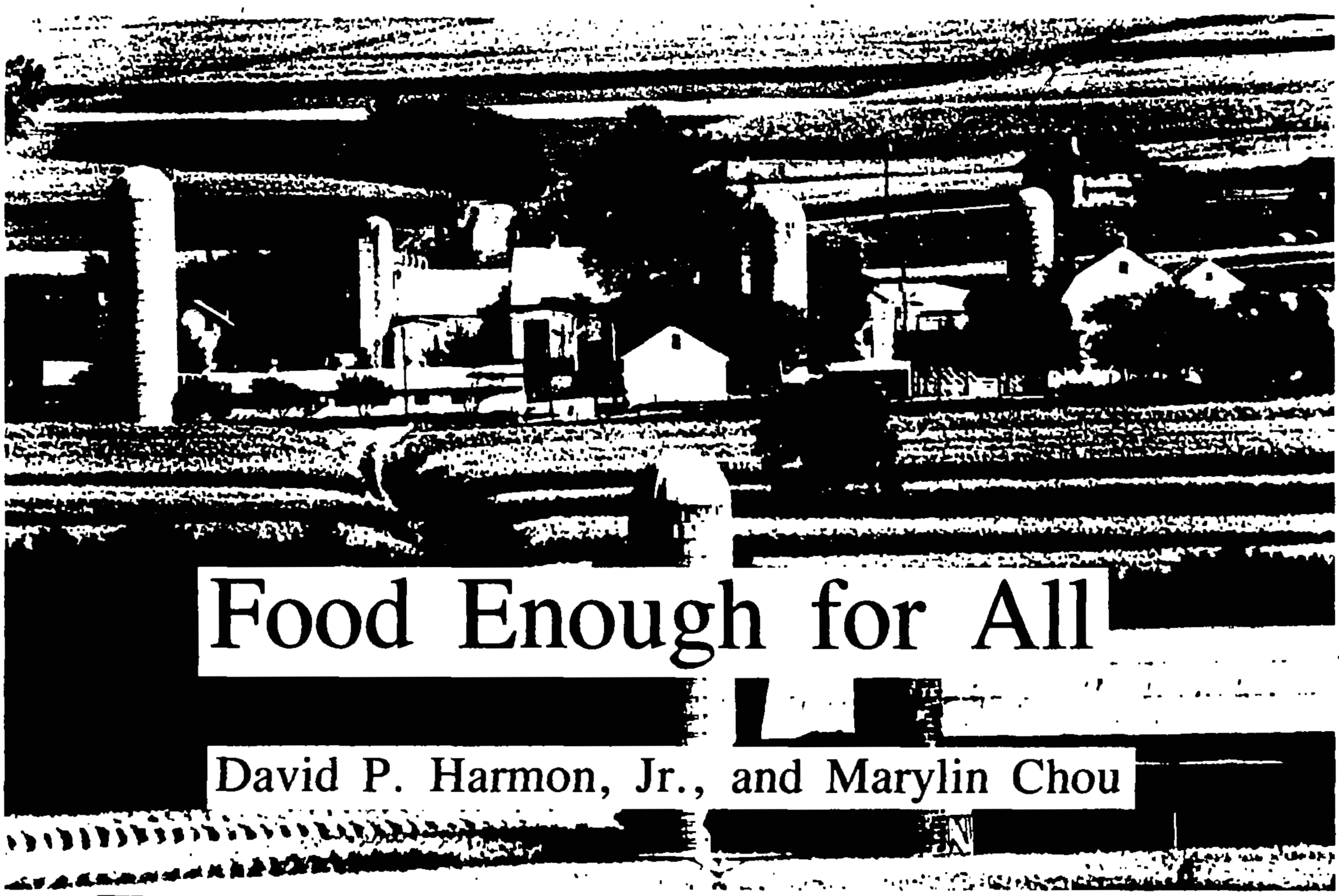
The pessimists may be right but the evidence—and the imperatives—are on the other side



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Food Enough for All

David P. Harmon, Jr., and Marylin Chou

Through constant repetition over the past year considerable credence has been given to a very pessimistic outlook for world agriculture. The pessimists argue that recurrent and ever more serious food shortages will occur as a result of increasing population growth, rising affluence, and decreasing availability of cultivatable land. Based largely on world consumption of food and feed grains ranging between 1.1 and 1.2 billion tons per year, with a yearly growth in volume of some 25 million tons needed to meet increased demand, it has been asserted that the world has twenty-seven days worth of food reserves left and is living on a razor's edge with respect to famine. This assertion does not bear up under close examination.

The general surplus conditions that existed in 1970 had largely disappeared by the summer of 1972. Carry-over stocks or inventories of the main food and feed grains were at extremely low levels by the end of 1973. For example, the wheat stocks of the four major exporting countries amounted to some 29 million metric tons, the lowest level in twenty years.

In 1974 a slight rebuilding of U.S. food grain stocks was possible. That did not happen, however, with feed grains (except soybeans), because planting and harvest were hard hit by bad weather. In addition, and as exemplified by the Soviet Union's 1972 grain purchase, there is an increasing tendency for certain countries to rely on imports in order to maintain consumption instead of going through the traditional process of belt tightening.

The pessimistic view holds that population growth, as the dominant source of demand for food, will cause food scarcity with increasing frequency in the future. Coupled with population growth is rising affluence. The total growth in food demand per year is estimated at 2.5 per cent annually, of which 80 per cent is accounted for by population growth and the rest by rising affluence. The total increase in production, however, is 2.7 per cent per year. Increased demand by developed countries is estimated at 1.6 per cent per year, with production increase approaching 3.8 per cent. Just the reverse is true of the developing world. There demand rises at an annual rate of 3.7 per cent, and production increases at 2.6 per cent. The real problem is distribution.

Assuming that economic development will continue, population growth should decrease with the process of urbanization, industrialization, and modernization—all of which are accompanied by affluence, literacy, and improved health. These conditions tend to cause a

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change in priorities and values that may in turn result in smaller families. The main reasons this decrease should occur are:

- increased costs and difficulty of raising children, including higher perceived monetary costs of educating children
- diminishing potential value of children's labor to the family
- improvement of medical and health facilities resulting in a decrease in death rates so that fewer births will be needed to ensure surviving children to provide security for old age
- increased effectiveness of government birth control programs

The Peoples Republic of China accounts for slightly over 20 per cent of the world's population. Through a program of later marriages and smaller families it has reduced its population growth rate to 1.7 per cent per year. Other examples in the developing world are Taiwan, Hong Kong, Singapore, and South Korea. All have, within the past ten to fifteen years, reduced their growth rates from the "traditional" 2.5 to 3 per cent per year to 1.8 per cent per year or less. The phenomenon is not limited to the Chinese culture area. Costa Rica, Egypt, and Tunisia have also reduced their population growth rates. Even India has had some success, albeit limited, in decreasing population growth over the past decade from 2.6 to 2.2 per cent per year.

These countries seem to have some things in common. They have public programs for family planning with birth control information widely disseminated. They have declining infant mortality, so that it does not take the birth of twelve children to ensure the survival of five. They have literacy programs that are working. And they have increasing equity in the distribution of incomes. In short, the people of these countries have a measure of control over their futures.

Rising affluence is indeed a major claimant on food resources. It is argued that the developed countries should curtail their consumption of agricultural goods and inputs in order to make food and inputs available to the developing world. But what would have happened if the United States and the northern tier of industrial countries had cut their per capita consumption to half the actual level of the past twenty years? D. Gale Johnson of the University of Chicago suggests the probable results of such a policy:

- Much less grain would have been produced.
- Carry-over stocks would have been much lower, meaning that much less food would have been available to India and Pakistan in 1973 and 1974.
- Incentives for investment in agricultural research and development would have been limited.
- The major breakthroughs of the early 1960's, cutting the cost of nitrogen fertilizer by almost one-half, might not have occurred.

In addition, had U.S. grain production been only 125 million metric tons instead of the present 200 million metric tons, it would have been politically impossible to have had 70 million metric tons available as reserves in 1972. The drop in real grain prices and costs from 1910 to 1971 took place at the same time that output increased substantially. This means that incentives existed for the development of techniques that have both decreased cost and increased production. Had demand for grain remained stagnant over the past twenty years, there certainly would have been extremely limited investment in agricultural research and development.

We are told that international scarcity is likely to prevail in the future. It is argued that little uncultivated land is left, that all the diverted acreage in the United States is now back in production, that increasing yields will increase costs (in part due to diminishing returns with fertilizer), and, lastly, that the price of farm inputs, especially those based on petroleum products, will be substantially higher in the future. Each of these arguments calls for closer examination.

The assertion that the world has only twenty-seven days of food reserves left was principally based on the assumption that all U.S. farm land that was in soil bank or under federal supply management programs would be returned to production in 1974. The fact is that only about half of this land (some 30 million acres), the more marginal land, has been returned to production. Looking at planted acreage in 1972 (approximately 300 million acres, with some 62 million acres lying idle) versus planting intentions in 1974 (approximately 330 million acres with no cereal grain acreage except a small amount of rice idled under federal programs), there were 30 million acres that did not come back into production. This was primarily due to price response, that is, farmers were not persuaded that prices were going to stay high enough long enough to warrant bringing this land back into production. Then too, farmers felt, and still feel, that Washington's foreign policy decisions on food introduce added uncertainty in food pricing, and this in turn adds to their reluctance to farm the even more marginal land.

When acreage restrictions were in effect, farmers learned to make a living on fewer acres by turning to technologies that showed promise of raising yields. The available capital was spread over a reduced number of acres, and thus more money was available for nonland costs. This emphasis on increased yields is the main factor behind the Department of Agriculture's projection that 10 per cent less acreage than is now being planted will be needed in the year 2000. According to its experts, by then, given continuing high farm prices, another 40 million acres, drawn primarily from cropland pasture, would be readily available. Some additional 260 million acres (or another 80 per cent), consisting of forest land, pasture, range land, and "other" land, are potentially available. To bring land from these categories under cultivation, farm prices would have to remain at high levels over the long term in order to justify large-scale investment.

In other parts of the world also large land areas are potentially available. The eradication of the tsetse fly would free for cultivation some 7 million square kilometers of sub-Saharan Africa, a region larger than the agricultural area of the United States. The cost of such a program is estimated at $2 billion. Tropical soil research aimed at solving the problems of natural and applied nutrients now leached away by heavy rainfall coupled with year-round farming (multiple cropping), as well as desert reclamation, could significantly add to the amount of available land.

As agricultural economist Theodore Shultz has underscored in a paper published in *Agricultural Economics* (University of Chicago, 1974), land is only one factor in agricultural production:

> ...only *about one-tenth of the land area of the earth is cropland. If it were still in raw land in its natural state, it would be vastly less productive than it is today.* With incentives to improve this land, the capacity of the land would be increased in most parts of the world much more than it has been to date. In this important sense cropland is not the critical limiting factor in expanding food production. The original soils of Western Europe, except for the Po valley and some parts of France, were, in general, very poor in quality. They are now highly productive. The original soils of Finland were less productive than most of the nearby parts of the Soviet Union, yet today the croplands of Finland are far superior. The original croplands of Japan were vastly inferior to those of Northern India. Presently, the difference between them is greatly in favor of Japan. There are estimates that the Gangetic Plains of India could, with appropriate investments, produce enough food for a billion people.... Harsh, raw land is what farmers since time immemorial have started with; what matters most over time, however, are the investments that are made to enhance the productivity of cropland.

Fertilizer is key in any discussion of increased costs and yields. The argument that increased yields in developed countries are increasingly expensive to obtain on already heavily fertilized land avoids the dynamic and flexible nature of agriculture. Table A demonstrates that we should look at another criteria such as technology, plant size, and increased capacity. (Urea is a major component in fertilizer.)

Thus a 200-ton per day plant operating under 1960 technology with free natural gas ended up with a gate price of $164 per ton. With 1974 technology and the benefits of economies of scale, even with the price of gas at a dollar per thousand cubic feet, the price of urea is $116 per ton. The "increased capacity" part of the table is relevant to developing countries, where many fertilizer plants operate at 60 per cent or less of capacity. Increasing that capacity to somewhere around 90 per cent drops the gate price of fertilizer considerably.

Fertilizer is just one of the many inputs used in increasing yields per acre. As the productivity of the other inputs increases, costs are decreased accordingly. Additionally, the fertilizer yield function changes over time. That is, as farmers learn to use fertilizer more effectively, costs drop. Also, as farmers work with better adapted seeds, with higher plant densities, and with more effective types of fertilizer, the fertilizer yield function changes.

There are still other areas where increased U.S. yields are possible using today's technology. Currently some 8 to 10 per cent of the soybean harvest in this country is lost in the harvesting process. New combines are under design which would reduce this loss to near zero. Planting narrower rows increases the plant population per acre. The increased possibility of double cropping, using early maturing varieties of small grain sorghums and soybeans, promises significant production growth. Table B shows the Department of

TABLE A

Price of Urea

	Technology/Plant Size		Increased Capacity*	
	1960 vs.	1974	60% vs.	90%
	200 tons/day	1000 tons/day		
Price of Natural Gas (MCF)	Free	$1/MCF	$1/MCF	$1/MCF
Price	$164/ton	$116/ton	$155/ton	$120/ton

*Operating capacity of 1,667 tons/day

TABLE B

Production — 1973, 1980, 1985

	1973	1974	1980	% Increase over 1973	1985	% Increase over 1973
Corn (billion bushels)	5.7	4.6	8.1	42.1	9.1	59.7
Soybeans (billion bushels)	1.6	1.2	2.1	31.3	2.3	43.8
Feed Grains (million short tons)	205	168	283	38.1	315	53.7
Wheat (billion bushels)	1.7	1.78	2.2	29.4	2.3	35.3

Agriculture's grain production estimates, assuming "normal technological advances."

By 1980 the world will require approximately 1.35 billion tons of cereal grains, an increase of 150 million tons over what we currently consume. If the potential production increase indicated above materializes, the U.S. will be able to meet over 50 per cent of the world's increase in demand.

On the foreign side the use and flexibility of high yielding varieties, or miracle seeds, are emblematic of the dynamism of agriculture. As background: The Green Revolution started in 1965 with some 41,000 acres under high yielding varieties of wheat and rice. By 1970 the acreage increased to slightly over 50 million acres—or some 16 per cent of the 310 million acres planted in Asia and other parts of the developing world. By 1970 80 million acres were under high yield varieties—or about one-third of the wheat area and one-fifth of the rice area in the non-Communist developing countries. From 1966 to 1970 we were blessed with very good weather and ample supplies of inputs. During that time Pakistan began to export wheat, the Philippines stopped importing rice and was seeking export markets, and India developed a food grain reserve of some 10 million tons. From 1971 on problems with the high yielding varieties began to appear. It is within these past three years that the dynamic and flexible response of agriculture has been particularly evident.

In 1971 the Tungro virus severely reduced the IR-8 rice yields in the Philippines and actually prevented the use of IR-8 in Bangladesh. The response to this disease was the replacement of the IR-8 with IR-20, a cross between a new seed, IR-24, and a southern Indian variety of rice incorporating a broad spectrum of insect and disease resistance. After initial success with IR-20 it was found to be susceptible to both local pests and another strain of virus. By the next growing season IR-26 was in use and was found to resist almost all Philippine diseases and insects.

Since success with high yielding varieties is highly dependent on the proper inputs of fertilizer, pesticides, and agricultural infrastructure, as well as on abundant water, a more complex strategy had to be developed for countries lacking one or more of these factors (due to increased costs, lack of availability, or, in the case of water, inadequate rainfall or irrigation).

The new strategy evolved at the International Rice Research Institute (Philippines) employed the old technique of intercropping coupled with several innovations: Somewhat lower yielding hybrid seed varieties were used. They retain the disease resistance and responsiveness to local soils as well as permitting the use of well-established methods of cultivation. These varieties have somewhat lower yields when growing conditions are "ideal," but relatively higher yields when inputs such as fertilizer are limited or when pests are prevalent. The strategy also included combinations of crops (alleopathy) aimed at reducing pest attacks and weeds. For example, the combination of mung beans with corn caused corn yields to increase 20 per cent, since the beans acted as a weed suppressant. And it used a small (5 to 7 horsepower), unsophisticated power tiller which can be manufactured locally. This complex strategy permitted the easy adaptation of agricultural techniques, as distinct from technologies, to the demands of "traditional" cultures.

A prime example of a government program which is succeeding is the Philippines' "Masagana 99" (bountiful 99 cavans, or 4.6 tons/hectare). Masagana 99's success is based on a number of factors:

1. It has been given real national priority.
2. It focuses on the individual farmer and his goals.
3. It involves a massive education campaign, with 3,500 extension workers out in the field.
4. It offers ample credit to the farmer in the form of low-interest, no-collateral loans. Qualification for loans involves self-organization with small mutual-liability groups wherein, if one member defaults, his fellow members are partially liable. Such a system promotes cooperation and mutual responsibility.
5. It emphasizes simple irrigation projects.
6. The government subsidizes about one-half the price rise in fertilizer.

Significant increases in food production in the developing countries requires that there must be sufficient incentives to encourage farmers to make the required expansion. The first and most important incentive is profit. As a corollary, the farmer must feel that prices of farm commodities will remain sufficiently high to cover the cost of his investment and labor as well as to leave him a profit at harvest time. Security of land tenure along with enough credit and extension services are the other main incentives needed.

Once these incentives are evident, farmers in developing countries can be expected to make much more efficient use of their limited resources and to adopt new seed varieties as well as more complex production technologies. This, in fact, is what has happened when profitability has been evident. There is no doubt that increased food production requires also an adequate supply of inputs to increase per acre yields. There must be major expansion of agricultural research in the developing world aimed at particular national needs, and integrated with the country's overall development. Expansion and improvement of agricultural infrastructure is important—particularly in transportation, storage, and marketing and processing facilities. There must be education in the new techniques and technologies, and it must be disseminated widely. Finally, trade barriers of developed countries must be lowered in order to give the developing countries' agricultural products a market and thus stimulate production for export.

Whether in the very short term the developing countries can escape serious food shortages over, say, the next two to three years depends upon contingencies such as global climate conditions, the capacity of the developed world to respond to food shortages combined with the ability of the developing world to finance their shortfalls, and upon the ability of the developing countries to increase their own agricultural production and improve their grain handling and distribution facilities.

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Continuing high farm commodity prices should bring increases in the amount of acreage planted in the U.S. Early planting intentions for this crop year indicate an increase of approximately 6 million acres over last year, to be planted primarily to soybeans and other feed grains. If planting intentions hold and there is good weather, the U.S. should have ample grain at harvest time to respond to foreign food shortages.

While current world food problems are serious, they represent only a relatively temporary aberration from a long-term upward trend in per capita food production. In that larger perspective it appears the world will be able to produce enough food to keep ahead of demand. The world's stock of land and productive inputs seem sufficient to support greatly increased food production. Cropland is not the critical limiting factor in expanding food production, since less than one-half of the world's potential agricultural acreage is now cultivated. And as the modernization of agriculture continues, the relative importance of land tends to decline. In the last twenty years U.S. farmers have increased wheat production by one-third on one-third fewer acres.

Whether and how fast production increases depends more on government policy decisions than on natural forces or limits to productive inputs. In addition to incentives to the farmer one of the most necessary components for the success of the Green Revolution is the ability of the adopting government to marshal the resources and implement the policies necessary to achieve rapid agricultural progress. As we have noted, and despite chronic mismanagement, even India has been partially able to reap the benefits of the Green Revolution.

Although relatively little was spent on research in developing countries, they were able to increase their per capita food production by 20 per cent between 1966 and 1972, a long-term trend that has kept ahead of population growth. The Rome World Food Conference called for research spending in developing countries to increase several-fold by 1985. Such investment should result in even higher productivity.

The dynamic nature of agriculture and the positive experiences of developing countries to date are the reasons for optimism about the world's long-term ability to feed itself. Apocalyptic predictions about a growing world population running out of food have been proved wrong in the past. Of course that is no guarantee that it cannot happen. But if we understand the dymanic rather than static character of agricultural economy, we have every reason to expect today's pessimists also to be proved wrong.