate and more helpful to analyze the role of agriculture in a total economy as was done in this study than it is to emphasize these five points. They give the impression that agriculture is important mainly in the beginning of development and that its role is primarily to make non-agricultural industrialization possible at the expense of its own early welfare and eventual decline. This interpretation is grossly misleading.

Agriculture remains virtually the only way known to produce human food in quantity. Food never loses its importance and today, with good reason, is a matter of urgent concern. This food does not have to be produced by a relatively primitive and disadvantaged sector of an economy. Instead, agriculture can and should be as highly-dynamic, capital-intensive, and efficient as most other types of production. At the present time in the United States, productivity per worker is increasing more than twice as fast in agriculture as it is elsewhere in our economy. Agriculture need not "give way to" more productive types of industry as the productivities of the farm and non-farm sectors of an economy are mutually dependent.

Moreover, in a world of international trade any one nation need not grow food in order to have enough to eat, but it must be *productive* as a consequence of which it can purchase the foods it needs and does not produce. The importance of agriculture in many currently

developing countries, in this context, flows not so much from the fact that agriculture produces food as from the fact that it represents the preponderant opportunity of most of the people of those countries to be productively employed. They have land, sunlight, draft animals, and agricultural skills. They can build on this base, thereby contributing both to the world's supply of food and to their own purchasing power to buy necessities they do not themselves produce.

Agriculture must provide employment for a large share of the labor force. In the currently developing countries, the total number of persons dependent upon agriculture for a livelihood will not decline for many years to come. This results from current rapid rates of population increase and the high capital costs of creating non-farm industrial employment. It will be extremely difficult, and very costly in terms of investment, to create urban industrial employment fast enough to absorb the annual net increase in the total labor force in most countries for many years. Agriculture will likely be required to support more people, as the "residual employer," even when additional farm workers can add very little to agricultural output. Meanwhile, there are more than enough workers to staff new industries without any being released from agriculture. This is one of the unfortunate restraints within which agricultural development must be pursued today.

Enormous amounts of capital are needed for investment both within and outside of agriculture if productivity is to rise. Part of this capital can be borrowed from abroad if the investment climate is favorable to foreign investors. An important but relatively small portion may be provided by capital grants from abroad. Most of it must come from current production within each country, and, if production within a country is chiefly agricultural, the net flow of capital will have to be from agriculture to non-agricultural industry. However, the needs for investment within agriculture are great, and unlike the situation historically in certain developed economies, present research techniques are such that it may be more productive in many countries to concentrate on investments within agriculture for the time being rather than to drain capital out of agriculture to finance non-agricultural industrialization. Each case is unique. Certainly each country that has substantial agricultural potential should try to assure that "agri-support" types of industry are given priority in whatever programs of industrialization it may inaugurate.

So the role of agriculture in the economy of any country where there is agricultural potential must be seen as *coordinate*, not *subordinate*. These interrelationships between agriculture and the total economy are presented in Figure 8-2.

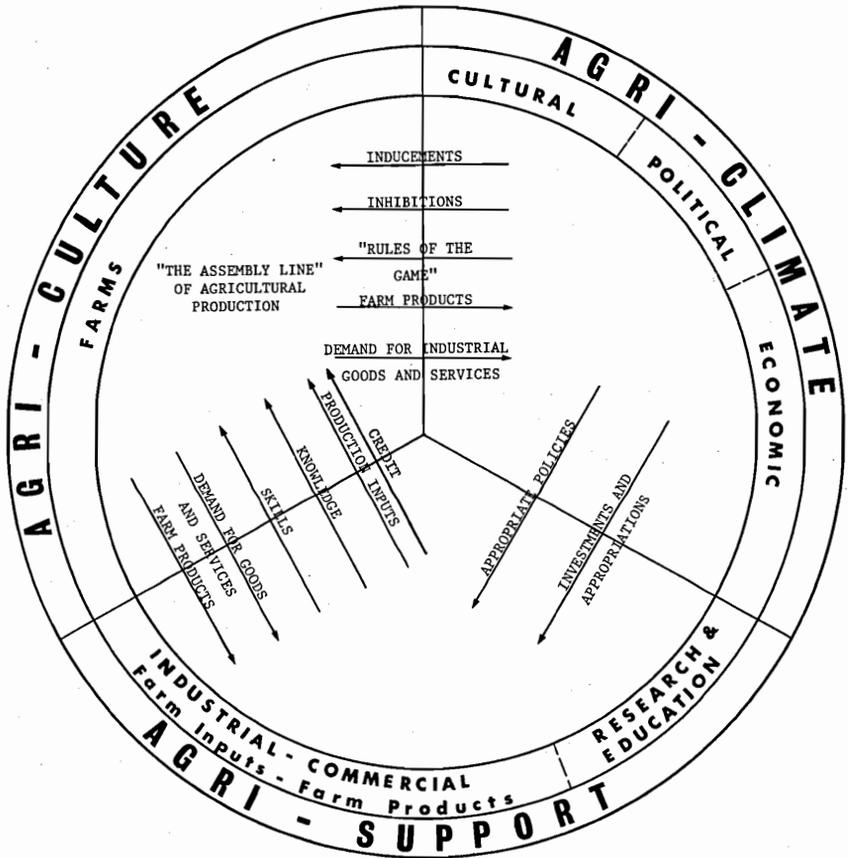


FIGURE 8-2.—Major interrelationships between agriculture and the total economy.

*From agriculture*, the national economy needs food, industrial raw materials, and an economic demand for its non-agricultural industries, supported by rising farm incomes. In many countries, the national economy needs foreign exchange to finance purchases of industrial equipment and finds its greatest opportunity to secure such foreign exchange through exports of farm products. The national economy also must depend on agriculture to employ a major part of its total labor force.

*From the national economy*, agriculture, if it is to advance, must have a research program that is constantly developing new technology to maintain and increase the potential for higher and more efficient farm production. It must have easy access to farm supplies and equipment embodying this new technology, and easy access to markets for its products. Agriculture must have access to new knowledge and skills and the services of trained technicians of many types. The

national economy must provide a favorable pattern of land tenure, price relationships, and tax policies to induce farm-operators to increase production and industrialists to produce farm inputs. Agriculture must have a type of representation in the political process that will enhance the likelihood of these contributions from the national economy.

### **8.7.0 *Production Incentives for Farmers*<sup>1</sup>**

While nations or other social institutions may commit themselves to long-range objectives for the common good, the mass of individual citizens in a country rarely do so. Instead, they respond to incentives that affect themselves and members of their families quite directly. The problem of commitment is most difficult in a free society where individual choices are given paramount importance and where social decisions and social actions must reflect the sum of individual values. In an authoritarian society, the factors or means which induce appropriate economic behavior in voluntary ways may be important. In a democratic context, they are critical.

In discussing food production in the developing countries, no single factor is more important than the provision of adequate incentives for farmers to increase productivity. Agricultural development, in the last analysis, depends on the production decisions and actions of farm operators.

There are three sets of factors that influence production incentives of farmers. Some flow from the general cultural, political, and economic characteristics of each country or region. Some are effects of policies and programs designed to serve agricultural development but not primarily to affect incentives. Some are programs undertaken primarily to influence farmers' incentives and decision-making.

General cultural influences include traditions and values, social organization, and particularly, arrangements with respect to land ownership and tenure. These affect primarily each farmer's degree of freedom of action, determining whether he is under pressure to adhere to traditional ways or is free to innovate. In general, traditions and values are not subject to direct manipulation; instead they change, slowly or rapidly, under the impact of new opportunities and new pressures. The laws governing land ownership and tenancy determine the distribution of political power and thereby policies and programs that can aid or inhibit agricultural development. They affect current production decisions of farmers via the conditions they decree for division of the sharing, if any, of production costs. They affect farmer's incentives to invest in farm improvement and the decisions to concentrate or divide the resources on farm operations. The legal structure determining farm ownership and land tenure can and must

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<sup>1</sup> See Volume II, Chapter 9.0.

be changed in many countries before the potential for agricultural development can be fully realized.

The second set of influences arises from private or public programs undertaken to speed the progress of agricultural development and are not aimed primarily at incentives. These programs or facilities include markets for farm products, local outlets for farm supplies and equipment, the transportation system, production credit agencies, and irrigation facilities. All of these taken together determine the opportunities for farmers to adopt more productive methods. Their availability is a powerful stimulus to farmers to use them and they are the essential pre-conditions for the success of efforts aimed more directly at influencing the decisions of farmers.

The third set of influences are programs undertaken primarily to increase production incentives. The most important of these are price policies and programs of extension education. Recent studies have established the responses which peasant farmers make to price changes, at least with respect to the acreages devoted to commercial crops and of subsistence crops in regions that are already market-oriented. There is little or no evidence that pricing can induce yield-increasing changes by peasant farmers, but this result is inconclusive. Other pre-conditions for increasing changes, including the facilities listed in the preceding paragraph, were still lacking in the localities where the effect of price changes were studied. Where these pre-conditions are met and farmers are already market-oriented, it is highly likely that price relationships will prove to be an influential factor in the incentives of farmers to increase yields. Meanwhile, the unfortunate tendency in most low-technology countries is to base pricing more on a desire for low food costs in cities than on the production incentive needs of farmers.

Programs of extension education can have a substantial positive effect on the production incentives of farmers, once essentials such as markets for farm products, local outlets for farm supplies and equipment, and favorable price relationships exist. A broader comprehension of the potential role of extension activities in developing countries is required if these programs are to have a maximum effect on incentives. Extension programs not only can "take research results to farmers" and "impart knowledge and skills" but can, in addition, and frequently do, substitute for old traditions and values, overcome reservations about the risks and uncertainties involved in innovation, speed the transition from subsistence to market orientation of farmers, stimulate the development of local auxiliary services, and generally make agricultural planning more realistic and practical.

Early in agricultural development, attention needs to be concentrated upon the whole range of factors that influence farmers' incentives. Pricing policy is of great importance even at this stage. At the very least, a farmer must remain solvent; he cannot be expected to

produce for the market at a loss. But price structure can only affect farmers' production incentives where farmers (1) have a considerable degree of freedom of action without general or specific cultural restraints; (2) have production alternatives available, locally provided through research and appropriate off-farm services, to distribute farm inputs and to market, process, and distribute farm products; and (3) are, in consequence, able to operate primarily in a market rather than a subsistence economy. Each of these pre-conditions requires much additional attention in most of the countries of Asia, Africa, and Latin America.

### ***8.8.0 Marketing, Processing and Distribution of Food***<sup>2</sup>

The inability of the developing countries to store, process, and distribute foods is as serious a problem as their inability to produce the kinds and amounts of food needed for their hungry and rapidly increasing populations. The encouragement of private investment to develop facilities for storing, processing, and distributing foods deserves a very high priority. Governments of developing countries must provide a climate hospitable to the kinds of private enterprises that can stimulate change from a subsistence farming economy to a market-oriented farming economy.

The factors that are required to induce a change away from subsistence agriculture are (1) certain services that can be provided by government; (2) private investment in facilities and organizations to collect, store, process, and distribute farm products; and (3) consumers with money to buy the foods required to meet their nutritional requirements.

Because of the urgent need for high protein foods for preschool children, a major effort should be made to develop, process, and distribute foods of this kind. The development, production and distribution of these products should be performed by private enterprise wherever possible. The urgent need for such foods could provide the motivation for government and private organizations to collaborate on the development of model marketing systems that could gradually be expanded, developed and adapted to less specialized foods for other segments of the population.

### ***8.9.0 Transportation***<sup>3</sup>

Because farming is inherently an activity that must be widely dispersed over the land area of a country, agricultural development is heavily dependent on a widespread transportation system. Such a sys-

<sup>2</sup> See Volume II, Chapter 10.0.

<sup>3</sup> See Volume II, Chapter 11.0.

tem is needed to move production inputs to farms and to move farm products to ultimate consumers, domestic or foreign.

The transportation facilities of a country must consist of a well-articulated system in which each of the parts is efficiently linked. The elements in such a system include a widespread network of access roads connecting farms with local collection points or market towns, intermarket and intercity highways or railways of heavier carrying capacity, major transport connections to seaports, adequate access to international seaborne transport, and efficient terminal and transfer facilities between each of these links in the system.

In general, the proportion of public expenditures that are devoted to improving and operating transport systems is as high (20 percent to 40 percent) in most developing countries as it should be, but much greater effectiveness could be secured by better allocation of funds among different links in the system and by greater efficiency of administration and operation.

In almost every developing country, the network of access roads between farms and local market towns is still inadequate. It is usually the absence of roads that must be corrected. Maintenance of existing roads is a major problem also but, for the time being, the efficiency with which carriers are operated over these roads is of secondary importance.

Intercity transport exists in most places and is accorded high priority in current investments in transportation facilities. However, its efficiency is usually neglected and the facilities linking cities need additional and major attention. Seaborne transportation is reasonably adequate and most additional future needs can be expected to be met by private investment and operation. Greater attention needs to be paid to improving terminal facilities throughout the transportation systems of developing countries.

In view of the high importance of a complete transportation system to agricultural development, emphasis should be placed on providing a complete network of access roads in those regions of each country that have the greatest potential for increased agricultural production in the near future, together with the connecting links between each region and major cities and seaports. The potential of a region for higher productivity depends as much upon the availability of new farm technology already developed and verified by research and an adequate market demand for farm products as it does on inherent soil fertility or present production levels.

Transport alone is not sufficient to increase the supply of food, but it is one of the essentials to agricultural progress and its neglect can nullify all other measures designed to increase farm productivity. Current plans for increasing the output of food which tend to focus

on fertilizers and other farm inputs without considering the need to deliver the inputs to the farm and to distribute outputs to consumers will not realize their potential effectiveness. In regions where the food problem is most critical, the transport capacity is often least able to move the required tonnage of farm inputs and the facilities needed to move foods to markets are lacking, too costly, or too slow.

## 9.0 TECHNICAL AND RESOURCE OPPORTUNITIES

### 9.1.0 Availability of Land<sup>1</sup>

The area of potentially arable land on the earth is much larger than estimated previously, being 24 percent of the total ice-free area and considerably more than twice the land that has been cultivated at one time or another during the last few decades. It is more than three times the area actually harvested in any given year. More than half of the potentially arable land, amounting to more than 4 billion acres, lies in the tropics, and about a sixth of it is in the humid tropics. Another 20 percent of this land is in the subhumid tropics where a season of abundant rainfall alternates with a relatively dry season. Outside the tropics, there are large areas of potentially arable land in temperate parts of North America and in Australia.

In contrast to the principal areas of *potentially* arable land, most of the *presently* cultivated land is in the cool—temperate zone. The largest areas of potentially arable land lie in Africa and South America which, outside of the relatively small continents of Europe and Australia, have the smallest cultivated areas. The potential for increasing net cultivated area is very small in Europe and Asia and relatively small in the Soviet Union.

In Asia, if we subtract the potentially arable land area in which water is so short that one four-month growing season is impossible, there is essentially no excess of potentially arable land over that actually cultivated. *To increase food supplies in Asia, therefore, it will be necessary either to increase yields per unit area or to increase the gross harvested area through double or triple cropping, often but not always, based on irrigation development.* The Panel estimates that the potential for increase in irrigated area in the Indian subcontinent and Southeast and Southwest Asia is over 200 million acres. The total capital costs to develop irrigation in these regions would be approximately \$80 billion.

In Latin America and Africa, the limiting factors in agricultural development are not potential land and water resources, but economic, institutional, and social problems.

The very large and ever-increasing disparity between population size and potentially arable land in Asia, on the one hand, and the still-

<sup>1</sup> See Vol. II, Chapter 7.0.

unused potential in Latin America, North America, and Africa, on the other, suggests that very large-scale intercontinental migrations, such as characterized much of the 19th century, might occur in the future. Human migrations within different countries will almost certainly be required in the crowded agricultural lands in Asia. The marginal productivity of agricultural labor is approaching zero in these countries. It will be difficult to apply modern technology to raise agricultural production without moving large numbers of people off the land into the cities. For this, and other reasons, *agricultural development must be accompanied by general economic improvement and particularly by large-scale urbanization.*

### 9.2.0 Problems of Tropical Agriculture<sup>2</sup>

The present technology for agricultural production is inadequate for the humid tropics and for most of the subhumid tropics. *New plant varieties must be developed and new methods of fertilization, pest control, soil conditioning, and water management must be found.* Even the basic data on soil properties and climatic conditions are scanty or lacking for most of this region. Major emphasis should be given to research and development of tropical agricultural technology.

In much of the tropics, crops must be grown on soils which are severely leached of nutrients and with high infestation of pests whose depredations never are interrupted by winter. The lands are cultivated by tradition-bound peasants who often are controlled by a political system which has its power base in cities and is unfamiliar or unconcerned with problems of farming and with measures needed to improve its productivity.

In the tropics, there are large areas of uncultivated land whose general climatic and soil characteristics suggest a vast unused potential for food production. But to realize this potential, we must:

1. Obtain knowledge of tropical soils and of practical soil and crop management systems needed for sustained high yields.
2. Provide technological and economic inputs of the kind and size now available to producers in temperate regions.

Tropical soils range from highly leached ones of the rain forest, through alkali-saturated soils of the desert, rich volcanic soils of Java, alluvial soils of the Nile delta, to impoverished soils of the Ancient uplands. On a few of these soils, cultural methods similar to those employed in temperate zones have been successful in giving annual yields far in excess of those of temperate regions. In other areas, these same cultural methods have failed completely and often have resulted essentially in the destruction of the soils. Unfortunately, up to now, farming techniques imported from the temperate zone have usually

<sup>2</sup> See Vol. II, Chapter 8.0.

been inferior to those of the indigenous cultivators for management of soils in the tropics.

A common agricultural system of the humid tropics is the slash and burn method. The forest is cut and burned, the soil is cultivated until the natural fertility is gone, and then the leached infertile land is abandoned for a number of years while forest vegetation is established again.

The local cultivators may be uninformed, but they do not lack intelligence. They have made adaptations needed in the tropics. For example, to obtain fertilizer, cattle are released to forage in the daytime and penned at night—manure is then collected from the pens and put on the kitchen gardens. Primitive farmers in some countries have used human manure for centuries. As a result, the soil in some places, especially in China, is reasonably fertile within walking or bullock-cart distance of the villages.

Technology and cropping systems must be devised within each developing nation. A vast effort will be required to learn what technologies are applicable in the tropics. Some particularly important areas suggested for investigation are soil science, mineral deficiencies, high-temperature physiology and biochemistry, weeds, diseases, insects, and adaptation of temperate zone plants, especially legumes, to provide proteins. The United States should take effective leadership with interested governments to develop agricultural research and educational institutions in tropical areas to focus on the problems of production, storage, processing, and marketing of food crops.

### 9.3.0 Water and Irrigation <sup>3</sup>

In irrigation development, much more attention needs to be paid to ground water resources and their use, particularly in the Indian subcontinent.

Problems of water management and the interaction of water with other production inputs should be emphasized also. Whenever irrigation removes the moisture ceiling on crop yield, other management practices such as fertilization, liming, improved seeds, and insect and disease control become much more critical to success. *Failure to follow through with all required practices can easily offset the advantages of irrigation.* It is important to note that most major irrigation projects are concerned with only a small part of the total picture. Such projects normally are limited to storage dams, diversion structures, canals and laterals, and, in some cases, to tubewells. All who are involved in project planning, project authorization, and project operation should recognize the vital necessity of providing adequately, not only for water, but for all of the inputs and processes that agriculture requires if an irrigation scheme is to make a major contribution to

<sup>3</sup> See Vol. II, Chapter 7.0.

increased agricultural productivity. Only if all of the inputs required to make an irrigation project fully productive are provided in a timely manner can the high capital cost of such projects be justified.

#### 9.4.0 *Fertilizers, Seeds, Pesticides, and Machinery*<sup>4</sup>

*Where adequate water is available, the optimum return on the investment and effort in food production comes through the development of improved farming systems involving more fertilization, better seeds, better machinery, and improved cultural practices, including water management.* Fertilizers account for most of the capital investment required to produce these inputs, as well as two-thirds of the cost to the farmer, and are an absolute necessity for improved yields. The effectiveness of fertilizers can be increased greatly, often more than doubled, by the concomitant use of improved plant varieties, adequate pesticides, improved machinery, and proper water management.

The quantities of these physical inputs required to provide for the food needs of the developing world, outside of Mainland China, by the year 1985 have been projected for the Panel. Estimates of requirements were related to specific percentage increases of food production on land now in cultivation.

Estimates of fertilizer needed to *double* agricultural production in the developing countries indicate an increase in the usage of plant nutrients from the six million metric tons used in 1966 to 67 million metric tons. It is anticipated that, by the year 1985, capital totaling approximately \$17 billion will be required for mining, manufacturing, and distribution of fertilizers, and it should be noted that immediate, as well as future, needs for capital are quite large. Manyfold increases in intercontinental shipping will be needed to serve international trade in fertilizers, since efficient nitrogen plants, potash mines, and phosphate mines are necessarily quite large and the needed raw materials are by no means uniformly distributed around the world.

Of the inputs needed to improve agricultural production of developing countries, seeds and improved plant varieties are important components. The new varieties must not only be developed but also be used as a part of improved farming practices. Experience has shown that, for some plant crops, production has been doubled when 25 percent of the seed planted is of the improved type. The capital investment that will be required is relatively low—about \$300 million.

Large increases in the use of pesticides are necessary to increase food production. All types of insecticides, fungicides, herbicides, nematicides, and rodenticides are needed. At the present time, only 120 thousand metric tons are used in the developing world, excluding Mainland China. If food production is to be doubled, 700 thousand

<sup>4</sup> See Vol. II, Chapter 6.0.

metric tons will be required. To provide this quantity of pesticides will require \$1.2 billion in capital for manufacturing plants and \$670 million for formulation and distribution facilities. It is suggested that most pesticides should be manufactured in the developed nations where skilled manpower, utilities, and raw materials are easily available, but trade and monetary restrictions and excessive nationalism, of course, may be limiting factors. Formulation of pesticides, a relatively simple operation, can be carried out locally in the country of use.

In the developing free world, more machinery is badly needed—not as a labor-saving device, but to increase productivity. At the present time, machine power available to the farmers of Asia, Africa, and Latin America averages only a fraction of the more than one horsepower per hectare utilized by the farmers of Europe and the United States. This lack of power makes it difficult to prepare seedbeds efficiently and timely and to place seed and fertilizer accurately, both of which can contribute markedly to improved yields and to the economical utilization of these inputs. Although there are one or two exceptions, an analysis of yields in various countries indicates that a power level approaching 0.5 horsepower/hectare is needed for an efficient agriculture. It is estimated that \$500 million will need to be invested by the end of this century in plants for the production of farm machinery in the developing countries. The total capital investment, including components which can best be imported, will approximate \$2 billion.

*It is estimated that the annual cost to farmers of improved inputs—fertilizers, seeds, pesticides, and machinery—will amount to approximately \$14 billion by 1985. This will make it necessary to provide systems for farm credit on a scale manyfold greater than is available today.*

#### *9.5.0 Intensification of Plant Production*<sup>5</sup>

Production of major food crops can be substantially increased in both the developed and the developing countries. To accomplish this, however, will call for coordinated, crop-oriented research and production programs, especially in the food-deficit nations, if food requirements of the 1970's and 1980's are to be satisfied. Even under the most favorable circumstances, the interval between inauguration of such programs and their realization in the form of increased production of crops will be at least five to 10 years.

National programs such as the wheat programs of Mexico and Pakistan and the maize program of Kenya should be used as models for establishing similar programs in other developing countries. *No*

<sup>5</sup> See Vol. II, Chapter 3.0.

*campaign for accelerating food production should be initiated, however, before completion of the applied research necessary for the adaptation of the principles of crop production to practices under specific, local conditions.*

#### 9.5.1 Immediate Prospects

For the short-term, advantage should be taken of the existing body of knowledge concerning the geographic adaptability of many of the world's improved crop varieties. These should be distributed and tested widely in the developing areas where they are likely to prove useful. The following deserve special attention :

1. *Rice* varieties which originated in Taiwan and were improved at the International Rice Research Institute, which have short stature, stiff straw, and excellent response to high levels of fertilizers.
2. *Dwarf wheat* varieties developed in Mexico which have wide geographic adaptation.
3. *Maize varieties and hybrids*, developed in tropical America and Southeastern United States, which appear to be adapted to areas of Southeast Asia and Africa.
4. *Sorghum* genotypes which possess unusually wide ranges of geographic adaptation.

#### 9.5.2 Future Effort

For the long-term approach, there are five major considerations :

1. Attention to *basic food crops* that can be propagated rapidly—wheat, rice, maize, pulses, oilseed legumes, sorghum, millet, potato, sweet potato, yams, cassava, and banana. Attempts toward self-sufficiency in specialized, poorly adapted crops should be avoided.
2. Substantial plant *breeding efforts*, in the regions and by the nations where the crops are to be used, should be supported and encouraged.
3. Establishment of organizations that can produce and supply adequate and dependable quantities of *high quality seeds*. Generally, private enterprise has been much more effective than government monopolies in producing and distributing seeds of improved varieties or hybrids.
4. Establishment of *integrated national crop-oriented programs* under unified leadership.
5. Plant breeders must develop plant types adapted to high levels of soil fertility or to high levels of applied nutrients which convert these nutrients into end-products of better *nutritional quality*. Attempts now being made to isolate cereal genotypes with a better balance of amino acids should be intensified and greatly expanded, especially the transfer of the genes opaque-2

or floury-2 into maize varieties. These genes are capable of increasing the lysine content of maize by about 100 percent and tryptophan by about 65 percent.

### 9.5.3 "Package Approach"

The full potential of improved varieties for increasing agricultural production cannot be realized unless adequate quantities of mineral nutrients and water and protection from pests are provided. Use of fertilizers is probably the quickest and most dramatic way to increase crop yields. Doubling or tripling yields by adequate fertilization is not uncommon. Response to fertilizers by improved varieties in the national wheat programs of Mexico, India, and Pakistan have ranged from 17 to 30 pounds of grain for each pound of nutrients applied as compared to 11 to 16 pounds for the locally grown varieties.

*The key to success in accelerated food production programs is the adoption of the "package of practices" approach, involving the use of new, high-yielding varieties, adequate fertilization and irrigation, and improved cultural and plant protection methods.*

### 9.5.4 Problem Areas

Agricultural progress is being impeded in many developing nations by the following problems:

1. Lack of personnel properly trained for effective participation in national crop-production efforts.
2. Failure to emphasize yield concepts based on production per unit area per unit of time instead of fixed crop-growing seasons. This is especially important in tropical and subtropical areas.
3. Lack of a capability of American personnel in tropical agriculture commensurate with the United States Government's expressed willingness to respond to requests from developing nations for help in the improvement of their agriculture.
4. An erroneous concept that agricultural technology is directly transferable from country to country, when, in reality, the principles of crop production must be applied specifically to local conditions by adaptive research and testing.

The practical limits to intensified plant production are likely to be economic and socio-political rather than biological. These economic and socio-political factors range from deep-seated traditions of rural societies to total policies and attitudes of governments. Rural societies are slow to change and difficult to approach directly, but governments, by making appropriate policy decisions, can provide the impetus and the incentives to bring about change. The formulation of agricultural policy, giving agriculture the status, prominence, and priority which the magnitude of the food problem demands, is the first step in creating conditions for increasing production.

### 9.6.0. *Foods From Land Animals*<sup>6</sup>

One of the most difficult aspects of the world food problem is to provide supplies of protein adequate to assure good health and to prevent the occurrence of protein malnutrition among children. Man traditionally has balanced his diet of largely plant materials with foods of animal origin which contribute essential amino acids, as well as fats, minerals, and vitamins. Provision of adequate quantities of animal products is one way to help improve world protein nutrition.

There is no shortage of animal protein in the world as a whole; however, supplies available in the developing countries amount to only 9 grams per person per day as compared to 44 grams per person per day in developed countries. FAO short-term targets for the developing countries are 15 grams and long-term targets are 21 grams.

#### 9.6.1 *Potential Role of Livestock*

World food planners tend to discount the contribution that land animals can make to the world food supply, presumably because they believe that increases in animal production can be made only by diverting to animals foodstuffs that otherwise could be eaten by people. Livestock can consume food that cannot be eaten by man, such as forages, wastes, by-products, and even chemicals such as urea. Whether or not large quantities of grains are fed to livestock is a local economic and political question.

There are over 3 billion livestock in the world and about the same number of domesticated fowl. Although 60 percent of these animals are raised in the developing countries, these nations produce less than 30 percent of the world's meat, milk, and eggs. This low productivity is due largely to a failure to utilize scientific principles of disease control and animal husbandry.

According to FAO data, *world production of meat, milk, and eggs increased during the decade 1953 to 1963, particularly in the developing nations where, with few exceptions, this increase was at least as rapid as human population growth.* Estimates of increases in world production of animal protein have been made for the Panel based on the rate of increase during the decade from 1953 to 1963, the availability of resources, and the potential for animal production in various regions. These projections also consider the likelihood that efforts will be made to maximize production of plant food for human use. Average per capita production of animal protein is expected to increase until about 1990. After that time, if population increases continue, the per capita supply will decline.

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<sup>6</sup> See Vol. II, Chapter 4.0.

### 9.6.2 *Wild Animals*

It is not known what contribution nondomesticated animals currently make to the world food supply. However, in Africa, which is richly endowed with wild animal species, they contribute to human diets presently and offer a great potential for the future. Under certain natural conditions, wild animals produce more meat than livestock species. A great deal of research on wild animal biology and diseases is required and there also is a need for more attempts to domesticate new species that are better adapted to tropical conditions than existing species of livestock.

### 9.6.3 *Need for Disease and Pest Control*

Animal diseases and pests constitute one of the most important limitations to animal production in Asia, Africa, and Latin America. Epizootic diseases, capable of debilitating or destroying large livestock populations, still exist. The most important epizootic diseases are rinderpest, contagious bovine pleuropneumonia, foot-and-mouth disease, African horse sickness, African swine fever, hog cholera, Newcastle disease, fowl plague, trypanosomiasis, East Coast fever, and piroplasmiasis. It will be impossible to develop productive livestock industries until these diseases can be controlled better. Parasitic, infectious, nutritional, toxic-metabolic, and organic diseases also cause large losses by killing animals or reducing their productivity.

Animal diseases cause significant wastage of valuable animal protein. Based on FAO estimates, *a 50 percent reduction of losses from animal diseases in the developing countries, which is a realistic goal, would result in a 25 percent increase in animal protein.* Prospects for controlling most of the major livestock diseases are very good, provided agriculturalists and political leaders decide to invest the necessary effort and money.

### 9.6.4 *Animal Nutrition and Livestock Management*

Inadequate nutrition is also an important cause of low production of animal protein. Adequate quantities of essential nutrients must be provided to livestock during all seasons of the year for efficient production. Improved systems of harvesting, preserving, and storing plant materials must be developed to feed animals during seasons of reduced plant growth caused by cold weather, drought, and other environmental changes. Substantial proportions of the agricultural land of Asia, Africa, and Latin America are grazing lands. The productivity of these lands could be increased enormously by the use of improved techniques of pasture and range management.

Much research is needed on tropical forages and tropical range management. Although the principles of forage and range management from temperate regions are useful guidelines, so little is known

about effective techniques for tropical areas that large testing programs are essential to success.

Livestock can utilize for food a wide variety of wastes or by-products of agricultural and industrial operations. At present, many of these feedstuffs are not being utilized at all. Residues from food grains such as corn, wheat, rice, sorghums, oats, and barley are useful feeds. Vegetable wastes, sugar beet by-products, cottonseed meals, gin wastes, extracted sugar cane (bagasse), spent brewery grains, and molasses are suitable for animal feed. Animal by-products, such as meat scraps, fats, tankage, and bone meals, and even certain animal manures can serve as sources of food. Oilseeds, such as peanuts, sesame, safflower, soybeans, as well as palm and coconut products, are highly nutritious and are often wasted or used as compost in developing countries. Even residues from fruit processing industries can be used in animal feeds.

Urea can be utilized in protein synthesis by rumen bacteria and, if it is used in feeds, urea can fulfill some of the requirements of ruminants for dietary protein. Wider use of this chemical would reduce requirements for protein in some animal feeds.

There is need for greater use of new tropical breeds of livestock and the breeding of additional strains of livestock that are resistant to the climate and diseases of the tropics.

A livestock *industry* depends on adequate marketing, processing, distribution, and transportation systems and on the availability of manufactured inputs and livestock services. Adequate incentives, government policy, and land tenure systems favorable to livestock production are needed just as they are for increasing crop production. An understanding of traditions and social, political, and cultural factors that influence progress in development of the livestock industries is necessary also.

### *9.6.5 Needed Education and Research*

There is a critical shortage of trained and experienced manpower in the sciences and technologies underlying animal production in the developing countries. Existing schools which offer training at the professional level in veterinary medicine and in animal husbandry must be strengthened. Additional schools should be developed as the resources to do this become available. There is a great need to expand subprofessional education to provide manpower to implement extension and regulatory animal science programs as well as to supply support for commercial enterprises. Vocational training in animal husbandry should be expanded to develop widespread understanding of scientific livestock production by the individuals that manage and service farm livestock operations.

Knowledge of the biology, diseases, and husbandry practices of animals in the tropics is meager. Much research on animal diseases and parasites, feeds and forages, animal nutrition, physiology of animals, animal breeding (including the development of heat- and disease-resistant strains of livestock), and husbandry practices will be required to bring tropical animal production up to modern standards. Animal production and disease research centers should be established in the humid and the dry tropics and at least one center should be devoted primarily to research on epizootic diseases.

The developing countries should be provided with technical assistance in the development of livestock extension and regulatory programs. Particular attention should be given to encourage the participation of the private sector. In addition to supporting their own commercial interests, the private sector can be highly effective in livestock extension programs.

Education of foreign students in the animal sciences in the United States should be made relevant to the needs of their countries. Thesis research should be on problems pertinent to the situations existing in their native lands. The most justifiable situation for bringing these students to the United States is often related to learning new techniques for research and observing their application. Programs are needed for the education of American students who wish to enter careers in international livestock development. Following the acquisition of specific disciplinary skills, knowledge of the processes of international development, and an understanding of the social, cultural and political aspects of the region in which they will work, overseas tutorial experience with a skilled and experienced livestock development expert should be provided. It must be made possible for a university that wishes to engage in international livestock development programs through its School of Veterinary Medicine or Department of Animal Science to make long-term commitments to these programs so that members of their faculties can develop careers in international livestock development.

#### *9.6.6 Future Prospects*

The possibilities for future expansion of animal protein production in Latin America, Africa and the Near East, and Southeast Asia are very good. The problem is more complex in India and Pakistan, but, even in these countries, substantial increases are possible. At the present rate of development of world livestock production, the per capita supplies of animal protein are expected to increase until about 1990. The development of animal programs in developing countries could be accelerated considerably if this objective were accorded priority in planning.

## 10.0 RESEARCH AND EDUCATION<sup>1</sup>

Research and education at a greatly expanded level are absolutely imperative to provide the basis for increasing the production and utilization of food with high nutritional quality and for further development and implementation of family planning. Insufficient understanding of this fact has limited technical assistance from the more advanced nations. Support is hampered by short-sighted national policies and lack of national commitments.

One reason that some developing nations have failed to recognize research needs is that, in the past, the clearing and cultivation of new lands has provided them with new sources of food. For most of the world's hungry, however, new lands are scarce or nonexistent. Improvements in technology brought about by research and education are required to increase yields on the land now in use.

Some who are concerned with the world food problem reason that high-level technology of developed nations can be applied directly in the developing countries. Only in a few cases is this correct. Plant varieties, animal breeds, and farming practices must be developed for each environment. Most of the developing nations have climates, soils, cropping systems, and harvesting, processing and marketing techniques vastly different from those in the United States and Europe. Under these circumstances, technology cannot be transferred without extensive adaptive research. The misconceptions of "know-how, show-how" must be erased.

Although educational levels in less developed countries are quite diverse, certain common deficiencies exist. Most of the rural and farm populace cannot read or write. Of the small portion of the total population of children who start to school, many drop out after a few years with only a small percentage continuing to an effective level of education.

Little direct help for food, agriculture, and nutrition comes from secondary and university general educational programs as these are highly academic and attract mostly non-rural students. Important as an academic orientation is in training agricultural students, it is inadequate when it fails to focus on the food-population problem.

Students sent abroad to the United States and Europe are interested mainly in traditional arts and sciences rather than in studies relating to food and agriculture. Similarly, few scientists and students sent

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<sup>1</sup> See Vol. II, Chapter 12.0.

from the United States to the developing countries are concentrating on the food-related areas.

The net result of all these educational deficiencies is a near void of trained and educated manpower in many of the developing countries. Illiteracy limits the masses to the simplest tasks and greatly reduces their opportunity to learn. The shortage of teachers, technicians, and other vocationally trained people is acute. Scientists and engineers often must be imported from the more developed areas.

Research is among the activities greatly handicapped by manpower shortages. The level and quality of research on food, nutrition, and population is closely related to the quality of education. Low salaries for personnel, inadequate support, and poor facilities have likewise limited the quantity and quality of research.

During the past 25 years, the United States and other developed countries have contributed scientific personnel and financial support to a variety of programs in an attempt to help improve food production in the developing nations. In general, however, these technological and scientific inputs have been quite inadequate. Programs have lacked continuity, organization, and long-range planning. Also, they have failed to obtain institutional commitments essential for staff and program quality. Because of these and other deficiencies, help from the developed world has had little effect on crop yields or food quality.

Intensified extension efforts have been made in recent years to motivate farmers in the developing areas to adopt new and improved practices, but most of these efforts have failed. In some cases, they failed because research has not provided improved practices. In other instances, farmers lacked confidence in the extension specialists or social or economic incentives were not sufficient to encourage change.

Although many research and educational programs have provided less than the desired benefits, notable exceptions exist. These give hope for the future progress and provide guidelines for program development.

In a pilot program in Italy, television has been used to teach large numbers of illiterates to read and write. This was done at a fraction of the cost of the conventional classroom approach. In other countries, films, radio, and comic strips are being used to communicate information on food, nutrition, and family planning. Initial successes suggest that these innovative techniques deserve extensive trial as they could provide the needed tools for breakthroughs in general and extension education. Successful research and training programs in Mexico and other Latin American countries have demonstrated the value of continuity and of long-range funding and planning.

The successful development of regional or international research and training centers has been demonstrated. The International Rice Research Institute in the Philippines, the International Maize and

Wheat Improvement Center in Mexico, and the Institute of Nutrition in Central America and Panama are examples. Again, initial successes should motivate expansion of these techniques to a limited number of selected problem areas elsewhere in the world.

The need to first understand the social patterns through which farmers can be motivated has been demonstrated in pilot programs such as those in Peru and East Pakistan. The need to involve farmers in extension to foster social and technological change is best illustrated by the program in Taiwan. Lessons from these innovative programs can and should be used elsewhere.

The development of indigenous institutions for education and research should continue to receive high priority. Long-range funding must be available to permit universities to work effectively with their overseas counterparts. Selected indigenous institutions should be improved to provide education and training for surrounding countries with similar ecological and social problems. This should minimize the need for sending students to the United States or Europe.

The research which has already been done and the better public understanding offer encouragement in realizing the potential for long-range family planning. Extensive educational programs must be implemented in order to inform the public and create an interest in family planning. An educated public is required if financial support is to be obtained for basic research to further the development of new and better methods of birth control.

The ultimate, long-term success of research and education resides with the countries in which these activities are carried out. The United States and other developed nations must of necessity contribute significantly in the initial stages of cooperative research and educational programs. As rapidly as the recipient nations improve their competencies and capabilities, they should assume the responsibility and leadership for their own research and educational programs but continued cooperation should be encouraged with scientists and educators from developed countries.

## 11.0 THE ROLE OF PRIVATE ENTERPRISE

Discussion of foreign aid in general, and, specifically, the world food problem during the past decade are replete with references to the necessity of enlisting private industry. This has been a recurring oratorical theme in connection with United States foreign assistance and with the programs of the FAO. Despite numerous indications on the part of the "business community" of a great willingness to respond to and cooperate with United States governmental initiatives, most involvement of American industry has remained at the "talking" or advisory stage. There has been only a small engagement of American industry in economic development or technical assistance *within the framework of the official foreign aid program of the United States.*

This does not mean, of course, that American industry has hesitated, where conditions warranted, to extend its regular commercial enterprises into other countries. To the contrary, there has been an expanded overseas activity of all types with the resultant accumulation of an enormous volume of experience in dealing with foreign governments and with customs and traditions of trade that are very different from those in the United States. The involvement of American industry in other countries has occurred spontaneously, because it is "good business," and has not been part of any coordinated, long-range plan for systematic alleviation of the economic problems which beset the developing countries. Indeed, many of the countries that need capital most urgently have been largely avoided by American businessmen simply because the existing investment climate is so dismal relative to the opportunities for expansion elsewhere. In those countries such as Taiwan, Mexico and the Ivory Coast, which have provided a satisfactory climate for private enterprise, rapid and innovative contributions have been made to the economy.

While this discussion of private industry and the world food problem will be limited to "agri-businesses" or "agri-support" activities, the principles involved are essentially the same for any industrial engagement in aid programs designed to stimulate economic development.

The difficulties experienced in mobilizing the resources and skills of American firms as a coordinated and relevant segment of our foreign aid program are largely attributable to two factors. The *first* is the inability of the responsible government agencies to portray the needs (and opportunities) in terms that are meaningful or opera-

tionally relevant to business, where long-term planning is extremely important. The *second* is the rather obvious fact that, despite accumulation of overseas experience since World War II, industry has not really been engaged in overall economic development and, to be effective, must be informed better about what is included in this broader context.

A recent, perceptive analysis of the possible role that American food processing firms might play in economic development (again, the principles apply to other industries as well) summarized the situation:

However, no U.S. company can be expected to undertake operations which do not provide a fair return to the stockholder. As great and growing as the need and potential market are, food processing in the developing world is still a risky business . . .

The U.S. food processing company going into a developing country is, of course, eligible for guarantees extended by the Agency for International Development of the U.S. Government against expropriation, convertibility of currency and "business risks." But these are essentially negative guarantees which, in the opinion of the leaders of the United States food industry, are inadequate to meet their needs.

The fundamental issue really boils down to two questions:

1. How important is it to the government and people of the United States that the food processing industry offer its managerial skills and technical competences to the developing World?
2. What is the order of priority? (Plainly, if it were important enough, it could be done on a far larger scale than at present.)

Questions such as these are peculiarly difficult for Washington to handle because of the nature of the bureaucracy, which is so highly specialized along traditional lines that it tends to be insensitive to new and integrative problems. The world food crisis, for example, is the concern of the Department of Agriculture. The Agency for International Development also has an interest, since it directs our program of aid to developing countries, including the promotion of U.S. private investments in them.

However, because both of these agencies are essentially technically oriented, they are mainly concerned with projects and programs to achieve specific material results. Their programs include shipments of U.S. food to hungry nations and the provision of technical assistance to help them improve their agriculture . . .

While, in the case of AID, in recent years there has been a slight shift in this regard, its programs are still largely judged according to their technical and material impact . . .

American managerial genius has to be plucked from the administrative slot into which it has fallen by virtue of tradition and jargon. It has to be looked at for what it is—namely, an extraordinary resource for:

- (a) The organization, synthesis, and integration of disordered communities.
- (b) The more efficient production, preservation, distribution, and marketing of an item which is not only growing critically scarce, but without which survival is impossible."<sup>1</sup>

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<sup>1</sup> Lodge, G. C., Food processing—key to economic development, Harvard Business Review, Sept.-Oct. 1966, p. 4.

In considering what private enterprise could do in helping to increase food production within the developing nations, three different, but related functions can be identified:

1. Establishment of branches or plants in developing countries to supply products (fertilizers, pesticides, and machinery) and to function in support of agricultural development in much the same fashion that industry does anywhere in the world.
2. Undertaking project activities such as training managerial personnel for a country or of making market surveys. This could be done without venturing capital, creating any risk for stockholders, or making any long-term commitment to locate within the country.
3. Fostering modern business practices within the private sector of a developing country either by direction (through the use of managerial teams) or by indirection (by setting an example within a country).

The private enterprise community and, in particular, the agri-business group of companies which includes fertilizers, agricultural chemicals, implements, seeds, irrigation equipment, food processing, and food marketing companies, have shown a responsible interest in participating in the war on hunger. To take advantage of this reservoir of interest and purpose, the Federal Government must accelerate its already considerable efforts to work with the private sector in the developing countries. Beyond the present measures of liberalized loan policy, investment guarantees and other facilitation of investment, bolder measures should be taken for partnership with the private sector of industrialized nations.

A fuller appreciation of the full-range of analytical, programming and productive skills of the agri-business community is required by government policy-makers as well as by the regions and Missions of AID. New ways of involving the private sector's analytical and programming skills in country mission agricultural planning must be found. From such augmented planning of a country's agricultural needs, consortia can be created to provide a total systems approach to a nation's agricultural development, working in concert with United States technical assistance (government and academic), with foundations, and with local extension and university programs. The private sector can provide the profit-making engine, around which the other skilled resources can be deployed, for a concerted attack on agricultural problems ranging from inputs of fertilizers and seeds through the marketing of finished products to the consumer.

An information service is needed to provide industries with data on the requirements for private industrial projects and plans in foreign countries. The Federal Government must be concerned with this pro-

gram and make it possible for firms to get information that is within the jurisdiction of many Federal Departments. The Department of the Treasury is now the source of information about duties and quotas. The Department of Commerce must grant licenses for trade with certain countries and the repatriation of earnings is handled through the Department of State. The Department of Agriculture has information on farm products, but the information on commodities, such as fertilizer, can be obtained from the Department of Commerce. Information about the financing of exports may come from the Export-Import Bank.

With the interest in and need for United States industrial involvement in research and development in the developing countries, the Panel sought to determine:

1. The extent of present research and development activities related to food and nutrition.
2. The extent to which companies might be expected to participate in research and development activities related to food and nutrition.

Data were compiled from a survey of the membership of the Agricultural Research Institute. A questionnaire containing 11 questions was sent to the 85 members of the Institute and 71 replies were returned. (The questionnaire and an analysis of the replies are recorded in Volume III.)

Almost half of the members replying had no research and development activities in foreign countries and, furthermore, these companies indicated they had no interest in starting research and development work overseas. On the other hand, more than 80 percent of the companies now conducting research and development indicated they would undertake a program in a developing country if the program were supported by the Federal Government.

The survey indicates that the agricultural industries presently involved in international operations are likely to be the representatives of the private sector in any expanded program that might be encouraged by this Government. It was also indicated those United States firms already operating in foreign countries are likely to expand their operations abroad as a response to increased stability of foreign governments and to reasonable assurance of a financially successful operation.

Industries concerned with food and chemicals, particularly fertilizer, led among the wide range of businesses reporting. More of these companies operated in Europe than any other area with Latin America the second most frequent location. Thirty-four firms had 335 research and development personnel employed in Europe including the United Kingdom or about three times the personnel complement reported in Latin America. The firms responding had personnel in Can-

ada and countries in Oceania, but there were relatively few personnel in all other foreign countries. For example, there were only 16 in Asia, excluding Japan, and only 12 in Japan.

*Lack of trained manpower* was cited most frequently as the major deterrent to expansion of commercial operations in developing countries. In spite of this, only a limited number of foreign students are being trained. The survey showed a total of 48; 22 in foreign universities and 26 in United States universities. American industries also supported only a small amount of research and development work in foreign public and private institutions. The total was about 26 man years. Whether this is due to the lack of available research workers or to some other factor was not determined from the survey.

American industry can assist in a training effort, but the governments of the developed and the developing nations must provide financing for training programs. The lack of sufficient numbers of adequately trained personnel is likely to become a much more acute problem as more resources are needed to meet increased needs for food production.

The companies currently operating overseas plan to expand their research and development activities. About half indicated expansion of 50 percent or more by 1976. But, from other information obtained from the survey, it is evident that most of the expansion will be within the developed countries.

## 12.0 SOME NEWER TECHNOLOGIES AND THEIR APPLICATION TO FOOD PROBLEMS

The use of technology has increased greatly in our society. Techniques which seemed fantastic ten or twenty years ago are now used routinely or appear promising. This section describes three examples of new possibilities which may increase our food resources in the future: weather and climate modification, the use of satellites, and resources inventories.

### 12.1.0 *Weather and Climate Modification*<sup>1</sup>

Weather, the short-term changes in atmospheric conditions, and climate, the long-term averages of atmospheric conditions, are obviously of vital importance in the production of food. Our recent improved understanding of cloud physics and of atmospheric processes has given rise to the hope that man can modify weather conditions to his advantage.

Weather may be modified by "triggering" instabilities already present in the atmosphere. The presence of super-cooled water in the atmosphere is the major instability which has been exploited in recent years. Small water droplets are unstable below the freezing point and should become ice. However, without nuclei, these droplets remain liquid well below the freezing point of water. The introduction of nuclei can cause crystallization and the release of latent heat of fusion. The heat released can cause the air to rise, cooling it, thus forming more droplets and causing the crystals to grow large enough so that they fall as rain or snow. This technique has been used to clear cold fog at airports, and it appears that under certain conditions precipitation from clouds can be increased in the temperate zone.

The technique is being tested in extensive experiments in the western United States. There is evidence that, under some conditions, the snowpack can be increased which would be beneficial in dry seasons.

Experiments in tropical latitudes have been aimed particularly at the modification of hurricanes. Although the mechanism is not completely understood, induced condensation may cause tropical cumulus clouds to rise spectacularly. This "blow up" condition might lead to increased rain or to spreading hurricane energy over a wider area.

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<sup>1</sup> See *Weather and Climate Modification: Problems and Prospects*, National Academy of Sciences Publ. No. 1350, Washington, D.C., 1966.

Before weather modification can become operational, it will be necessary to cope with legal and other problems. At present it appears that increased precipitation in one area does not reduce rain downwind, at least for a distance of 300 to 500 miles. Longer range effects may be present and must be studied, however.<sup>2, 3</sup>

Climatic modification has occurred in the past for reasons that are not understood. In addition to the great changes that occurred in the ice ages over geologic time scales, there have also been very significant changes as recently as 500 B.C. As we understand more about the balance of radiation, there is concern over the effect of increased atmospheric carbon dioxide on the general levels of temperature of the earth's surface.

It is conceivable that man's activities can also have an effect. For example, spreading carbon black over the Arctic ice pack has been discussed as a means of changing the radiation balance. It seems unlikely that such far-reaching attempts to change weather will be undertaken in the future because of our inability to foresee the consequences.

### *12.2.0 Satellite Technology*

The advent of satellites gives an opportunity to accomplish studies on a global scale which were inconceivable a few years ago. This unprecedented opportunity has been used in some operations and the use of satellites is growing.

Meteorological satellites today are photographing global cloud distribution, observing the birth and movement of tropical storms, and are used daily in improving weather forecasts. To the extent that these techniques will improve weather forecasting, they will have a significant effect on food production.

Satellite use will probably increase markedly if the development program for a World Weather Watch becomes effective. This system employs free floating balloons and buoys to measure atmospheric variables. The information obtained will be transmitted to passing satellites which interrogate the balloons and buoys to transmit to ground stations. If the program is successful, a significant improvement in weather forecasting will result, and this will have a profound effect on agricultural planning.

A report prepared by Stanford University<sup>4</sup> estimated the poten-

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<sup>2</sup> "Plan to Develop Technology for Increasing Water Yield From Atmospheric Sources", Bureau of Reclamation, U.S. Department of the Interior, Washington, D.C., November 1966.

<sup>3</sup> Weather and Climate Modification, Report of the Special Commission on Weather Modification, NSF Pub. 66-8, National Science Foundation, Washington, D.C., 1966.

<sup>4</sup> "SPINMAP, Stanford Proposal for an International Network for Meteorological Analysis and Prediction", Stanford University, Palo Alto, June 1966. (The Agricultural Summary from SPINMAP appears also in "The National Space Program—Its Values and Benefits", Committee Print, Committee on Science and Astronautics, U.S. House of Representatives, U.S. Government Printing Office, Washington, D.C., 1967.)

tial benefits to agriculture that might result from the development of a capability to make an accurate two-week weather forecast. These results are presented in Table 12-1. The benefits on nine selected crops amounted to more than \$3 billion.

In addition, satellites can be used eventually to map resources.<sup>5</sup> Aerial photography and infrared sensors are now able to measure crop distributions, observe when crops should be harvested, and locate diseased trees and salty soil. The information may be easier to obtain with satellites although the cost-benefit relationships of this technology and aerial surveys must be determined. In the future, these developments are likely to have far-reaching effects on agricultural production.

TABLE 12-1.—*Agricultural benefits from accurate 2-week weather forecasting by country, in millions of U.S. dollars (assumed percentage benefit equals 5 percent of all crops)*

Country	Corn	Wheat	Rice	Coffee	Grapes	Sugar	Bananas	Tomatoes	Cotton	Crop total
France.....	10.0	34.0	0.3	-----	45.0	-----	-----	0.6	-----	89.9
Italy.....	9.5	25.0	1.5	-----	46.0	-----	-----	4.4	-----	85.4
U.S.S.R.....	65.0	-----	0.7	-----	15.0	-----	-----	-----	0.5	81.2
Canada.....	2.3	60.0	-----	-----	0.2	-----	-----	0.5	-----	63.0
Mexico.....	16.0	6.0	0.7	6.5	0.4	10.0	1.8	0.75	-----	42.2
United States.....	260.0	9.5	8.0	0.3	17.5	10.0	-----	7.0	1.0	313.3
Argentina.....	13.0	34.0	0.45	-----	12.0	5.0	0.35	0.4	-----	55.2
Brazil.....	19.5	1.2	15.0	80.0	2.5	32.0	-----	0.75	0.2	151.2
India.....	11.5	32.5	81.0	3.5	-----	50.0	-----	-----	0.3	178.8
Thailand.....	2.3	-----	25.0	-----	-----	2.0	4.0	-----	-----	33.3
Japan.....	0.3	2.1	43.0	-----	0.9	0.2	-----	0.6	-----	47.1
Ivory Coast.....	0.4	-----	0.5	12.5	-----	-----	0.85	-----	-----	14.3
Kenya.....	0.2	0.5	-----	2.2	-----	2.0	-----	-----	-----	4.9
United Arab Republic.....	4.3	5.0	-----	-----	0.5	2.0	-----	1.5	-----	13.3
Australia.....	0.4	27.0	0.3	-----	3.2	6.0	0.7	0.2	-----	37.8
Total, 15 nations.....	415.0	227.0	177.00	106.0	142.0	119.0	7.70	17.00	2.0	1,211.0
Estimated world benefit.....	1,100.0	750.0	625.00	200.0	250.0	150.0	110.00	25.00	3.0	3,213.0

### 12.3.0 National Resources Inventory

The Engineer Agency for Resources Inventories was established in the Geographic Branch of the Office of the Chief of Engineers, U.S. Army, in 1963 with a threefold mission:<sup>6</sup>

1. Acquire, catalog and reference resources data.
2. Prepare resources inventories.
3. Assist the Agency for International Development by the preparation of analytical studies and supplying source data,

<sup>5</sup> Earth Resource Surveys from Spacecraft, Vol. 1, Space Applications Programs Office, National Aeronautics and Space Administration, Washington, D.C., 1967.

<sup>6</sup> Information supplied by Mr. Dickran Y. Hovsepian, Chief, Geographic Branch, Office Chief of Engineers, U.S. Army.

and to provide these data on request to other organizations or institutions.

The Inventory may be divided into two phases:

1. *The General Inventory of Physical Resources.*
2. *The Detailed Inventory of Physical Resources.*

The General Inventory of Physical Resources is an overview of all significant data required for general planning for a given country or region. It is designed to provide country planners, non-technical personnel involved in program development, and high-level individuals concerned with policy; the bases for decisions relating to national planning and programs. It includes information on natural and man-made features such as: soils, vegetation, mineral and water resources, geology, existing and potential land use, sociological and population factors, transportation, utilities, industry, institutions, urban areas, climatological data, and other information. The Engineer Agency has contacts with 70 institutions and libraries in the United States, many in-country agencies, and various international bodies.

In the production of inventories, researchers in the Analysis and Evaluation Branch first use the information identified and located by the Reference Branch. The data are formatted at a common map scale best suited to the size and shape of the study area, and supporting textual and tabular data are prepared. The base map is selected in consultation with the host country, the AID Country Mission, and other organizations which might be involved. The initial compilations reflect areas of strength, weakness, or absolute gaps.

The analysts then proceed to the country of study with the compilations. There they work with host country personnel in the various governmental agencies concerned, with AID consultants, and with representatives of the UN and other international organizations which may be active in the region. In the case of El Salvador, the inventory represented the joint efforts of the Engineer Agency for Resources Inventories, several other United States agencies, 24 agencies of the Republic of El Salvador, and six international organizations.

The analysts use all sources to the maximum extent possible to supplement the initial compilations. All materials are then returned to the Engineer Agency where the professional staff uses the newly acquired and often unpublished information to strengthen or possibly revise the existing compilation.

The second compilation is returned for review by the host government agencies and the AID mission. In the case of Central America, the Secretariat for Economic Integration of Central America (SIECA) and the AID Regional Office for Central America and Panama (ROCAP) also review the materials. Any new data, not previously used, are incorporated at this stage.

The organizations and the Engineer Agency arrive at agreements that the materials as finally compiled are as complete and current as can reasonably be expected. The Technical Support Branch of the Agency then prepares the inventory for publication. In the case of Latin American studies, the inventories are published in a single-volume, bilingual, Spanish-English form.

In Latin America, the Engineer Agency has completed inventories on the Republics of El Salvador, Costa Rica, Honduras, and Nicaragua. In preparation are inventories on the Republics of Guatemala, Panama, Venezuela, and a regional, single-volume inventory on the six Central American countries. In the Far East, the Mekong Resources Atlas should be completed next year.

These inventories are new and significant documents for the developing countries. They are important tools to assist in accomplishing national and regional planning and to achieve national objectives. For the first time, policy-makers, planners, and others have the same composite, comprehensive document to serve as a standard base in national planning for each country and for regional action.

## 13.0 ECONOMIC IMPLICATIONS <sup>1</sup>

### 13.1.0 Need and Demand

The Panel's projections, based upon demographic and nutritional analyses, indicate that total food consumption in the developing countries must approximately double during the period between 1965 and 1985 if the critical physiological needs of rapidly expanding populations are to be met. Increases in food production, however, are not stimulated by physiological and nutritional *need* alone. As is true of industrial production of any type, the rate of increased production in the agricultural sector is determined by effective market *demand*. In other words, it costs money to produce food just as it costs money to produce any other commodity and someone must pay the bill for an increase in output.

In any national economy, there is a definable relationship between the demand for food and overall income. This parameter is the so-called *income elasticity of demand for food* and is an expression of the percentage change in food demand as a function of the change in total income (Gross National Product, GNP). If a 10 percent increase in GNP is followed by a 6 percent rise in demand for food, the income elasticity of demand for food is 0.6. If one knows income and elasticity of demand, one can calculate the effective market demand for food.

Ordinarily, then, economists look upon food demand as being causally dependent upon the level of income. A low level of income generates a low effective demand for food. If this approach is taken, no world food shortage can ever exist in a *strictly economic* sense. However, a world food shortage in a nutritional sense *can and does* exist.

The Panel, therefore, of necessity, has quite literally reversed the usual economic approach by first estimating the food shortage and setting a future goal for food production. The next step was to calculate the rate of change in income that will be required to generate the effective market demand for the calculated nutritional needs.

There is a strong interdependence between agricultural output and the total output (GNP) of a national economy. The demand and supply of foodstuffs, therefore, cannot be considered independently from overall economic growth if an analysis is to be meaningful. Nutritionally defined food needs have to be converted into effective demand which in turn requires purchasing power in the hands of the popu-

<sup>1</sup> See Volume II, Chapter 13.

lation. This necessitates balanced farm and non-farm (industrial and agri-business) growth and development as well as structural changes in income distribution which will place purchasing power in the hands of the nutritionally impoverished, lower-income 25 percent of the population.

The following data provide a basis for understanding the dimensions of the economic problems facing the developing countries.

	<i>Developed countries</i>	<i>Developing countries</i>
Population.....	1.0 billion.....	1.6 billion.
Population growth rate.....	1.3 percent.....	2.5 percent.
Per capita income.....	\$1,700.....	\$180.
GNP growth rate.....	3.0 to 4.0 percent.....	2.5 to 4.0 percent.
Per capita growth rate, GNP.....	1.7 to 2.7 percent.....	0 to 1.5 percent.

In terms of an individual's income, how much difference does a 4 percent GNP rise mean in these two situations? In the developing countries, on the average, it adds \$1 to \$2 yearly; in the developed nations, it adds about \$50 yearly. One's flexibility and choices increase little if his earnings rise but \$1 or \$2 per year.

### 13.2.0 Required Growth Rates

An aggregate analysis of the compound growth rates that will be required in the developing countries to achieve the effective *demand* for food to match the *need* for food by 1985 as calculated by the Panel is shown in the following tabulation:

	<i>Present</i>	<i>Required</i>
Increase in food demand.....	3.0%	4.0%
Increase in food production.....	2.7%	4.0%
Increase in GNP.....	4.0%	5.5%

To achieve such growth rates will require a massive effort which will have to be more successful than history has recorded in any previous period of two decades. Certain countries such as Mexico and Taiwan now have growth rates of the order deemed necessary. *A priori*, there is nothing to indicate that these growth rates are beyond the realm of possibility or feasibility.

Because of problems of balance of payments and because the developing countries are now importing a substantial portion of their foodstuffs (permitting consumption to rise at 3 percent per year while production rises at only 2.7 percent), production within these countries must rise sharply if the nutritional requirements are to be met by 1985. The Panel's study has shown that such an increase is biologically possible and that most of the increase, given proper research and production incentives, can come about by intensified production on crop lands already under cultivation. The crucial condition necessary for this to occur, however, is the existence of a strong demand

generated by rising incomes and accelerated rates of *total* economic growth.

### ***13.3.0 Required Capital Investments***

The Panel has made partial estimates, not verified by individual country studies, of additional investments necessary to accelerate agricultural productivity in the developing countries. The direct capital requirement for fertilizers, seeds, pesticides, and mechanization for a 4 percent growth in agricultural output is estimated to approximate an additional investment of more than \$300 million annually in the beginning, increasing to nearly \$4 billion annually by 1985. This estimate does not include direct investments in land or water nor does it include necessary direct "infrastructure" investments in power, transportation, credit, food processing, storage, and distribution. It appears that to achieve a 4 percent growth rate in food demand and food supply, capital investments must rise from 15 percent to 19 percent of the GNPs of these countries.

Are such investments and rates of total economic growth possible? The analysis carried out by the Panel is preliminary and indicative only. Data on unlike countries, of necessity, have been aggregated. Foreign exchange and other requirements have not been spelled out on an individual country basis. Intersectorial economic analyses of the major individual countries are needed and the Panel urges strongly that these be undertaken.

Nevertheless, the aggregate analysis and the experience of individual developing countries such as Mexico indicate that growth rates of the order suggested above are not beyond the range of possible attainment. *To reach the goal within the next two decades, however, will require a commitment on the part of developed and developing countries alike on a scale that has never before been achieved in peace time.*

## 14.0 ORGANIZING FOR THE TASK

There is one quality more important than "know-how . . ." This is "know-what" by which we determine not only how to accomplish our purposes, but what our purposes are to be . . . Whether we entrust our decisions to machines of metal, or to those machines of flesh and blood, bureaus and vast laboratories and armies and corporations, we shall never receive the right answer to our questions unless we ask the right questions.

—Norbert Wiener

### 14.1.0 Basis for Future Planning

After nearly a year of study of the World Food Problem, the Panel is unanimous in the belief that the solution of the problem will be crucially dependent upon the actions taken by the United States within the immediate future. We further believe that to have any chance of averting widespread starvation with all of its attendant misery and political upheavals a new, long-term, global policy is required that will address directly and effectively the massive task of alleviating this central problem of today's world. If an assault on the World Food Problem is deemed an objective of first priority, the United States will have to assume leadership of the free world and its international institutions in a coordinated, strategic program. Such a program would raise the economic level of the poor nations, thereby meeting the challenge of hunger, increasing world trade and economic activity, and moving ever nearer to that ultimate objective; the achievement of a lasting peace.

The urgent need for the United States to take the lead is nowhere better illustrated than in the attitude expressed in the so-called Jeanneney Report, a detailed review of France's foreign aid program:

The conclusion reached by the only approach to the problem which appeared possible was that it will undoubtedly be impossible to satisfy the needs of the Third World for aid. This being so, it has been considered here that the only problem was to determine how much it was possible for France to offer.<sup>1</sup>

While it is understandable that France or almost any other one of the world's developed nations might necessarily adopt this viewpoint, the Panel believes that the American people, once fully informed of the magnitude of the problem, will choose to embark upon a course that promises the successful achievement of a better life for all. It

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<sup>1</sup> French Aid, (A translation of the Jeanneney Report "La Politique de Cooperation avec les Pays en Voie de Developpement", 1963), Overseas Development Institute, Ltd., London, 1964.

is essential that decisions about long-range programs be taken with the best possible understanding of their implications.

### 14.2.0 *The Lessons of Past Efforts*

Much has happened since President Harry S. Truman enunciated Point Four:

Fourth. We must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas.<sup>2</sup>

Several of the original aims stated in that historic inaugural address are worth re-examining, now that nearly two decades have passed:

More than half the people of the world are living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant. Their poverty is a handicap and a threat both to them and to the more prosperous areas . . .

Our aim should be to help the free peoples of the world, through their own efforts, to produce more food . . .

We invite other countries to pool their technological resources in the undertaking. This should be a cooperative enterprise in which all nations work together through the United Nations and its specialized agencies wherever practicable. It must be a world-wide effort . . .

Only by helping the least fortunate of its members to help themselves can the human family achieve the decent satisfying life that is the right of all people.<sup>3</sup>

It is neither necessary nor appropriate to rehearse the detailed history of this country's programs of foreign assistance.

#### 14.2.1 *Genealogy of AID*

The following outline is helpful, however, giving perspective to the situation as it exists today:

- 1940 Lend Lease
- 1941 Board of Economic Warfare
- 1943 Foreign Economics Administration
- 1946 Institute of Inter-American Affairs<sup>3</sup>
- 1948 Economic Cooperation Administration<sup>4</sup>
- 1950 Technical Cooperation Administration<sup>5</sup>

<sup>2</sup> Inaugural Address, January 20, 1949.

<sup>3</sup> The Institute of Inter-American Affairs began as the Office for Coordination of Commercial and Cultural Relations Between the American Republics (August 16, 1940), shifted to State in 1946, and to FOA in 1953. It was wholly devoted to technical assistance. It lost its identity with the creation of AID in 1961.

<sup>4</sup> ECA was vaguely involved with capital and technical assistance to colonial possessions of the European powers in Africa and the Far East during the Marshall Plan days. With the phasing out of the Marshall Plan, the ECA staff transferred its energies to Africa and the Far East, providing a combined program of capital and technical assistance. For this reason, TCA, the Point Four Program agency, largely confined its attention to the Near East and Southern Asia.

<sup>5</sup> The Technical Cooperation Administration, within State originally, conducted technical assistance programs primarily in the Near East and South Asia. It lost its identity upon transfer to AID in 1961.

- 1951 Mutual Security Administration
- 1953 Foreign Operations Administration
- 1955 International Cooperation Administration
- 1957 Development Loan Fund
- 1961 AID<sup>6</sup>

It suffices to say that, since the Act for International Development was passed in May 1950, creating the Technical Cooperation Administration (TCA), there have been many successes and many failures, many surprises and many disappointments. Helping the emerging nations has proved to be immensely more difficult than had been anticipated at the start. When, in 1953, the Mutual Security Administration (a product of the Korean War) was combined with TCA to form the Foreign Operations Administration (FOA), military and economic assistance were merged and the ensuing years have seen increasing confusion, criticism, and disillusionment on that basis also. In 1964, I. W. Moomaw, former executive secretary of Agricultural Missions, Inc., wrote:

In the years since the beginning of Point Four, ten different directors have been in charge. Each sought to effect his own ideas for change. No other arena of governmental responsibility has been so frequently surveyed and changed. Eight Presidential committees have scrutinized it. Three Administrations have completely overhauled it. This created grave doubts overseas as to our intentions.<sup>7</sup>

Suggestions for simplifying the administrative structure for our economic assistance program have been frequent, both at home and from abroad. Well-intended advisors have generally failed to recognize how incredibly complicated are the many wide-ranging problems that must be dealt with when one undertakes to stimulate a traditional society to enter the modern world and to achieve sustained economic growth. One need only realize that an AID mission director and his staff must cope with such disparate problems as how to advance farming methods which have remained unchanged since biblical days, how to assure a potable water supply in a large city, or how to negotiate a loan in seven figures with the host government.<sup>8</sup>

Economic assistance personnel are advisors in the country which is the recipient of aid and when, with the permission of the host government, they make policy or exercise the power of decision, they do so under the control of that government. Success in accomplishing results often necessitates exerting authority or influence upon the government itself. If the sanction for this influence is a threat of with-

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<sup>6</sup> This simplified listing does not trace the surplus food programs administered for a period by Department of Agriculture, for a period by Department of Defense, nor other programs (such as the Atoms for Peace Program) that have ended up in AID. None of these programs had new agencies created to carry them out, but involved existing agencies or departments.

<sup>7</sup> Moomaw, I. W., *The Challenge of Hunger*, Frederick A. Praeger, Inc., New York and London, p. 36, 1966.

<sup>8</sup> *Ibid.*, p. 194.

drawal of economic assistance, the suspicion that they are acting with the interests of their own national government is aroused. "Neocolonialism" is likely to be charged to any nation which participates in the social structure or daily life of a developing country. "Neocolonialism" is merely another way of implying that the rich always exploit the poor and that all apparent altruism is ulteriorly motivated. It is impossible to ignore the existence of this attitude in recipient nations because it can easily vitiate all attempts to help. The avoidance of the situation is much easier if one knows clearly and exactly what is being denounced. This implies the need for careful records concerning activities and projects and a compilation of a permanent record of the searching evaluations of results of projects and programs.

It has become abundantly clear that no matter what system is employed for foreign assistance, a developed country cannot contribute substantially to the economic growth of developing countries without having a close relationship with them. This fact alone leads to suspicions and misunderstandings, to arguments and disagreements. These need not be regarded as serious in a specific instance unless it becomes evident that the relationship between the donor and the recipient is inherently at fault. When this becomes evident, the overall working agreement must come under mutual scrutiny.

It is this intrinsic difficulty of bilateral agreements that has led, through the years, to repeated suggestions of increasing the amount of aid from developing countries that is administered through multilateral agencies. While favoring an increase in multilateral aid, the Panel warns that existing international agencies will have to be reshaped if they are to carry the brunt of a program designed to solve the world food problem. Any major changeover, therefore, would involve a period of transition, during which time the United States would have to take a responsible lead in developing criteria, policies, and guidelines for multilateral programs.

#### 14.2.2 Full Cycle

Whatever the shortcomings, inadequacies, and difficulties of the United States foreign assistance program have been and no matter how bitterly it has been criticized and how often it has been second-guessed both here and abroad, one fact remains: *It still stands as a pioneering, humanitarian effort without parallel in all of history.*

The United States, unfortunately, has had to pay a high price for the many hard and practical lessons that have been learned in the course of an undertaking that is unique in the annals of human relationships.

Congressional authorization is now almost entirely on a year-to-year basis; budgets can be and are dealt with ruthlessly; and the annual

passage of the foreign assistance act has evolved into one of the most tedious and agonizing processes within the entire government.

A special chamber of torture is reserved in the capital for the man who runs foreign aid, and yesterday, it received its twelfth victim in fourteen years (David E. Bell).<sup>9</sup>

The comment of Mr. Eugene L. Black is more appropriate to the Panel's thinking:

If I could wish for David E. Bell one thing, I would wish for him to have a clear-cut contract for five years in order that he might have the opportunity to put into effect some of the improvements he wants to make.

The hard-won experience of the past two decades and the increasingly urgent problem of feeding the burgeoning millions in the underdeveloped countries, taken together, signal the need and the opportunity for a reorientation and expansion of the United States program of economic assistance. It is the Panel's unanimous opinion that our concern should be to mold a new instrumentality that will minimize the errors of the past and will enable the United States, in concert with other nations, to apply the knowledge that has been acquired through strenuous and dedicated effort.

The view that events in our foreign assistance effort have come full cycle is nowhere better supported than by the following two statements, uttered nearly 16 years apart.

Dr. Henry Garland Bennett, the first administrator of TCA, defined Point Four in 1950 as:

Simple, down-to-earth, self-help to assist other peoples to increase their food production, better their health conditions, and improve their educational system.

President Lyndon B. Johnson, in the State of the Union Message of January 12, 1966:

This year I propose major new directions in our program of the foreign assistance to help those countries who will help themselves.

We will conduct a world-wide attack on the problems of hunger and disease and ignorance.

### *14.3.0 The Reasons for Foreign Aid*

There are four distinct but related reasons for a United States program to assist overseas economic development:

1. *A humanitarian* reason which may be served by channeling additional capital, technical assistance, and food aid through international agencies. The increasing use of multilateral assistance is not a new idea, of course. The size and duration of the effort that will be required to cope with the problem of world food supply will necessitate a strengthening and restructuring of the existing United Nations agen-

<sup>9</sup> Evans, Rowland, Jr., *The New York Herald Tribune*, November 29, 1962.

cies, many of which are not geared to operational efforts on the scale that will be required. Bilateral effort should be maintained and expanded by the United States, particularly in technical assistance and in programs involving the private sector of this country. The willingness of United States universities and business firms to increase their activities in the developing countries will be better preserved and expanded through bilateral programs.

Such efforts should be planned on a basis of long-term *strategy*. Their continuity should not be subject to threat from episodic disagreements among nations and withdrawal or curtailment should not be employed as a United States foreign policy sanction except under the gravest of international crises. This program should operate with a five-year minimum authorization from the Congress.

Funds for bilateral aid should also include the assignment of counterpart commitments to ensure the participation of the private sector in foreign assistance. A goal of multibillion dollar investment by the private sector within five years should be established.

The agency or agencies charged with this aspect of the foreign economic effort of the United States must have a new capacity to measure economic and agricultural development and hence the food supply problem. It is essential to develop a system to examine all the elements required to deal with this complex situation and permit the drafting of coordinated programs to be carried on throughout the world. One way in which this critically important function could be accomplished would be through a non-profit planning organization. Such a group could undertake this task of measurement, appraisal, planning, programming and monitoring results. The extraordinary technological resources now available in this country can be creatively applied to this immense problem.

2. A *tactical foreign policy* reason, primarily for improving bilateral relationships. This could encompass the whole range of capital assistance and technical assistance. It could and should include the financing of projects intended for prestige (ranging from airlines to palaces). Foreign aid is not a substitute for diplomacy but it can supplement and enhance its effectiveness. The separation of these short-term "tactical" diplomatic functions from almost all of the strategic, long-range "humanitarian" programs would be desirable, but practically speaking, this would have to evolve over time and there will always be an inseparable overlap in what we have called tactical and strategic programs. Recognition of humanitarian purpose as opposed to diplomatic purpose does not imply that any final separation into two distinct programs is necessary or feasible

3. A *security* reason, relating primarily to the military aspects of national security. Military assistance, obviously, can also play a major

role in the bilateral relationships mentioned under diplomatic and foreign policy functions.

In a larger sense, humanitarian, long-range economic assistance will contribute to national and world security. The importance of insulating that (as opposed to strictly military) form of assistance is nowhere better described than in the words of Secretary of Defense Robert McNamara:

Our security is related directly to the security of the newly developing world. In a modernizing society, security is not military force—though it may involve it. Security is not traditional military activity—though it may encompass it.

Security is development.<sup>10</sup>

Again, the idea that security is more than military might is not a new one. Seneca, nearly two thousand years ago, warned the Roman Senate:

A hungry people listens not to reason nor is its demand turned aside by prayers.

4. A long-range *economic* reason, involving the eventual creation of additional markets for United States goods and products. This aim is not entirely self-serving for the achievement of sustained economic growth by the developing countries will be dependent upon their participation in world markets on a competitive basis.

This last goal of foreign aid has important implications for the inclusion of trade concessions in the humanitarian and strategic programs of assistance discussed above.

Trade adjustments which appear to involve immediate sacrifices may, in the longer view, be far less costly than capital assistance given in traditional fashion. It is highly likely, in most instances, that provision of export markets based upon competitive advantage will be a most effective stimulus to development.

All too often, the United States has seemed to regard economic assistance as a short-term relief to countries which are temporarily poor. The experience of the past two decades indicates that aid should become a part of a concept of the economic relations between unequally developed countries, which will last for many decades to come.

#### 14.4.0 Long-Range Commitment

In 1959, the Senate Foreign Relations Committee commissioned a series of studies by its own staff and by 12 leading foreign policy research centers in the United States on the subject of United States Foreign Policy during the decade of the 1960's. The resulting 13 major reports were summarized and synthesized by the Foreign Policy Clear-

<sup>10</sup> Excerpt from speech given by Secretary McNamara at Montreal, Canada, on May 18, 1966.

ing House. In the summary of Economic Assistance Policy, the major reports were unanimous in stating:

*The United States must encourage the emerging states to formulate long-range plans for balanced economic, political, and social growth . . .*

*The importance of long-range commitments of American aid is difficult to over-emphasize. Unless underdeveloped countries can count on receiving continuing assistance from the United States and other donor nations, they cannot make effective long-range plans for their economic growth. It is therefore vital that the United States operate its economic assistance program, first, to establish the principle that aid to underdeveloped countries will be given for the foreseeable future, and, second, to make specific financial commitments for a number of years ahead so that the states can confidently plan on outside aid in mapping their development programs.<sup>11</sup>*

If a single conclusion can be drawn from this study of the World Food Problem, it is that the solution of the problem will be dependent upon long-range *continuous* programs of both capital and technical assistance from the United States and from the other developing countries of the free world. Without claiming to have discovered such an obvious fact, the Panel reiterates it in the strongest terms and warns again that the time for decision is now.

From the point of view of donors and recipients and of planners and implementers and for the sake of ultimate success, long-term commitment of substantial resources is an absolute necessity. *The fallacious notion that foreign aid's main business is to put itself out of business should be dropped for the remainder of this century. All programs based upon this thesis have succeeded only in proving otherwise.* Where one program of assistance has terminated, others have had to take over. The signal of success should not be the "pull out;" the criterion might better be changed to the "output." The Panel is unanimous in agreement with the following statement by M. J. L. Dols, the eminent Dutch scholar, made at the World Food Congress in Amsterdam in 1962:

Funds for economic aid can no longer be viewed as charity, but our bounden duty to this period of history. Those who speak of our spending the next 50 to 80 years at the job may be more realistic than the year-to-year planners.

The Panel believes that the Congress would be more receptive to a program which includes a long-term commitment which specifies the several objectives of foreign aid and provides mechanisms for their accomplishment. The nature of the long-term commitment that will be required if the world food problem is to be faced realistically has

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<sup>11</sup> Cerf, J. H. and Pozen, W., "Strategy for the 60's", (Prepared for the Foreign Policy Clearing House), Frederick A. Praeger, Inc., New York, pp. 4-5, 1962.

nowhere been portrayed more vividly than by Dr. F. F. Hill, for ten years Vice President of the Ford Foundation :

Countries threatened by food crises need *emergency research teams* from the U.S. for at least the next ten years.<sup>12</sup>

### 14.5.0 *Technical Assistance*

Particularly in the field of agricultural development, but by no means limited to this sector, technical assistance is essential to achieving the ultimate objective of foreign aid, namely, self-sustaining economic growth.

The summary of the reports on foreign policy commissioned by the United States Senate Committee on Foreign Relations has this to say about this form of assistance :

In addition to the need for capital, the reports stress the *importance of the American technical assistance program*. Technical assistance is much less expensive than the granting of capital, yet it can play a vital role in the development process. The reports urge that the United States broaden its technical assistance program and gear it to the particular needs of each state. U.S. technical assistance should . . . develop to the fullest the human resources of the recipient country . . . offer opportunity for many groups in the society, not just the urban elite, to participate in the urbanization process . . . help create the laws and institutions required by an industrial society . . . adapt modern skills and technology to the physical, social, cultural, and economic conditions of the recipient country . . . lay an effective basis for future cooperation.<sup>13</sup>

#### 14.5.1 *Difficulties*

Technical assistance has suffered from four difficulties :

1. It is *inexpensive in relation* to capital assistance programs involving large sums and, consequently, it tends to be "lost in the shuffle". This somewhat paradoxical fact, that technical assistance is pushed into the background by its relatively low cost, is discussed later for it has important implications in the organization of foreign aid.
2. It is a *very difficult job*. It has taken, quite literally, nearly two decades of trial and error to discover what the requirements for overseas technical assistance are and how the duties of an engineer, an agronomist, or a physician overseas differ from those he performs in the very different environment of the United States.
3. It *requires a long time* for technical assistance to be effective. Furthermore, the criteria for successful technical assistance programs in foreign aid are far less clear and the accomplishments far more difficult to portray to those who make funds available than are the end-results of capital assistance projects.

<sup>12</sup> American Farm Economics Association Meeting, New York City, December 1965.

<sup>13</sup> Cerf, J. H. and Pozen, W., "Strategy for the 60's", (Prepared for the Policy Clearing House), Frederick A. Praeger, Inc., New York, p. 5, 1962.

Failure to allow for the length of time required for technical assistance to produce results has caused frustration among individual technicians and professionals, among educational institutions which have contracted with AID to carry out programs in developing countries, and among agencies of the Federal Government which have been called upon to supply expertise for such programs overseas.

The disillusionment of individuals has made it increasingly difficult to obtain direct-hire personnel of a quality and in a quantity required for proper planning and supervision of programs implemented by contract or PASA (participating agency service agreement). As was pointed out by John W. Gardner when he was President of the Carnegie Corporation of New York:

AID cannot intelligently administer an extensive contract system unless the best of its direct-hire personnel are able to deal with development problems at the same professional level as the best university people. It *must* be in a position to bring first-class, intramural judgment to bear on a question. Furthermore, its relations with the universities will never be established on a sound basis until it has on its own staff the caliber of professional personnel who can deal with university people on equal terms.<sup>34</sup>

4. Finally, technical assistance is *easily misunderstood*. The feeling persists in many quarters that research or science is a sort of luxury or prestige activity which has no substantial place in a program of aid to developing countries. Quite apart from the fact that adaptive research is an absolute prerequisite to the use of modern agricultural systems in different regions of the world, the basis for continuing agricultural development in *any* country, including the United States, is continuing research. Research in modern agriculture is a never-ending task.

Until technical assistance programs have been successful in establishing within the developing countries the institutional and manpower bases for continued research in agriculture, in health, in all aspects of physical, biological and social sciences, and in administration, management, and techniques of diffusing knowledge, no amount of capital investment alone will succeed in bringing about self-sustained economic growth in these nations.

#### **14.5.2 Place of Technical Assistance in United States Foreign Aid**

A brief review of United States technical assistance is helpful in placing the situation in context.

Technical assistance was under a separate agency, or was a separate function within an agency, from 1940 until AID was established in 1961.

The central concept behind AID was that of creating an instrumentality for executing a comprehensive, coherent aid strategy for

<sup>34</sup> Gardner, John, "AID and the Universities," Agency for International Development, Washington, D.C., 1964.

development. The different responsibilities and authorities were gathered together and placed within a single agency. The merger was not complete. The Department of Agriculture retained some measure of control over the surplus food disposal program. The Export-Import Bank escaped the net altogether.

Prior to 1961, technical assistance managed to preserve a certain identity of its own. Whatever weaknesses and lack of quality were beginning to plague the technical assistance program before it was transferred to AID, clearly grew worse after AID was created.

A major reason was the subordination of technical assistance to the supervision of a capital assistance-oriented staff. Education and research require comparatively small investments of United States dollars. In the Taiwan Aid Program, out of the approximately \$1.4 billion of foreign economic assistance provided from 1951 to 1965, \$35 million was devoted to education, public administration and public health, or about 2.5 percent. Almost one-fourth of United States aid in the period was channeled into the agricultural sector, largely, however, *in the form of physical resources*.

In any event, it is clear that in a typical assistance operation, technical assistance is greatly overshadowed by the much larger amounts of money involved in other phases of the program. Since quality is of utmost importance in technical assistance programs, the neglect of this sector can quickly lead to its decline and disintegration as a tool for development.

Different talents and backgrounds are needed for a capital assistance staff and a technical assistance staff. It may be possible to find the unusual type of leadership capable of directing both operations simultaneously, but it is mandatory that both capital and technical assistance programs have outstanding leadership and direction.

The organization of foreign assistance should reflect the fact that technical assistance and capital assistance are of equal importance in achieving development objectives, a fact which the larger dollar amounts involved in capital assistance tend to blur. Such coequal stature and recognition is the only way to attract and hold the talents and leadership capabilities needed to direct an effective, long-term technical assistance effort. As it now stands, technical assistance is relegated to the role of a staff service in a lending organization. It must become a full partner with capital assistance in the foreign assistance organization.

#### 14.5.3 Personnel Needs

The excellent report, "AID and the Universities," by John W. Gardner describes in detail the need for a personnel system which will offer opportunities for careers in development in some context other than that of the Foreign Service. Furthermore, the report makes numerous workable suggestions about general support of universities,

selection of career personnel, training and in-service educational programs for AID personnel, and several other aspects of the problem of maintaining a technical assistance program of quality and quantity, calling upon the resources of other government agencies and of industry.

Insofar as the Panel has been able to determine, none of these important suggestions has been implemented, even in a token fashion.

Rather than reinvent the Gardner report, the Panel prefers to subscribe to its findings and its recommendations.

#### *14.5.4 Needed: A Mandate for Action*

An anomaly in the present technical assistance program is the inability of the various agencies of the Federal Government to bring their extensive resources and expertise to bear upon problems in the developing countries.

The difficulties experienced by AID in obtaining high-quality professional personnel are not shared, for example, by the Department of Agriculture or the Department of Health, Education, and Welfare. Similarly, USDA and HEW have traditions of excellent cooperative relationships with universities throughout the country. The fact that both authorization and funds for technical assistance overseas by these agencies are provided through AID has made it virtually impossible for them to operate effectively in development programs. These agencies are constrained by short-term contracts from AID and clearly feel that their involvement in projects should be at the planning stage as well as at the stage of implementation. Furthermore, the commitment of personnel to foreign programs is in competition with their domestic mission. These agencies should be allowed to staff for the overseas commitment as a part of their regular mission.

The fact that many overseas activities, particularly in health and in agriculture, appear to Congressional committees to be at variance with domestic interests provides an additional constraint upon their activities.

Consequently, through a combination of factors, those agencies which, through experience and expertise are best able to conduct programs of technical assistance overseas, are largely excluded from program planning and limited to short-term activities.

The size and scope of the problem of economic development overseas, typified by the problem of the food supply, are such that some mechanism should be sought that will utilize the great capabilities of the Federal agencies in a coordinated, long-term effort.

Coordination and funding would probably be achieved best through a central, responsible authority, but a clear mandate is needed for participating agencies to staff and to plan for foreign activities on a continuing basis. The coordinating/funding agency should be in-

structed to seek and to use these agencies on a continuing basis in planning, execution, and evaluation of technical assistance programs.

The extent to which the agencies can respond will also be dependent upon Congressional agreement that *the national commitment to overseas economic development is not at variance with the short-term exigencies of domestic programs.*

The Panel has become well aware of the difficulties, both political and technical, that will beset attempts to change the existing missions of agencies committed primarily to domestic programs. The change, however, appears to be an absolute necessity to success in any United States program to take the lead in solving the world food problem.

### 14.6.0 Implementation

#### 14.6.1 Particularity

Clear distinctions must be made among an overall grasp of the world food problem, the creation of a coordinated long-range strategy for dealing with it, and the *actual execution* of workable programs within developing countries.

In specific programs, particularity, control, and effective concentration of effort must be the immediately applicable criteria, not scale and scope. Once overall plans have been drawn, areas should be selected for concentrated development and in these, the full scale of resources later to be deployed on a global basis should be assayed in pilot form. The choice of these pilot countries and regions should be based on a priority determined jointly by the urgent need for food and economic development and the willingness of the host countries to engage in the self-help effort required for a successful program. Every consideration must be given to the enlistment of the local government and local private and educational resources so that the sovereignty of the host nation is not impaired. Conversely, the local government must recognize the ambitious and promising goal that can be achieved by a comprehensive economic effort employing all of the latest technological resources, and must enter wholeheartedly into the program to achieve self-sustaining growth and an improved food supply.

#### 14.6.2 Further Planning

The guidelines that have been presented in this report should be followed up by a detailed economic evaluation of the food problem in several of the developing countries. The importance of such detailed analyses before instituting long-range programs calculated to meet the food needs of a given country is emphasized in the preceding section.

“. . . and he gave it for his opinion, that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together.”

Jonathan Swift in  
*Gulliver's Travels*

“Agriculture is perhaps, of all the useful arts, that which improves the most slowly among democratic nations.”

Alexis de Toqueville in  
*Democracy in America*

## NOTES

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