The Global Food Supply

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There is currently a wide divergence of opinion as to whether in the year 2000 there will be sufficient food supplies to feed a prospective world population of 7 billion. The pessimists warn that even before that time there may be widespread outbreaks of famine, complete exhaustion of our natural resources, a hopelessly deteriorated physical environment, and a world ruled by virtual chaos. The optimists trust that somehow man's intelligence will meet the challenges as they arise. Somewhere between stand the realists, who are aware of the growing threats, but who believe that positive measures taken now can forestall the predicted disaster.

The principal thrust of my remarks today is that the ways and means to provide enough food for the world's people, even at the present rate of population growth, are known and are available; there is no need for panic unless man's intelligence, imagination, and enterprise choose to retreat or abdicate in the face of seemingly insurmountable problems. My conviction is, however, predicated on the faith that nations will not fail to take effective steps to lower birth rates, that they will intensify and multiply all efforts to stabilize their numbers.

More than half the world suffers from extreme shortages of food. If we were to add to this figure all the people who have a barely sufficient diet but who are not severely undernourished so much as malnourished, the percentage would be much greater. Just to provide the more than 3.5 billion people alive today with a minimally adequate diet would require twice the amount of food now produced. Yet in spite of the existence of such enormous food deficits, the population of the globe is each year increasing at the rate of 70 million. At this growth rate—about 2% a year—the number of human beings will double by the end of this century. Thus even if by herculean efforts the world does succeed in doubling its agricultural production by the year 2000, the food/population ratio would be no closer to being equalized than it is now; more than half of the world would still be underfed. And, in terms of actual numbers of hungry people, there would be at least 2 billion more than there are now.

Absolute food deficits, however, are not the only cause of world hunger. There are other factors which complicate the problem of global food supply. In theory, the total calories contained in the 1.088 billion metric tons of food grains which the world now produces are more than enough to provide its 3.5 billion inhabitants with the minimal nutritional requirement of 2500 calories a day. This remains, however, merely a paper-and-pencil exercise for several compelling reasons. The most important is the great disparity in the distribu-
tion of the world's food resources. A disproportionate share of the world's food is consumed by the 11–12% of the world's people who are fortunate enough to have a plentiful and high-quality diet containing 3000 calories or more a day. This unequal distribution is not solely a question of poor countries versus rich countries. Even within a single country or region, severe maldistribution can exist, resulting in famines in some areas and more-than-adequate diets in others. Another reason why the total amount of the grain produced in the world cannot be taken as an indicator of the sufficiency of the global food supply is that 27–30% of the grain produced is used to feed livestock and poultry. Although animal protein is a desirable dietary item, it is not available to everyone. A third reason is that 20–25% of potential annual harvests never reach the consumer because of pests, pathogens, rodents, losses in storage and transportation, and other forms of preventable wastage. And a fourth reason is that cultural taboos and lack of nutrition education frequently keep people from fully utilizing the grains and other foods that are available to them.

Any progress, therefore, toward improving standards of living and the quality of life for all people during the years ahead will depend upon two vitally important considerations. The first is whether we can begin to make progress toward reduction in the number of births. The second is whether we can increase the food resources of the world at a rate substantially above that required merely to keep up with population growth. If we can assume that during the next three decades visible progress toward stabilizing populations will be made, then we can draw up plans for vastly augmenting world food production with some assurance that they will ultimately be effective.

Occasionally, one hears it stated that the world food problems could be solved if the more economically advanced nations were to increase several-fold the proportion of their own land devoted to food crops. By applying the most advanced technology to growing food on this additional land, it is suggested, countries such as the United States, Australia, and Canada could grow enough food to feed the entire world. This proposal is highly unrealistic. It overlooks the fact that in many of these countries, much of the acreage formerly cultivated has now been transformed into airports, suburbs, industrial complexes, and highways. Furthermore, much of the agricultural land in these countries is devoted to crops other than food grains—forests, fibers, fruits and vegetables, animals and animal feeds. In theory, it might be possible for the United States to produce food for millions of people in the rest of the world by doubling or trebling the acreage devoted to food grains. But in reality this "overproduction" would be accomplished at the expense of other sectors of the economy and would soon become prohibitively expensive.

A further reason why the solution to food shortages cannot be found in balancing total world agricultural production against total world food requirements is our existing system of independent and sovereign nation-states. Under the exigencies of international trade and balance of payments, food-deficit nations have to have the raw materials, commodities, or industrial products which are desired by the other nations in exchange for needed food supplies. Unfortunately, most of the poorer nations are so economically undeveloped that
they produce little that they can exchange for the huge quantities of foodstuffs they need to import. And to rely on outright donations of food from other nations is an expedient that is severely limited both as to duration and scope.

A first principle, therefore, to an understanding of the world food problem is to recognize that poor countries with severe food shortages have no practical alternative but to increase greatly their own capacity to feed themselves.

**Causes of Chronic Agricultural Underproduction.** A variety of negative factors have contributed over the years to the chronic agricultural underproduction that prevails in most of the less developed nations. These factors include extremes of climate, difficult terrain, scarcity of water, fertilizer, and other natural resources, inadequate numbers of trained personnel, and failure to take advantage of new technologies. Furthermore, until a few years ago, it was customary in these countries to apply advanced agricultural practices principally to the plantation cash crops destined for world markets rather than to local food crops. Many of these countries are still dependent on the export income derived from one or two crops, but when world markets become oversupplied, a single-crop economy frequently leads to economic disaster. Also, during the past twenty-five years death rates have fallen sharply, while birth rates have continued high; consequently, food supplies were insufficient to meet local needs.

The plight of the less-developed countries has not, of course, gone unnoticed. With a view to increasing their capacity to produce more food, numerous national, binational, and multinational efforts have been made since World War II to help advance their economic condition. With some of the early foreign-aid programs, there was too great a tendency to look for single-answer formulas, and to some extent this is still true. Suggested cures all include land reforms, crash programs in education, the establishment of large water impoundments and irrigation systems, the general expansion of agricultural extension, and the massive application of chemical fertilizers to food crops. All of these are necessary, but none is a panacea, and alone each contributes relatively little to the solution of the total problem.

Nor is the opening up of new and fertile lands in the developing regions of the world an immediate, practicable solution. In those countries with heavy population pressures, most of the easily accessible land is already being cultivated—which is not to say that it is being fully utilized. Even though there are millions of acres of potentially arable land not now being cultivated, the capital and the technology required to bring these lands into productive agriculture within the next two or three decades are linked in most of the poorer nations. Therefore, in view of the urgency of the world food problem, this possibility cannot be counted on to provide an early solution. It does, however, hold the promise of being a partial and long-range solution, the potential of which I will point out a little later.

**Raising the Level of Efficiency of the Land Now under Cultivation.** For the years immediately ahead, therefore, the most rapid, the most practicable, and the most capital-conserving way to increase the capacity of the less-developed world to feed itself is to raise the level of efficiency of the land presently under cultivation. Or, to put it another way, to increase the food-output per acre.
In the regions of the world that suffer the most from food deficits, the land devoted to growing crops is invariably being utilized at an exceedingly low level of efficiency and the production performance of the agricultural sector as a whole is grossly inadequate.

The most direct way for a country to solve the problem of underproducing land is to utilize all the information and materials including improved crop varieties and modern management methods that science and technology can provide. When combined with intelligent planning, adequate financing, and a determination of the part of all groups—farmers, government officials, and political leaders and others—to increase national production figures, enormous gains can be and have been realized. The quickest results will come from concentrating on good lands that have adequate water supplies and applying to them the basic components of productive agriculture.

There is concrete evidence that food production can be at least doubled in many areas. Since the establishment in 1961 of the International Rice Research Institute in the Philippines, where the so-called “miracle rice” was produced, per-acre yields on large areas in a dozen rice-growing countries have doubled, trebled, and sometimes even quadrupled. Under a program initiated somewhat earlier, Mexico moved from a substantial deficit in wheat production in the early 1940’s to an annual surplus, and the highly-productive improved varieties that were developed there are now contributing to dramatic increases in other countries.

**Multiple Cropping.** Of all the steps which may be taken to increase the efficiency of the land which is already under the plow, one of the most promising is to produce more than one crop per year on the same land wherever climate and water supplies permit. This practice of so-called “multiple-cropping” obviously has the effect of multiplying farm land without actually expanding the acreage under cultivation. And it increases on-farm employment.

In the less-developed regions of the world, much of the agricultural land lies in the tropical and subtropical latitudes where there is a year-round growing season. Many of these lands have adequate water supplies, unlimited sunlight, and temperatures ideal for most food crops. The prevailing practice, however, is to grow only a single crop, leaving this highly productive land lying idle 6-9 months of the year. In the Philippines, for example, land which traditionally produced one rice crop a year of 2-2.5 tons per hectare now yields up to 20 tons from successive crops of rice, corn, sorghum, and sweet potatoes.

**Improved Varieties of Plant and Animals and Better Utilization of Water.** The principal sources of food energy for the world’s population are rice, wheat, corn, sorghums, millets, and pulses. In some areas these are supplemented by barley, rye, potatoes, and other crops. We already have elite varieties of rice, wheat, corn, and sorghums with very high productive potentials, and even more improved varieties of these four are being developed. Great progress has also been made in improving barley, potatoes, and sweet potatoes. And although the cereal crops are the most important source of human food, any global effort must include legumes, the most important source of plant protein.

Wherever agriculture is practiced at subsistence or below-subsistence levels,
it is unlikely that the local diet will include significant amounts of animal protein from meat, milk, or poultry, since it is cheaper for man to eat plant foods directly. Here again, however, scientific innovations of improved varieties could result in substantially increased amounts of protein in the human diet. The greatest hope today in this area lies in genetic engineering, which has enabled us to develop new crop varieties that have a much higher amino-acid content.

Compared with crop cultivation, animal husbandry is likely to be an expensive, high-risk investment. The original capital is usually hard to come by, and animal losses due to pests, diseases, and drought can be destructive. Nevertheless, animal proteins are important wherever economically feasible. But the "improved variety" theme must be pursued here, too, and a promising approach might be the development of highly efficient dwarf species of food animals.

Two Longer-Term Possibilities. Over the longer term, significant contributions to world food supplies can be expected from two additional activities. I find both exciting, although the full potential of neither will be realized for years to come. One is the opening up of new lands to cultivation, and the other is the practice of what can be termed "non-conventional agriculture."

1. Opening up new lands to food production: Today, crops are being cultivated on about 3.5 billion acres. This is only a little more than 10% of the earth's land surface. A huge proportion of the remaining 90% is, of course, non-arable. Nonetheless, millions and millions of acres—one estimate is 7 billion—could be brought into the production system by various forms of technology. These lands vary widely in character: some are arid or semi-arid; others are wetlands with heavy rainfall; some are too steep and others too saline. In some cases there are such biological obstacles to cultivation as tsetse fly infestation. On a large proportion of them, human habitation is also sparse because of unfavorable environment—extremely high altitudes or torrid climates. As population pressures mount, however, many of these obstacles will have to be overcome.

Improvements which now are uneconomical—for example, the massive conversion of saline waters into fresh water for agricultural purposes—will appear more feasible each year as technology advances, demands for water supplies increase, and the need for these lands becomes greater. Where there is too much water at certain times of the year, it will become necessary to control and conserve it for agriculture and other industries. The application of appropriate research could restore to productivity many soils that have been damaged by waterlogging, salt accumulation, or industrial operations such as mining.

Of all programs which would extend agriculture into "new" lands, the one offering the greatest potential is that dealing with tropical and subtropical areas. They could become regions of extremely high food productivity if made more attractive for human habitation. With technologies developed from existing scientific knowledge, it will become possible to improve living conditions in the tropics and to create vast new possibilities for increased food production.

2. Non-conventional agriculture: I would like to mention briefly non-conventional agricultural systems. In some ways, these are the most interesting of all—because they are the most different. One possibility is better utilization of our marine resources. Managed properly, the oceans, fresh water lakes,
impoundments, and rivers all can provide far more protein than they do now. The sea estuaries and other saline bodies of water can produce much larger quantities of shellfish, crustaceans, and conventional fishes. Research and development, undertaken on the basis of international agreements, could readily result in greater food production from our oceans, without exploiting the ocean bed in ways that would upset its biological equilibrium.

Today we are only scratching the surface of the possibilities of unconventional agriculture. A great deal is still to be learned about such possible feed or food sources as proteins, high-protein microorganisms, bacterial transformations, and the use of certain petroleum and other industrial products. Much also can be done in the area of food enrichment—especially amino acids—texturization, and recombinations. It would be unintelligent to believe that man's ingenuity and his research and development capability will not take advantage of these less traditional food sources for his own benefit.

Initially, some of the newer technologies obviously will appear to be too costly. But as population pressures mount, as demands for greater food supplies increase, and as technology is refined, many of these non-conventional methods gradually will become economically feasible. One day, there may be food factories in which yield figures never before contemplated will be achieved for a whole variety of crops grown under mini-Astrodomes. Consider the possibilities of taking agriculture indoors, where we could exercise total control over the environment! The multiple-cropping system described above will appear old-fashioned by comparison.

**Prevalent Attitudes That Tend to Hinder a Nation's Efforts to Increase Food Production.** At this point it should be quite apparent that the persistence of food shortages in the world is not the result of any lack of scientific knowledge, of biological materials, or of technological information. Rather, it is due mainly to several attitudinal factors, which prevent rational and genuine understanding on the part of the developing nations as to what can be done and which stand in the way of their taking effective action to modernize their agriculture.

The first of these is that in many countries, industrialization is still surrounded by a special mystique causing it to become a national desideratum to the exclusion of all other forms of development. If this mystique prevails and the agricultural sector continues to be given low priority, the economies of these primarily agrarian nations will inevitably suffer, with the result that resources that should be devoted to their most basic industry—agriculture—are diverted into the building of uneconomic status symbols or into financing ill-conceived and inefficient industrial operations.

The second attitude that tends to bar the way to any real progress toward increasing food production is the traditional view that agriculture is a way of life rather than a highly sophisticated industry. Because of this attitude, the agrarian populations in general and the farmer in particular are often sadly neglected. In many of the developing nations, the government has made no effort to understand or identify the problems of the agricultural sector, much less take steps to resolve them. The farmer has too often been denied the combination of basic materials and information which can make the difference between success and
failure. He has not been protected against exploitation and is completely vulnerable to, and at the mercy of, the vagaries of weather and the fluctuation of commodity prices. Absolutely essential to healthy modern agriculture is a national determination, backed by the governmental institutions and the general public, to create an efficient agricultural industry and an awareness of what has to be done to achieve it.

Thirdly, many people in positions of leadership, not only in the developing countries but in nations attempting to aid them, have had serious doubts that what has been accomplished by the agricultural industry in the most highly developed nations could be duplicated elsewhere. This attitude was in part an over-reaction against an earlier and equally erroneous idea that successful agriculture could be imported from abroad as readily as automobiles. The facts are that the knowledge, technology, and materials can be imported, but they must be applied within the local context and modified and adapted to fit that scene. The best maize varieties in the United States are not necessarily the best for India. But their superior genes can be combined with others in order to produce new varieties adapted to local conditions and capable of achieving major gains in yield.

The Green Revolution. We have heard a great deal lately about the so-called green revolution. This dramatic phenomenon is not the result of any single factor, but came about through a combination of factors: the introduction of new and improved varieties, proper soil-management techniques, adequate supplies of chemical fertilizers and water, and the positive and constructive attitudes and backup support of both the public and private sectors. Today, the green revolution stands as a striking example of what can be done to improve agricultural production in areas that have long been frozen into patterns of chronic underproduction.

One of the major contributions of the green revolution thus far is that it serves as a demonstration of what can be accomplished when problems are identified, priorities established, and intelligent and continuing action taken toward reaching solutions and goals. It provides visible proof that the proper mixture of ingredients can bring about phenomenal change and almost incredible increases in production. If the green revolution fails to live up to its promise—and this is possible—it will be because there has been failure to take advantage of the opportunity which is offered and to translate its potential into growing and ultimately massive action by attacking the basic problems and barriers to agricultural production.

Conclusion. In conclusion, it is apparent that insofar as modern technology, biological materials, and systems of management are concerned, mankind now possesses the knowledge and tools to produce the food supplies that the world's population will require for the rest of this century. There is no question that we also have the ability to open up new areas in the tropics to productive agriculture, and the technology to develop new, non-conventional sources of food.

My major concern is whether world leaders and policy makers, both in governmental and non-governmental positions, in both national and international bodies, will react constructively to the problem of increasing food supplies.
Will they themselves have an understanding of the basic principles that must be applied in order to transform underproductive agriculture to productive? And, when they have acquired this understanding, will they be able to enlist the support of the entire society, to establish proper priorities, and to set up the requisite organizational machinery to effect the transformation? It is not the scientist, the educator, the businessman, or the farmer, either as individuals or as groups, who are holding back agricultural progress. Rather, it is the lack of trained manpower, the inadequate communication, the limited resources, the preoccupation with industrial development, and the drain on scarce capital resources for military purposes. These are the factors that combine to prevent the integration of efforts necessary for essential agricultural reforms.

If the population problem is to be solved and if world food supplies for the foreseeable future are to be guaranteed, we must have forward-looking, effective, and stable leadership and balanced economic development. All sectors of the society must understand and support all the efforts that are essential to success.