WORLD FOOD PROBLEM: Clippings from articles
Assembled by Roy Jenne (September 1975)

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<td>Science, 20 Dec 74</td>
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<td>World starving for fertilizer, U.S. News, 25 Nov 74</td>
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<td>(3.5% of U.S. fertilizer is for non-farm purposes)</td>
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<td>Crop portection to increase food supplies, Ennis, et al., Science, 9 May 75</td>
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<td>(Annual loss of production due to pests is about 30%)</td>
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<td>National Wildlife Federation, 15 Aug 75</td>
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<td>Management of famine relief, Mayer, Science, 9 May 75</td>
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<td>U.S. Agribusiness and agricultural trends, Walsh, Science, 9 May 75</td>
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<td>Food production: technology and the resource base, Wittwer, Science, 9 May 75</td>
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<td>(Has crop yields, number of pets, forages eaten)</td>
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<td>Weather variability, climatic change and grain production, Thompson, Science, 9 May 75</td>
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<td>(Also has forecasts of world grain production)</td>
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<td>Efficiency of feed conversion, Byerly, Science, 25 Aug 67</td>
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<td>Fuel from food or waste, Calvin, Science, 19 Apr 75</td>
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<td>Aspects of world food problem, U.S. News, 24 Mar 75</td>
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<td>Russian farming and their grain purchases, U.S. News, 18 Aug 75</td>
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<td>Ralph Nader and the terrible ten, Jukes</td>
<td>National Review, 12 Sep 75</td>
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A Fresh Look

ENOUGH FOOD TO FEED THE WORLD, IF—

An end to famines and food wars? It’s possible. The world could feed three times its present population—but it will take some action.

The world will be able to feed its teeming billions after all, and the mass starvation widely predicted by the end of this century can be averted. These conclusions are emerging as food and population experts take a fresh look at the crisis that gave rise to doomsday predictions over the past year. Required will be a massive shift of money and know-how from rich nations to poor, and from industry to agriculture. The World Bank estimates the cost in foreign aid from the U.S. and other well-to-do nations at $140 to 160 billion dollars over the next 10 years.

"The world has the physical capacity to feed itself, no doubt about it," says William R. Gasser, a top economist at the U.S. Department of Agriculture. He reports:

"Less than half the arable land on this planet is being cultivated now. And the technology, fertilizer and other raw materials will be available if people and their governments are willing to pay the price."

And agronomists say Thailand’s big rice surplus shows what the lush countries of Southeast Asia could accomplish if they were not constantly at war.

China eats. Perhaps the most dramatic example of progress is the People’s Republic of China, the world’s most populous country, where mobilization of manpower and more-even distribution of available supplies reportedly have ended centuries of food shortages and even starvation in less than a decade. Communist regimination and the end to constant civil wars get much of the credit in China’s turnaround. But disruptive attempts at collectivizing farms are often blamed for food shortages in socialist Tanzania, along with problems of weather and terrain. And critics say poor soil, adverse climate and a lack of farmer incentives also restrain production in the vast grainfields of the Soviet Union, where output per acre is only a fraction of the level in the U.S. Russia, the U.S., Western Europe and Japan are accused of hogging precious grain to satisfy a growing taste for meat among their people. Each bushel of grain used to fatten cattle for these countries would provide several times the human food value if it were eaten directly by people in the hungry nations.

Reducing consumption among the affluent will do little good, economists say, unless the poor can afford to buy the food that would be saved—or unless someone is willing to buy it for them. Otherwise, conserving food will only lead to surpluses that would drive prices so low that farmers in the well-supplied nations would have to cut production.

Crops and crisis. The present food crisis, economists agree, was triggered in 1972 by bad weather that curbed crop yields in the Soviet Union, Africa, Asia and Australia. Output recovered in 1973, but not enough to offset the crop disaster that struck the United States Midwest in 1974.

During the two previous decades, world production not only increased 50 per cent, but kept ahead of population growth by 22 per cent, largely because of modernization of agriculture. Even in the less-developed countries, per capita food production was increasing at an average of one half of 1 per cent a year, despite rapid population growth.

But during the 1972 and 1974 years of droughts, frosts and floods, the world’s food reserves were gobbled up. Twenty years of progress and optimism turned to alarm.

Economists at the U.S. Department of Agriculture point out that the world has come through at least five global food scares in modern times, going back to the dire predictions of overpopulation and mass starvation issued by economist Thomas Malthus in 1789. They insist the world will survive this scare, too—if governments will give top priority to growing food and getting it to places where it is needed most.

But even the most bountiful countries eventually would go bankrupt if they tried to meet the needs of hungry regions indefinitely, analysts agree.

Population in those areas is multiplying at almost three times the rate in the rest of the world and is expected to double in 26 years.

Does aid hurt? Some critics argue that past U.S. aid—more than 240 million tons of grain in the last 20 years—has postponed a more permanent solution by masking the symptoms of scarcity and lulling the poorer nations into complacency.

In the long run, they hold, it will be cheaper and more effective to help less developed countries grow more of their own food. Savings in shipping costs are one reason. Efficient use of agricultural raw materials is another. According to one estimate, each pound of fertilizer used in India would increase yields twice as much as it would in America’s already well-nourished soil. Secretary of State Henry A. Kissinger reported at the World Food Conference in Rome last November:

"Ironically, but fortunately, it is the nations with the most rapidly growing food deficits which also possess the greatest capacity for increased production. They have the largest amounts of unused land and water. While they now have 35 per cent more land in grain production than the developed nations, they produce 20 per cent less on this land.

"In short, the largest growth in food production can—and must—take place in the chronic-deficit countries."

What is needed to spur this growth?

"It mostly comes down to money," answers Richard M. Kennedy of the U.S. Department of Agriculture’s Economic Research Service. "Money for fuel, for fertilizer, for research on high-yield grains, for irrigation systems. And, most of all, money to cover higher food prices so farmers everywhere in the world will have an incentive to produce and so they can afford the new technology."

Many agricultural economists believe poor countries have neglected their agriculture while building factories and developing weapons.

U.S. NEWS & WORLD REPORT. March 24, 1975
The Highlights of the 15-20 July 75 Bangkok Conf.

- Countries with very high birth rates are invited to take action to reduce them by about 10 per 1,000 before 1985, and to achieve replacement levels of fertility in two or three decades or as soon as practicable.

- Countries with the highest mortality levels should aim to have by 1985 an expectation of life at birth of 62 years, a maternal mortality rate of not more than 210 per 100,000 live births, and an infant mortality rate of less than 120 per thousand live births.

- Priority measures to reduce death rates include sanitation, mass immunization, nutritional programmes, health education and insurance — and giving consideration to the liberalization of abortion legislation.

- It is urged that all countries ensure the availability of information and education about family planning to all who desire it, and the means to practise it effectively.

For most developing countries, it is difficult to save and invest enough from the meagre annual income to proceed with economic development at a satisfactory pace — even in the absence of rapid population growth. But prevailing high rates of population growth tend to increase current consumption, resulting in a smaller volume of investment — which means in turn a smaller increase in national income.

Population growth also "warp" investment, by increasing the gap between demand and supply. Annually, capital has to be diverted to supplying food, clothing, education, health, housing and other welfare measures. Less is left for investment proper — building up the future. The competition for resources has become severe.

The motherhood boom

The age-structure changes caused by rapid population growth have two undesirable consequences for development. First, the number of young people becoming parents is much greater than the number of parents leaving the child-bearing years. This "population dynamic", once begun, continues for a long time — even if fertility falls.

The women in the child-bearing years (aged 15-49) in the ESCAP region now total 526 million; by the century's end they will total 927 million, all of them potential mothers. The biggest increases in numbers will be in the poorest countries — implying that the pressure on the meagre resources of these countries will continue to increase during the current decade and beyond, thus making the task of development increasingly difficult.

Fears for the future

There are three aspects of the food situation in the ESCAP region which require consideration. First, the heavy imports of foodstuffs to meet the needs of the growing population divert scarce and badly needed resources from investment in agricultural and industrial development. Second, since most poor countries cannot afford to purchase their full requirements, the quantum of food intake is below desired levels. Third, the very low level of domestic production of nutritional items such as meat, milk and eggs and the relatively high prices of these items elsewhere have seriously affected nutrition.

The rapid increases in population which are expected to continue in most countries of the ESCAP region will further aggravate their already serious food situation.

Total and annual rate of growth of population:

World by regions and the ESCAP region by areas, 1970-2000

<table>
<thead>
<tr>
<th>Regions and areas</th>
<th>Population (in millions)</th>
<th>Increase (in millions)</th>
<th>Annual rates of growth</th>
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<tr>
<td>World total</td>
<td>3,621</td>
<td>3,988</td>
<td>4,401</td>
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<tr>
<td>More developed regions</td>
<td>1,084</td>
<td>1,133</td>
<td>1,183</td>
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<tr>
<td>Less developed regions</td>
<td>2,537</td>
<td>2,855</td>
<td>3,218</td>
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<tr>
<td>ESCAP region</td>
<td>1,976</td>
<td>2,202</td>
<td>2,452</td>
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<tr>
<td>East Asia</td>
<td>925</td>
<td>1,004</td>
<td>1,086</td>
</tr>
<tr>
<td>Eastern South Asia</td>
<td>284</td>
<td>325</td>
<td>373</td>
</tr>
<tr>
<td>Middle South Asia</td>
<td>749</td>
<td>853</td>
<td>971</td>
</tr>
<tr>
<td>Oceania</td>
<td>18</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>ESCAP region excluding Japan, Australia and New Zealand</td>
<td>1,857</td>
<td>2,074</td>
<td>2,316</td>
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Note: Countries of the subregions of the ESCAP region are: East Asia: China, Hong Kong, Mongolia, Japan, Democratic Republic of Korea and Republic of Korea. Eastern South Asia: Brunei, Burma, Khmer Republic, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Republic of Viet-Nam and Democratic Republic of Viet-Nam. Middle South Asia: Afghanistan, Bangladesh, Bhutan, India, Iran, Nepal, Pakistan and Sri Lanka. Oceania: Australia, British Solomon Islands, Cook Islands, Fiji, Gilbert and Ellice Islands, Nauru, New Zealand, Papua New Guinea, Pacific Islands, Tonga and Western Samoa.
Difficult Issues Underlying Food Problems

Harry Walters

World food problems developed with disturbing suddenness in 1972. Two decades of sufficient food—indeed surpluses, stable or declining food prices, large grain stocks, and large amounts of food aid seemed to indicate an increasing capacity to produce more food more efficiently. But in 1972 food prices rose sharply, food shortages developed, food aid shipments declined, and grain stocks fell to dangerously low levels. Subsequently, fears were expressed that the world might be near the limit of its capacity to increase food production while population continues to increase, so that some must starve (1) or the world's rich will have to share their food with the world's poor (2). In the background, climatic changes have been predicted that suggest even more ominous prospects (3).

Surprisingly, major studies carried out in 1974 to investigate the causes and character of present world food problems—one of them being the United Nation's own assessment for the World Food Conference in Rome in November 1974—did not reflect these cataclysmic anxieties (4). While the problems are serious, these studies all concluded that over the next decade more food can be produced and that the conditions existing now can be corrected.

The demand for and supply of food do have special properties which are important to an understanding of present problems. The demand for food grows fairly uniformly and predictably with population and income growth. For example, the world’s demand for grain is now increasing at about 25 million tons per year. This growth rate is fairly predictable, when grain prices are relatively stable, because of the rate of population growth, income growth rates, and the distribution of income around the world. The supply of food, however, can be unstable because of weather, other natural phenomena, and human and governmental decisions.

Contrary to what might be thought, food production grew at about the same rate in both the developing and developed countries during the past two decades—about 70 percent in both areas, or 2.8 percent annually. This growth of food production exceeded substantially the 2 percent annual growth in world population. On the average, therefore, the 3.8 billion people alive in 1973 ate 21 percent more food per person than was consumed by the 2.7 billion people living in 1954.

But annual population growth in the developing countries increased from 1.9 percent in 1950 to 2.5 percent by 1964 and has stabilized at that level since. In the developed countries, population growth was relatively stable at 1.3 percent throughout the 1950’s but declined during the 1960’s to 0.9 percent at present.

Rapid population growth in the developing countries thus limited per capita food production to less than 0.4 percent annually, while it rose at 1.5 percent per year annually in developed countries. Some developing countries and some groups in many countries did not, of course, experience any improvement.

With 86 percent of the world’s population growth now taking place in the developing countries, most people are born in areas where little improvement in per capita food production is taking place. Disruptions of food production in these areas quickly reduces the supply of food per capita to the low level of previous years, and this can turn into real hunger or famine for some groups.

Table 1. World production, consumption, trade, and stocks of major grains (excluding rice and minor grains) from 1960 to 1973; mmt, million metric tons.

<table>
<thead>
<tr>
<th>Marketing year</th>
<th>Area harvested (million hectares)</th>
<th>Yield (quintal per hectare)</th>
<th>Beginning stocks*</th>
<th>Production (mmt)</th>
<th>Total exports (mmt)</th>
<th>Consumption total† (mmt)</th>
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<tr>
<td>1960-1961</td>
<td>473.5</td>
<td>13.9</td>
<td>169.8</td>
<td>657.0</td>
<td>69.9</td>
<td>640.6</td>
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<tr>
<td>1961-1962</td>
<td>466.9</td>
<td>13.4</td>
<td>182.7</td>
<td>624.2</td>
<td>80.8</td>
<td>648.1</td>
</tr>
<tr>
<td>1962-1963</td>
<td>468.0</td>
<td>14.3</td>
<td>156.0</td>
<td>671.3</td>
<td>78.0</td>
<td>664.8</td>
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<tr>
<td>1963-1964</td>
<td>475.1</td>
<td>13.9</td>
<td>159.6</td>
<td>661.7</td>
<td>94.1</td>
<td>665.4</td>
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<tr>
<td>1964-1965</td>
<td>480.0</td>
<td>14.5</td>
<td>154.8</td>
<td>696.3</td>
<td>92.4</td>
<td>686.0</td>
</tr>
<tr>
<td>1965-1966</td>
<td>476.3</td>
<td>14.7</td>
<td>157.7</td>
<td>701.9</td>
<td>108.1</td>
<td>734.7</td>
</tr>
<tr>
<td>1966-1967</td>
<td>475.6</td>
<td>16.2</td>
<td>122.2</td>
<td>771.1</td>
<td>100.0</td>
<td>744.1</td>
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<tr>
<td>1967-1968</td>
<td>485.7</td>
<td>16.2</td>
<td>151.1</td>
<td>785.6</td>
<td>97.4</td>
<td>767.4</td>
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<td>1968-1969</td>
<td>491.1</td>
<td>16.7</td>
<td>163.1</td>
<td>822.4</td>
<td>89.7</td>
<td>794.4</td>
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<tr>
<td>1969-1970</td>
<td>487.4</td>
<td>16.9</td>
<td>191.3</td>
<td>825.7</td>
<td>102.1</td>
<td>839.3</td>
</tr>
<tr>
<td>1970-1971</td>
<td>476.1</td>
<td>17.3</td>
<td>168.6</td>
<td>823.7</td>
<td>109.2</td>
<td>855.5</td>
</tr>
<tr>
<td>1971-1972</td>
<td>484.4</td>
<td>18.8</td>
<td>131.5</td>
<td>911.4</td>
<td>111.2</td>
<td>892.8</td>
</tr>
<tr>
<td>1972-1973</td>
<td>497.4</td>
<td>18.5</td>
<td>149.3</td>
<td>888.1</td>
<td>141.8</td>
<td>925.4</td>
</tr>
<tr>
<td>1973-1974</td>
<td>499.6</td>
<td>19.4</td>
<td>108.1</td>
<td>970.4</td>
<td>151.0</td>
<td>959.5</td>
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* Stocks data are only for selected countries and exclude such important countries as the U.S.S.R., the People's Republic of China, and part of Eastern Europe, for which stocks data are not available; the aggregate stock levels have, however, been adjusted for estimated year-to-year changes in U.S.S.R. grain stocks. † For countries for which stock data are not available, or for which no adjustments have been made for year-to-year changes, consumption estimates assume a constant stock level. † Preliminary. $ 100 million tons is generally considered a worldwide minimum "pipeline" stock level below which there is no contingency reserve.
Policy Changes and Food Supply Response in the 1960's

At the beginning of the 1960's a dominant concern of the grain-exporting developed countries was to reduce surplus stocks and to increase markets. Grain stocks were between 70 and 80 million tons above a level of 100 million tons, which is considered a normal “pipeline” level, and equal to 1 year's normal exports (Table 1). There was widespread feeling that these stocks were a burden on taxpayers and an inefficient use of resources.

World Food Famine and Rapid Production Increases (1963 to 1966)

The efforts to reduce stocks were interrupted by other events. The Russians had major grain crop failures in 1963 and 1965. Unlike their earlier response to these shortfalls, the U.S.S.R. imported large amounts of grain after both crop failures. China also began to import wheat by 1960. India experienced major crop failures in 1965 and 1966 and imported large amounts of grain, much of it as food aid on concessional terms. The combined effect of these events raised grain exports sharply, and world grain stocks fell dramatically to about half of 1 year's annual exports (Fig. 1 and Table 1).

There was widespread fear of an approaching “World Food Famine” in the early 1960's (6). The major exporting countries expanded wheat production sharply (Fig. 2). The fertilizer industry responded with a dramatic 20-million-ton increase in capacity, assisted by important technological and transport improvements and low energy costs.

Serious attention was devoted to increasing food production in developing countries through the Green Revolution. The “revolution” depended primarily on high-yielding wheat and rice seeds exporting developed countries, especially the United States, farmers continued to receive the prices for grain that they had been receiving; but grain users, livestock feeders, and importers paid much lower prices because support policies had been changed. This stimulated both the feeding of grain to livestock in many developed countries and led to greater dependence on imports by developing countries, planned economies, and importing developed countries. Low prices of grain and food and reduced production of grain lowered the demand for fertilizer, which was then in oversupply, thereby causing fertilizer prices to fall to extremely low levels during the period from 1967 to 1971.

In this environment, anxiety about a “world food famine” was quickly displaced by enthusiasm about the unbounded success of the Green Revolution, which, still in its infancy, was experiencing by the early 1970's an erosion of the incentives previously provided. Despite the underlying weaknesses that were evident, the world food situation from 1967 to 1971 seemed to be characterized by inexpensive food and fertilizer. The potential vulnerability inherent in low grain stocks throughout the world received little attention in the face of such conditions and in the face of the recent large increase in production.

Surpluses and Low Prices (1967 to 1972)

By 1968-1969 “famine” had been turned back into “surpluses.” Grain exports fell and world grain stocks reached a new peak (Fig. 1). It is difficult now to recall the sense of pessimism about the future of food grain markets that prevailed from 1968 to 1971. Studies at that time projected long-run surpluses and falling prices for wheat and rice. Only feed grains seemed promising. The reemergence of “surpluses” caused the major grain exporters to reduce their wheat areas dramatically, shifting to feed grains or eliminating grain entirely; and their wheat production fell from more than 81 million tons to less than 60 million by 1971. World grain production held constant between 1968 and 1970, the declines in exporting countries being offset by growth in others (Fig. 3). Grain consumption continued to rise, however, with the effect that world grain stocks by 1971 had fallen sharply (Table 1).

This rapid reduction in grain stocks contributed to a further lowering of already low grain prices. In many grain-
ton, and rice prices increased from $130 to more than $500 a ton between 1972 and 1974. While this provided a tremendous stimulus to production, the stimulus fell on a fertilizer industry which, by 1972, had exhausted the sur-
plus capacity it had built up during the early and mid-1960's, and fertilizer prices rose almost as sharply—from $50 to $75 a ton in 1972 to $300 to $400 a ton in 1974.

Shipments of food and fertilizer as aid, which were dependent on large part on surpluses of both, dwindled as grain was drawn out of the United States, the largest supplier of food aid and the world's largest grain exporter. Food prices for the poor, who depend largely on cereals, rose sharply while food aid was dwindling.

The oil crisis, the devaluation of the U.S. dollar, rapid worldwide economic growth in 1972 and 1973, and inflation also played a role in these developments, but their role was primarily contributing rather than determining.

Future Possibilities and Issues

Developments over the past two decades point up four essential facts about food. (i) There is not one but many food problems, and a surprisingly large number of them are the result of human and governmental decisions rather than of immutable forces; (ii) food production can be and has been increased or decreased quite rapidly in "normal" conditions; (iii) food supply and price stability depend largely on stocks of food large enough to overcome shortfalls in production; and (iv) when food prices rise sharply, the poor are adversely affected.

Problems and Possibilities

All of the major studies of the world food situation in 1974 lead to generally the same conclusions.

1) There are sufficient resources—of land, labor, water, fertilizer, technology, and other capital—to increase food production substantially, at least in the next decade or two.

2) The major problem is to increase food production in those developing countries that have the potential to do so and that are facing the most severe food deficits.

3) If the trends of the past are not changed: (i) the food deficits of the developing countries will rise from about 20 million tons in 1970 to somewhere between 55 million and 85 million tons by 1985; (ii) the surpluses of the developed countries will match or exceed these deficits; but (iii) the transfer of much of this surplus to the sick poor countries would have to take place on concessional terms, which seems neither desirable nor likely.

4) Neither famine relief nor world food stability is possible without sufficient stocks of food to overcome unexpected and unpredictable disruptions in supply.

5) Malnutrition is a major problem that results largely, but not entirely, from low incomes. To correct this problem requires either an increase in the incomes of malnourished groups, an increase in the food production capacity of those within these groups who are farmers, or transfer of food to these groups. It will probably involve all three.

If these are the problems and the possibilities, it is worthwhile to consider their relation to the more popular concerns that have received such attention.

Are There Sufficient Resources to Increase Food Production?

Although concern has been expressed about the possibility that the world has reached or is nearing the limits of its food-producing resources, a number of recent studies on this question have indicated that there is about twice as much land on which to produce food as is now used—3.2 billion compared with 1.4 billion hectares. To bring this land into production would involve costs and much of such land is in Africa and Latin America where population densities are low. But the land resources exist.

A more important point is that land, as such, becomes progressively less important in food production as production methods are improved. In the developed countries over the past decade or more, land inputs decreased not because land was not available but because productivity (yield) increases were a more efficient means of raising production (Fig. 3). During the same period, yield increases in the developing countries accounted for about 60 per cent of the production increase. Yield increases will account for an even larger proportion of the increase in future production in the developing countries.

This realization has drawn attention to the future availability of fertilizer, which has recently been in short supply and experienced high prices. The energy crisis in conjunction with these developments has raised doubts about the availability and cost of fertilizer in the future. Two quite independent studies of this issue in 1974 indicated that the major cause for present shortages and high prices was the exceptional high demand and the present capacity limitations of the fertilizer industry (7). New fertilizer plants now under construction are expected to increase fertilized supplies substantially, so that prices should fall within a year or two. Prices are not expected to fall to the very low level prevailing in 1967 to 1971, but costs of higher energy and plant construction are not expected to cause fertilizer prices to remain high over the long term.

Sources of Food Production Increases

The crucial questions are not whether there are sufficient resources and techniques to increase food production, but whether the increases will come where they are most needed. While progressively larger food surpluses are projected in developed countries, it seems neither feasible nor desirable that the developing countries—primarily the grain-exporting countries—could or should produce large surpluses to be transferred to needy developing countries.

Food self-sufficiency in all countries is not only a desirable nor an efficient use of resources. The grain-exporting countries are undoubtedly efficient producers and can and should continue to increase production and exports. But it is equally clear that certain developing countries must improve their food production. Whether they can do so depends on whether they have the resources and techniques; whether they will be able and willing to devote sufficient resources to accomplish this; and whether the developed countries are willing to provide productive assistance.

Developing countries are not a homogeneous group. Some have large unexploited food production resources while others do not. Some are food exporters and some are and should be food importers. For some countries, especially the poorest in Africa, slow
food production growth is only one manifestation of a very complex set of economic and social problems associated with traditional societies. Countries, like India and Bangladesh, that have severe land limitations and extremely large populations face many other development constraints. The largest number of the world’s poor are found in these and other South and Southeast Asian countries, countries where the availability of food is largely a function of rice production, and rice production is in turn a major source of income. For countries such as these the issue is how to raise the existing, extremely low yields of rice (1 to 1.5 tons per hectare compared with 5 tons per hectare in developed countries) (Fig. 4).

On their own, it is not likely that countries such as these will have the resources to bridge this gap. Combinations of food and fertilizer aid and productive technical assistance will be needed for a long time.

Many of the basic techniques to raise yields in developing countries are known, but to transfer these techniques is extremely difficult. The early development of the Green Revolution (1950’s and 1960’s in Mexico and 1967 to 1972 in Asia) demonstrated that the adoption of new production techniques is a long-run process in which the benefits accumulate. The full benefits are not obtained until the country itself is able to develop an internal mechanism for adopting, modifying, and constantly improving the new techniques. The Green Revolution also demonstrated that new inputs—such as fertilizer and insecticides—are not readily adopted unless they are available, their use is understood, and the benefits of using them clearly exceed the costs.

One of the more disturbing facets of the world’s food problems is that, despite poverty and the low levels of productivity in many developing countries, the adoption of production increasing techniques often does not seem profitable because there is a limited market or the prices that farmers receive are too low to justify their use. A study of rice and fertilizer prices in 1971 demonstrated that in the major rice-producing Southeast Asian countries the farmer’s price of rice relative to the price of fertilizer was far less favorable than in developed countries.

**Future Stability of Food Supplies and Prices**

The stability of food supplies and prices during the two decades prior to 1972 was the result of uninterrupted growth in production, the existence of large grain stocks, and the absence of severe weather or import shocks to the world food system. While the evidence is not sufficient to support dire predictions of climatic change, 1972 and 1974 demonstrated that weather fluctuations can seriously reduce production. In 1974, much hinged on a good grain crop in the United States, but the weather turned bad and thus prevented a rebuilding of stocks and a reduction in grain prices. However, many farm prices have declined during the past few months and can be expected to decline still further if 1975 is a good crop year.

The world’s use of grain is now much greater than it was a decade or two ago and so is its interdependence. It seems self-evident that reserve food stocks are needed. But the past two decades have demonstrated that the maintenance of an appropriate level of stocks—in such a way that costs are not exorbitant, that both farmers and consumers are fairly treated, and that incentives to produce food where and when it is needed are not dampened—is an extremely complex undertaking involving both economic and political decisions that often need to be reevaluated. While such a system is being worked out (4), it would seem wise social policy to accept the need for stocks and absorb the costs of unexpected accumulations.

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**Fig. 3 (left).** World production, yield, and area from 1961 to 1963. All grain and rice are included. Rice is included as paddy as well as minor and mixed grains. [Data are adapted from the FAO Production Yearbook, volume 26 (1973); and FAO Monthly Bulletin of Agriculture Economics and Statistics, volume 23 (1974)]

**Fig. 4 (right).** World rice paddy production, year, and area, from 1961 to 1973. [Data are from FAO Production Yearbook, volume 26 (1973)]
Does "Rising Affluence" Impose a Restricted Diet on the Poor?

This is one of the most crucial questions that has been posed in the past 2 years. Many people in the developed countries have been shocked when they realized that they individually consume about 1 ton of cereals per year, most of it indirectly in the form of meat, eggs, and milk, while in the developing countries the average consumption of cereals is one-tenth of that, and very few livestock products are consumed.

Institutional Obstacles to Expansion of World Food Production

Pierre R. Crosson

Conditions for Adopting New Technology

Three conditions must be satisfied if farmers are to increase their use of fertilizers and the other ingredients of modern agricultural technology: (i) the technology must be invented; (ii) the farmers must know how to use it efficiently; and (iii) they must have incentives to use it efficiently. Incentives are determined by the price and productivity of the technology relative to the prices of the goods it produces, by the ability of the farmer to acquire the ingredients of the technology, and by the cost to the farmer of moving increased output to market.

The extent to which these three conditions are satisfied depends on the institutional structure within which the farmer lives and works. The more this structure encourages the flow of resources into development of and dissemination of knowledge about new technologies and strengthens farmers' incentives to adopt them, the faster will be the pace of agricultural development. Viewed in this way all obstacles to technological advance are institutional and all institutions may in principle be limiting. It is unlikely, however, that at any given time and place all institutions will be equally limiting. This suggests that a fruitful point of departure in assessing the ability of the LDC's to accelerate the growth of food production is to seek to identify the set of institutions most likely to limit the adoption of new technologies.

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C HANGES in American eating habits are knocking the props from under the nation's egg industry.

The average American ate close to 400 eggs in 1945. Last year, he ate only 287. Another decline of about a dozen

Profits in the industry, according to Mr. Cathcart, have been nonexistent for much of the past two years. During 1974, poultrymen lost an average of close to half a cent on each dozen eggs they sold. High feed costs and sinking prices in recent weeks have put even more red ink on their books, despite cutbacks in production.

U.S. NEWS & WORLD REPORT, July 7, 1975

Mood of America: US NEWS & WORLD, 6 Oct 1975

Despite a record crop this autumn, Midwestern farmers are unhappy. Their expenses have skyrocketed, and they see Washington's temporary embargo on more grain sales to Russia as "caving in" to AFL-CIO chief George Meany.

"They told us to plant more wheat, and now Mr. Meany says we can't sell it," complains Dick Andrews, who farms near Decatur, Ind. "Seems we've lost out to big labor, because big labor can give the President more votes."
INTERVIEW WITH SECRETARY BUTZ

Q. If farmers aren’t getting rich, who is?
A. You can’t say that anybody is getting rich at the expense of the consumer, but let me point out that what we call the “spread” in food prices has grown much more rapidly than returns to farmers. That’s the cost of getting food from the farm to the supermarket. At the present time, nearly 60 percent of the consumer’s food dollar goes for processing and distribution. The farmer gets roughly 40 percent at present prices.

For entirely too long we have focused attention on that 40 cents, and we’ve ignored the 60 cents that goes to the people in between the farm and the dinner table. I think it’s high time we took a look at that.

Q. What can be done to reduce costs in this area?
A. There are many things. What constitutes the 60 percent charge? It’s things such as transportation, labor and supplies. The big chunk of it is labor along all the line. The mere fact that we slowed our trucks down to 55 to 60 miles per hour increased the cost of moving beef from Sioux City to Philadelphia. I just cite that as a case in point.

There are many restrictive practices that we need to look at, such as the fact that Government makes it difficult to engage in the “back haul.” A farmer brings a truckload of livestock or produce, as the case may be, to a central market, and too often he has to return with his truck empty. If he could take a load back, it would cut the cost of transportation.

Many of the regulations that we’re now imposing in the name of environmental control, in the name of worker safety, under our Occupational Safety and Health Act, tend to be cost-raising.

Q. A couple of years ago you said that beef shortages were here to stay. Now beef is so plentiful that cattlemen are urging you to can some of it and send it to hungry people overseas. What caused the turnaround?
A. This is a cyclical feature that always occurs in cattle production. We have cycles in production and in prices that run from 10 to 12 years in length. It’s a historical pattern. We’ve been building up cattle numbers very rapidly. In 1973, we increased cattle numbers by 7 million head in this country. In 1974, we increased by another 5 or 6 million head.

Now we have to go through a period of adjustment—not to reduce numbers, but to stop the increase. And as we stop the increase, we increase the number slaughtered—and beef supply is increased and prices depressed.

That’s precisely where we are now. That’s the reason our per capita beef consumption in 1974 was approximately 7 pounds above 1973, and in 1975 may increase by another 6 or 7 pounds.

But in the longer run we’re going to need more cattle. As our population grows and as our appetite for beef continues to grow, we’re going to eat more beef.

Q. Much of the increase we’re going to get in beef production is reported to be grass-fed beef instead of corn-fed. Will Americans eat beef raised on grass?
A. Oh, sure they will. They’re doing that now. Grass-fed beef is not bad beef.

The number of cattle we have in feedlots right now is down some 25 percent from a year ago this date. So right now, much larger than normal share of our beef is grass beef. We have stores openly featuring it. I’m told that it’s moving well, at a little lower price than longer-fed beef.

I was 30 years old before I knew there was such a thing as longer-fed beef, and I grew into a pretty healthy youngster. It wasn’t bad eating.

We have made a proposal for revision of beef grades that would recognize the fact that the so-called choice grade ought to be broadened a bit, to include some grass-fed beef, which doesn’t have as much fat on it as we’ve thought we needed.

This went out for comments, and we’ve received opinions both ways. There has been some adverse consumer reaction. This is currently under study. I personally feel that we need to de-emphasize the large amount of fat we’ve had on our high-quality, long-fed beef in recent years. I think a roast can be just as good if you trim a quarter inch of fat off the edge as one where you have to trim three-quarters inch of fat off the edge. We need to de-emphasize the large amount of fat, which is very wasteful, in beef production and consumption.

Q. Would you be receptive to adding a new grade rather than broadening the choice grade?
A. This is under study. When you get to adding an additional grade, you run into problems of consumer acceptance, of re-educating both the trade and consumers. People get used to certain grade standards. This has to be considered.

Q. Some Senators and others are saying that every American should eat one less hamburger per week so that the United States can send more food to people overseas. You have opposed that. Why?
A. First, that slogan of eating one less hamburger per week is not very attractive to the cattleman who is losing money on his current operations. We need to eat more beef, not less beef, both in the short run and the long run.

Since the dawn of history, the companion of man has been the ox, the sheep and the goat. These are ruminants. Man has used these animals to convert forages, which he can’t use, into meat and milk, which he can use. At the present time, a much larger area of the world’s land is suitable for forage production than for grain production. And I guess I could argue that even now the world needs more ruminants, rather than fewer ruminants, to increase our capacity to feed people all around the world.

Q. So you don’t feel that if you and I would eat one less hamburger, this is going to make more wheat available for famine relief?
A. No, I certainly don’t, because we don’t feed very much wheat to our animals. We feed corn and grain sorghum—the so-called feed grains. These feed grains in the main are not consumed by human beings, except perhaps in Mexico and some other parts of Latin America. Corn is the most efficient converter of solar energy into grain crops that we have, that the world has, really; and the American corn belt is one of the most efficient areas to do this.

We produce a very substantial surplus of food grains. Our wheat crop was 1.8 billion bushels in 1974—it was a record crop. In 1975 it’s going to exceed 2 billion bushels, the way it looks now. We export two thirds of our wheat. We are the world’s great supplier of food grains.

Q. What can be done to help the starving people overseas?
A. One of the things that came out of the World Food Conference in Rome last November was a clear signal that we ought to broaden the basis for world food relief. The United States has a marvelous track record in this respect. We have put out 25 billion dollars’ worth of food aid around the world in the 20 years that Public Law 480 has been in existence—84 per cent of the world’s food aid in the last several years.

As long as the United States steps forward and says, “We are going to continue to take 84 per cent of this burden of food relief around the world,” I’m sure others will not rush forward and say, “Well, look, let us help you out.”
Green Revolution (I): A Just Technology, Often Unjust in Use

The Green Revolution is neither a miracle nor a hoax, nor has it shot its bolt. Before considering its social and economic impact, it is important to note that the acreage planted to Green Revolution crops—or high yielding varieties (HYV’s)—is still increasing in almost linear fashion, although the average yields of HYV crops have ceased to be quite as spectacular as in the early years. By crop year 1972/73, some 41.6 million acres in Asia and North Africa were being planted to HYV’s of wheat and 38.7 million acres to those of rice, amounting roughly to 35 and 20 percent respectively of the total wheat and rice areas in these countries.

The most distinctive of the Green Revolution package of practices is the seed. Traditional varieties of wheat and rice cannot make proper use of fertilizer since it causes them to grow too tall and topple over. The HYV’s incorporate a dwarfing gene which gives the plant a short, stiff straw and enables it to respond to fertilizer with larger yields. Other genetic improvements include resistance to certain pests—but chemical pesticides need to be applied as well—as well as insensitivity to day length, and shorter maturation, characteristics which together mean that a second crop can sometimes be squeezed in before the end of the growing season. Besides fertilizer and pesticides, most HYV’s developed so far also respond best to controlled supplies of water, which requires the land to be irrigated, not just rain fed.

A second major criticism made by economists and sociologists is that the Green Revolution displaces labor and increases rural unemployment. Like almost every other effect the revolution is praised or blamed for, rural unemployment existed and was on the rise before the new techniques were introduced. The Green Revolution should in theory be labor-intensive. The HYV’s require more care and attention in ground preparation, planting, and harvesting. Where they make it possible to get a second crop into the growing season, they double the need for labor. But in part because of its labor-intensity, the Green Revolution also offers the incentive—and profits—for the larger farmers to mechanize.

The mechanization that in practice accompanies the Green Revolution is itself double-edged; the use of tractors for rapid land preparation, for example, may create extra jobs by giving time for a second crop. But overall, mechanization is job destroying. According to one estimate, nearly 20 percent of labor in the Punjab will be displaced by machines by 1984.

Though HYV acreage has expanded each year, there has been a slow but steady decline in yield. According to Indian government statistics, yields of HYV wheats have dropped from nearly 4 to 2½ times those of traditional varieties over the last 6 years and rice yields have also fallen off (see Table 1). Bad weather probably contributed to yield declines in the 1970’s, but the principal cause underlying the downward trend is simply that the best land tends to be planted first to HYV’s. A rule-of-thumb estimate by Dana G. Dalrymple of the U.S. Department of Agriculture is that if HYV’s and traditional strains were grown on the same quality land, the HYV package in irrigated areas would probably give yields about 50 to 100 percent greater for wheat and 10 to 25 percent greater for rice.

These are quite modest margins of superiority compared with the multiple yields often talked about—a sharp illustration of the gap between the farmer’s field and the researcher’s experimental plot.
World Food: A Perspective

Thomas T. Poleman

One's view of the historical sweep of things is inevitably colored by the events of the day. In times of boom we tend to accept growth and change as the natural order of man, just as the occasional recession will bring forth dire prophecies of endless doom and gloom. And so it is that the escalation in food prices during the past couple of years has been accompanied by a revival of the fear, periodic in its emergence, that the world is running out of food and that some cataclysmic Malthusian solution will shortly be upon us.

Whether or not such fears are justified—and I think they are not—there is no question that the recent concern over agriculture has come as a rather surprising ending to a most extraordinary quarter century. We sometimes forget how great has been the change of the past 25 years. The real product of the world perhaps trebled, so that on a per capita basis we are on the average twice as well off as we were in 1950. Change, to be sure, has been concentrated in the developed countries, but not exclusively. The explosion in education and literacy has been worldwide. The Indian born today has a life expectancy of half again what it would have been at mid-century. Famine, if not entirely eliminated, has come to be localized and to reflect political failings more than anything else. The only year in which global indicators of food production turned down was 1972.

Despite this positive record, an overtone of Malthusian pessimism pervades the majority of assessments of the food situation since World War II. It has never been entirely clear why this should be the case. In part, I suppose, to prophesy catastrophe is a time-honored means for selling books. And the tidiness of the Malthusian apocalypse has a certain fundamentalist appeal. But in part also it finds support in all but the most recent publications of the Food and Agriculture Organiza-

The Wisdom of the 1950's

During the decade and a half in which the five surveys held sway, a rash of publications on food and population appeared in both the popular and scientific press. Most proclaimed that a new Malthusian debacle was upon us. Drawing heavily on the statistics presented in the three FAO and two USDA reports and on population projections for the LDC's, a majority of authors concluded that the world would shortly be unable to feed itself. Certainly starvation would be upon us by the year 2000 when global population was expected to reach 6 billion people. One went so far as to forecast widespread famine by 1975 (11).

A few voices were heard on the opposite side. In the early 1950's, M. K. Bennett, in many respects the first student of world food economics, detailed the drawbacks of the methodology followed in the World Food Survey and argued persuasively (to a limited professional audience) that the FAO was almost certainly overstating the magnitude of the world food problem (12). In amplifying this theme, some, Colin Clark being the most vocal, carried it almost to an opposite extreme, suggesting that the world could feed vastly greater numbers and that population growth was in certain instances probably a good rather than a bad thing (13). But few saw reason to listen. Continued population growth could only bring about a worsening of an already bad situation.

The 1960's: Pessimism, Then Optimism

Since the Third World Food Survey and the second World Food Budget were released in the early 1960's, there have been three sharp swings in popular thinking about global food problems. According to such generally used series of "world" production as that of the USDA plotted in Fig. 1, the LDC's seemed to be making fair, though hardly spectacular, progress from the mid-1950's to 1964. Then suddenly, 1965 and 1966 witnessed a leveling off of output and a marked deterioration in per capita supplies. Cursory disaggregation indicates that this change resulted almost exclusively from two successive droughts in India. Indian production bulks so large in the LDC aggregate that major fluctuations in her output visibly influence the index for all developing countries. This fact, however, was lost on many commentators. Looking at the figures and hearing of massive Public Law 480 shipments abroad—of the 30 million tons of grain shipped during the 2 years ending in June 1967, 15 million went to India—many people concluded that we were faced with a truly global problem and that starvation was just around the corner.

A reaction began to set in only a year later and again closely mirrored the Indian situation. A sequence of favorable years in terms of weather was accompanied by introduction into the Punjab of high-yielding varieties of Mexican wheat. The result was that the index of production for all low-income countries rose steeply, as did per capita availabilities. The assessment was as extreme in the opposite direction as it had been in 1965 and 1966. This was when we first began to hear of the Green Revolution. The situation in Northwest India, together with the introduction, as a consequence of work at the International Rice Research Institute and elsewhere, of high-yielding, stiff-strawed, fertilizer-responsive rice in wetter portions of Asia, led many to believe the situation had been fundamentally altered and that feeding the world's rapidly increasing population no longer posed problems. So pervasive was the optimism that the FAO even suggested in its State of Food and Agriculture for 1969 that the food problems of the future might well be ones of surplus rather than shortage (14).

Lending statistical comfort to this more cheerful view was FAO's 1971 evaluation of the global food picture. In response to criticism that its protein and energy allowances were excessively cautious, FAO in 1971 convened a new expert group to review them. Surprisingly modest reductions on the energy side were recommended, but the protein figures were slashed by a third. Although this reduction was accompanied by the warning that a portion of dietary protein could be used to meet energy needs if energy intakes were insufficient and that protein malnutrition could therefore occur even when supplies
were apparently adequate, the effect was to convert the list of "protein deficit" countries to ones of sufficiency. If the protein problem did not disappear overnight, its statistical underpinnings seemed to (15).

1972 and All That: Aberration or Permanent Turnaround?

The events leading to the latest turnabout in the food situation and to renewed popular concern for the adequacy of world supplies involve more than the shortfall in the 1972 grain crop and the subsequent running down of U.S. stocks. Simultaneously at work have been longer-term forces acting at home to hold down U.S. production and in importing countries to heighten the demand for American grain.

The agricultural capabilities of North America are vast; and, if U.S. farm policy over the past half century can be thought of as having a theme, it has been to prevent this productivity from driving down prices to the point where income to farmers could be maintained only by a massive exodus from the land. Whether or not the exodus has been slowed is debatable, but the tinkering with the market mechanism has been on a scale befitting the world's wealthiest nation. From Soil Bank to Public Law 480 to drowning baby pigs, little that might elevate prices has not been tried.

The Kennedy and early Johnson years saw the introduction of policies that were more costly to the government but more effective in limiting production. Support prices were lowered, and, to compensate for this, direct payments were made to farmers who agreed to keep a portion of their cropland idle. The effect by the late 1960's was to stabilize production and to make U.S. grain more competitive on the world market. This competitiveness was reinforced by devaluations of the dollar, totaling almost 20 percent, between 1971 and 1973.
Far less land and far less labor are needed to produce a thousand calories of energy value in the form of the starchy staples than in the form of any other foodstuff. Meat producers by comparison are inefficient converters; an animal must be fed between 3 and 10 pounds of grain for it to produce a pound of meat. But most people enjoy meat, and they turn away from the starchy staples as they become wealthier.

A simple way to rank diets is according to the percentage of total calories supplied by the starchy staples and an easy way to record change is to monitor shifts in this starchy staple ratio. In the United States the ratio stood at 55 percent a hundred years ago, when our great-grandparents consumed large amounts of bread and potatoes. Today our diets are dominated by meat, fats and oils, sugar, vegetables, and dairy products; and the starchy staple ratio has dropped to just over 20 percent. Yet per capita grain disappearance has risen to 1800 pounds per person per year. Of this amount less than 100 pounds are directly consumed; the bulk of the remainder is fed to animals (16).

Precisely this sort of dietary shift underlies the growing imports of grain by Europe and Japan, a shift accelerated by the boom years of the early 1970’s. A similar shift to a less efficient, meatier diet is taking place in the U.S.S.R., where over the last 15 years impressive gains have been recorded in the agricultural sector. Prior to the reforms initiated by Khrushchev, farming was the weak sister of the Soviet economy. Little was given it and little expected.

What is remarkable about Khrushchev’s reforms is the speed with which they have altered the Soviet diet. In 1950 the starchy staple ratio stood at 72 percent. By 1960 it had dropped to 59 percent and is now of the order of 50 percent. The Soviet consumer still accounts each year for several hundred pounds of grain consumed more or less directly, but total per capita disappearance has risen to 1600 pounds (17).

Not even the most totalitarian government would attempt to reverse such a trend of dietary improvement, and the Russian leaders obviously have no intention of doing so.

What does this mean? Because the FAO now (quite reasonably) reckons energy needs in South Asia average about 1900 kilocalories daily and protein adequacy to be a function of energy adequacy (25), it could mean either of two things. If the standard factor of 15 percent is applied to account for wastage between purchase and actual ingestion, the 200-kilocalorie gap could be interpreted as implying enforced reduced activity among the poor or actual physical deterioration (or both). Alternatively, one might postulate caloric adequacy among that element of society which is too poor to waste anything and which, because of the high rate of unemployment in Sri Lanka, leads a less active life and thus has lower energy needs. Thus you can have it either way: depending on your assumptions, you can prove beyond a statistical doubt that 43 percent of Ceylonese suffer protein-calorie malnutrition or none do.

One suspects that FAO’s response to this opportunity for “bias in, quantification out” has not been to minimize the number of people suffering protein-calorie malnutrition. Although Africa remains pretty much a statistical vacuum, it is not easy for anyone who has spent time there to accept the notion that a quarter of its population is underfed. None of the materials I have worked with suggests anything like so severe a problem, nor does ocular inspection. The same applies to the Near East. The 13 percent estimate for Latin America may not be too wide of the mark; at least it checks out with an evaluation we recently completed using some fairly trustworthy data for Lima (26). The Far East—and what is referred to is really South and Southeast Asia—is the big question mark. The 30 percent estimate is no doubt too high for the region as a whole, but may well be pathetically accurate for parts of India and Bangladesh.

Exaggeration or not, Table 1 and the changes at FAO that it implies are long overdue and welcomed. What we once thought to be a global food problem is, in fact, largely an Asian problem, and rising incomes hold the key to its resolution.

Among the things the Sahelian states inherited from the French was a policy of assuring jobs for all secondary school graduates. At one time this policy may have been the logical one to promote education, but as school enrollments have burgeoned and economies have stagnated, it has served to swell the unproductive ranks of the civil service. Budgetary crises have ensued and civil service salaries have been held down by controlling the price of food. But by pegging the millet price at about half what it otherwise might have been, it has been made unprofitable for farmers to grow more than they and their families require.

The employment-equity-income problem is another matter. How it will ultimately resolve itself remains a source of debate and speculation. Most observers seem prepared to follow the lead of the World Bank and USAID and accept that the solution has to lie in an increasingly labor-intensive agriculture (30). This view has taken on added respectability since the rediscovery of China.

Those who are not so certain—and I am among them—base their skepticism on a fear that reliance on eight-acre man will lead to equity without growth. It is not just that technical change in the countryside is more capital than labor-demanding. The noble peasant is a rich man’s delusion. People infected with rising expectations prefer almost anything to farming, and history equates progress with a decline, not a rise in agricultural employment. Over the long pull it would seem more promising not to flaunt such basic tendencies and to look instead to a revamping of the development process that will bring its benefits, particularly those having an effect on fertility behavior, to all. This may well imply consumption planning, massive welfare schemes for the generation of employment, and other things with which we are little experienced (31).
The Great Food Fumble

Fred H. Sanderson

Causes of the Food Crisis

What, then, accounts for the sharp deterioration in the world balance of supply and demand in the past 3 years? Why did grain and soybean prices more than triple (Fig. 1) (2)?

It is the purpose of this article to show that these events (6) can be explained essentially as the result of transitory factors: an unusual, but not unprecedented, series of crop shortfalls in the U.S.S.R., South Asia, and North America; and the failure of the major producing and consuming countries to prepare for such an eventuality. However, long-term factors, making for greater instability in world agricultural trade, played a contributory role.

As it turned out, the growth of population has exceeded the most pessimistic expectations. Yet world grain production (which accounts for the bulk of the original food energy produced), kept sufficiently ahead of population growth to permit an annual improvement in per capita consumption of about 1 percent. To be sure, the improvement was not shared equally among rich and poor. In the affluent countries, with production rising by approximately 3 percent a year, and population growing by only 1 percent, a 2 percent annual increment in grain supplies was available for livestock feeding to support the rising demand for animal products. In the densely populated developing countries, where the diet still consists predominantly of grain and nearly all the grain produced is needed for direct human consumption, the growth of production—though also about 3 percent annually—barely kept ahead of population growth (about 2½ percent). This situation, of course, is extremely unsatisfactory, if we bear in mind that perhaps one-third of the people in these countries continue to live on the margins of subsistence; but it is not new.

to restrain production. Between 1967 and 1972, U.S. wheat acreage was cut back from 59 to 48 million acres; the U.S. coarse grain acreage was cut from 103 to 96 million acres. Canada's wheat acreage was cut from 31 to 22 million acres. If the acreage had been held at the 1967 level, more than 100 million tons of additional grain would have been available in 1972. If the acreage had been held at the somewhat lower 1968 level, more than 50 million tons of additional grain would have been available—more than enough to ride out the crop failures of 1972 to 1974 without significant price increases.

The U.S. Department of Agriculture was slow in reversing gears even though it had become apparent that the market had turned around. So anxious was the department to "get rid of the surpluses," even after the Soviets had entered the market on a massive scale, that it kept increasing wheat export subsidies to offset the increase in domestic prices. Thus export subsidies amounting to about $300 million were committed within a few weeks before they were terminated in the summer of 1972. Acreage restraints were not lifted completely until the 1974 crop.

Admittedly, cause and effect are always seen more clearly with the benefit of hindsight. However, poor harvests have occurred in the past, sometimes affecting two or more areas of the world simultaneously or in rapid succession. North America experienced two severe drought years in the mid-1930's affecting all grains, and two more droughts affecting wheat. Crop failures in the U.S.S.R. in 1963 and 1965 and in India in 1965-1966 and 1966-1967 were the major factors in the 41-million-ton decline of major exporters' grain stocks, and the 46-million-ton decline of U.S. grain stocks during that period (Fig. 2).

Such a buffer stock could serve the interest of farmers as well as consumers in both exporting and importing countries. It would tend to support farm incomes when prices are low, while avoiding excessively high prices such as we have seen recently. It would not interfere with the functioning of the market but would influence the market in a predictable fashion.
Food fumble

As a rough estimate, based on data for 1972, a working carryover of about 20 to 25 million tons may be expected to be held privately, leaving a reserve of 95 to 100 million tons that would have been required to keep grain prices at their 1972 levels. Alternatively, the price increases could have been substantially moderated if we had entered 1972-1973 with a reserve of 80 million tons, instead of 60 million tons.

For the United States today, it is therefore appropriate to weigh benefits against costs. Yet this is an area of considerable uncertainty, partly because we lack adequate quantitative analyses of probable costs involved in carrying stocks adequate to keep prices within stated limits; and partly because of differing perceptions of the benefits (one man’s benefits may be the other man’s cost).

It is possible, however, to get a rough idea of the costs involved in carrying a specified level of reserves. To carry a stock of 80 million tons would involve around $450 million annually in storage costs alone. To this one would have to add interest costs and then deduct the price gain on resale. Both of these factors are affected by inflation:

Another benefit stems from the interest of the United States in preserving and developing its agricultural export markets. In 1974, grain and soybean exports brought in about $16 billion or 22 percent of total U.S. export earnings. It is true that current shortages and the resulting high prices were helpful in swelling our export proceeds for these commodities; in the long run, however, excessive instability of supplies and prices would be likely to stimulate protectionist tendencies abroad. Equally damaging to our export interests are the pressures for export controls, which are difficult to resist in times of acute shortages. The embargo on soybeans in the summer of 1973 and the barely averted threat of export controls on grains in 1974 already have led our traditional customers in Europe, Japan, and elsewhere to have second thoughts about their dependence on the United States as a supplier. A grain stabilization reserve would help to assure importing countries of uninterrupted supplies at reasonably stable prices, an assurance that is essential if these countries are to proceed with trade liberalization.

Last but not least, the United States shares with other countries a concern about averting famine abroad. The FAO has estimated that, on present trends, population plus income growth will boost net import requirements of the developing countries from an average of 16 million tons in 1969 to 1971 to 85 million tons by 1985 (5). Imports of this magnitude, while not precluded physically, would place a heavy burden on these countries’ ability to earn foreign exchange. Even assuming wheat prices drop back to about $100 per ton f.o.b. Gulf ports, the foreign exchange cost would be about $10 billion.

The possibility that millions of acres of efficient American food production capacity may again be idle because of acreage controls is difficult to reconcile with this prospect. If it should again become necessary to support American farm incomes, it would seem to make more sense to accomplish this objective through a carefully planned build up of reserves for future emergencies, and substantially expanded food aid. To secure appropriate foreign participation in food aid, the United States could propose an increase in the quotas under the Food Aid Convention, from the present 4.2 million tons to 10 million tons, and increased pledges to the World Food Program.

Does food aid make sense? There are many people who question present programs on the grounds that they do not reach the people in greatest need and that they may cause developing countries to relax their efforts to increase agricultural production and to control population growth. A more fundamental criticism is that aid funds could be spent more efficiently on fertilizer and agricultural development assistance, and, most efficiently, on education and research.

What the critics overlook is the element of time. It takes time to overcome the enormous technical, educational, and institutional obstacles to agricultural development. Even with greatly increased development assistance, there is a point beyond which the rate of improvement cannot be speeded up. The same is true of population control.

This does not mean that food aid should be regarded as a substitute for more direct ways of dealing with the basic problem, which is to speed up the growth of food production and to slow down population growth. There has been a marked shift in recent years in both U.S. and international economic assistance programs toward increased emphasis on agriculture, rural development, and family planning. Cooperation by the newly affluent oil exporting countries should make it possible to expand this effort several-fold. To enlist their interest, it will be worth pursuing the proposal of an International Agricultural Development Fund which was put forward by some of the Arab countries and endorsed by the World Food Conference.

9 MAY 1975

![Fig. 2. Total grain production, in the United States, the U.S.S.R., and India and beginning stocks of 3 major exporters. Rice is included on a milled basis. The data for 1974 are preliminary. The data are taken from (19).](image)

Table 1. Net exports (+) or imports (−) of grains, excluding rice (3, 17).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
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<td>+70.7</td>
<td>+74.9</td>
</tr>
<tr>
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</tr>
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</tr>
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<td>+18.7</td>
<td>+21.6</td>
</tr>
<tr>
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<td>+15.2</td>
<td>-17.5</td>
<td>-19.4</td>
</tr>
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<td>+1.0</td>
<td>-19.6</td>
<td>-4.6</td>
</tr>
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<td>-8.9</td>
<td>-8.0</td>
<td>-5.2</td>
</tr>
<tr>
<td>China</td>
<td>-3.7</td>
<td>-3.3</td>
<td>-6.1</td>
<td>-7.7</td>
</tr>
<tr>
<td>Developing countries</td>
<td>-15.4</td>
<td>-26.9</td>
<td>-23.2</td>
<td>-30.3</td>
</tr>
</tbody>
</table>

Also see P. 21

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World Starving for Fertilizer

In a world desperately short of food, this question is being raised:

Should Americans continue to lavish fertilizer on lawns and golf courses while millions of people in poor nations go hungry because there is no fertilizer to nourish their crops?

In Congress, 38 Senators are on record in favor of limiting fertilizer use in the U.S. so that more can be shipped to underdeveloped lands.

"Many less-developed countries... have been struck simultaneously by escalating prices for oil, food and fertilizer. They cannot afford the fertilizer needed to sustain past progress in food production under the green revolution."

The U.S., by far, is the world's largest user of fertilizer, with consumption in the crop year now under way estimated at 20.2 million tons of actual plant nutrients.

Russia, with more land under cultivation than the U.S., will use 14.5 million tons. Communist China will apply somewhat more than 6 million tons to its vast cropland, while India will use 3.1 million tons.

**IN U.S., USE OF FERTILIZER IS RISING STEADILY...**

![Graph showing rising fertilizer use in the U.S.]

**...AND FAR OUTPACES OTHER NATIONS**

<table>
<thead>
<tr>
<th>Country</th>
<th>Tons of Fertilizer Used in U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>20.2 MILL.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>18 MILL.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>16 MILL.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>14 MILL.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>12 MILL.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>11 MILL.</strong></td>
<td></td>
</tr>
</tbody>
</table>

*India, with approximately the same amount of land under cultivation as the U.S., will use an estimated 3.1 million tons of fertilizer in the crop year under way.*

*Russia, with more land in crops than the U.S., will use 14.5 million tons.*

**Other major users:**

- Communist China: 6.1 mil. tons
- France: 6.0 mil. tons
- Australia: 1.2 mil. tons
- Canada: 1.3 mil. tons

Note: Tonnages are the actual amounts of nutrients and do not include inert materials mixed with most fertilizers.

A spokesman for the plant-food industry, Edwin M. Wheeler, who is president of the Fertilizer Institute, agrees with the objective of making more fertilizer available to the less-developed countries.

He asserts, however, that this is more easily said than done, and that to continue the present "drum beating" program is "cruel, for it is raising false and frustrating hopes in the less-developed nations." He notes a headline in a recent issue of "The Hindustan Times," which read: "America May Give Fertilizers to India, Bangladesh."

Mr. Wheeler says that even if Americans did quit applying nutrients to their lawns and golf courses, the amounts saved would never reach the poor nations unless elaborate plans were worked out. Otherwise, he says, U.S. farmers "will soak up the tonnage like a blotter," because they have been unable to buy all they need.

Statistics compiled by the Fertilizer Institute indicate that no more than 3.5 per cent of total use in the U.S. goes for nonfarm purposes.

"Unrealistic talk." An official of the Food and Agriculture Organization of the United Nations, Robert W. Steiner, takes this view:

"It is unrealistic to talk about fertilizer being taken from golf courses in America to supply farmers in Sri Lanka. What is needed is funds from the wealthier countries to secure fertilizer deliveries and to help pay shipping charges to the users."

A primary cause of India's problems is the high cost of imported oil. Its oil bill this year will run about 1.2 billion dollars, compared with 350 million in 1973.

This means the country's oil-fed fertilizer plants not only are running behind in production—while demand is rising—but that less money is available to import increasingly expensive fertilizer from other countries.

To make matters worse, a power shortage has forced many farmers to turn to diesel fuel to run irrigation pumps. When the energy crisis hit, they had to stand in line for days to get a ration of only 2½ gallons.
Crop Protection to Increase Food Supplies

W. B. Ennis, Jr., W. M. Dowler, W. Klassen

Today, pests cause an estimated 30 percent annual loss in the potential worldwide production of crops, livestock, and forests. No part of our food, feed, or fiber supply is immune from pest attack, whether it involves marine life, wild or domestic animals, field crops, horticultural crops, or wild plants. Obviously if losses could be prevented or reduced food supplies would be increased. Although the problems are complex, the best strategy for achieving short-term gains is to make better use of existing technologies in production systems throughout the world.

Technologies for Managing Pests

Devising methods of avoiding crop losses has always been a challenge. Early farmers gradually learned to select plants that withstood disease and to use physical methods of reducing losses due to insects and weeds. The simplest method of dealing with both depleted soils and pest problems was to move to new arable land. When that solution was no longer routinely available, the sophisticated and scientific study of crop protection began. Today, as a consequence, methods are available that prevent potentially catastrophic losses due to pests.

However, changes in production systems often favor pests, and new pest strains and pest species appear. These changes in past populations are so great and come so frequently that scientists often are hard pressed to prevent serious reversals in the battle with pests. Frequently, trade-offs must be made among yield, quality, and cost.

In the United States agriculture relies heavily on crop protection chemicals to maintain a high level of production. These chemicals are integrated into a production system that includes use of other vital components. Without pesticides it is estimated that the total combined output of crops, livestock, and forests would be reduced by at least 25 percent; the price of farm products would probably increase by at least 50 percent; and we would be forced to spend 25 percent or more of our income for food (13). There is, therefore, concern about losing any pesticide that farmers have relied on to protect their crops against pests.

In the foreseeable future, chemical pesticides will undoubtedly remain the primary method of augmenting other controls because without them we cannot maintain present crop production, or more important, increase it. Meanwhile, we must continue the search for more effective pest control methods and for new approaches that will reduce crop losses and costs—in money and in effect on the environment.

When technologies are integrated for pest management, interrelationships among pests, hosts, and the environment are considered, and different approaches may be required in different localities or even in adjacent fields.

Actions to Reduce Losses

Since more food will be required to meet worldwide demands in the future, we must turn to double cropping, increased use of fertilizers and irrigation, planting large acreages to individual crops, and use of high-yielding varieties and effective pesticides. Such intensification will inevitably increase crop protection problems. For example, the rice whorl midge was not a significant pest in the Philippines until irrigation and continuous cropping of rice became a common practice (14). Now this insect causes yield reductions up to 25 percent. Our success in providing necessary food supplies hinges on our ability to cope with pest problems of this type.

National Wildlife Fed. 15 Aug 75

More than a year before the new federal pesticides control program goes into full effect, Congress and the Environmental Protection Agency (EPA) are butting heads over the need to restructure this four-year program which was set up in 1972 to assure the protection of public health and the environment. While some legislators are pushing strongly to give the Department of Agriculture (USDA) veto power over EPA's pesticide control authorities, EPA is vigorously opposing the measure along with more than 20 other proposals being considered in the House Agriculture Committee.

How did this major environmental conflict develop only three years after Congress revamped the existing pesticide control program with the enactment of the Federal Environmental Pesticide Control Act of 1972 (also known as the 1972 Amendments to the Federal Insecticide, Fungicide, and Rodenticide Act)? Dissatisfaction with EPA's banning of DDT, aldrin, and dieldrin plus restrictions on the use of pesticides for predator control are part of the reason.
Management of Famine Relief

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Jean Mayer

Causes of Famine

Almost all recorded famines have resulted from widespread crop failure. (A notable exception was the Great Plague of 1345 to 1348 in Europe in which 43 million people are said to have died. In that instance, the massive epidemic came first, totally dislocating society and bringing on famine.) These crop failures in turn may be caused by drought, crop diseases or pests, the impact of war or civil disturbance, or a combination of disturbances hitting both crops and farmers, such as floods or earthquakes. All of these four sets of causes have been at work in famines that have occurred since 1950 alone: flood, drought, and civil disorder in India and Pakistan; locusts and earthquakes in the Middle East; floods and dislocation of the agricultural system in China; earthquakes in Latin America (including the recent Peruvian disaster); and drought and civil war in Africa (the Sahel, the Congo, and Biafra) (2).

dams were destroyed and the irrigation canals abandoned. Desert now covers what had at one time been one of the great cities of the world: the capital of Cyrus and Darius is now a mound of sand. The second largest theater in the Roman Empire stands in the Libyan desert as a reminder of how drought, erosion, and famine can destroy seemingly permanent civilizations. More recently, northwest India and the Sahel offer us striking examples.

Famine Relief

The most immediate problem in a famine is to have a clear picture of the situation. With much of the structure of society broken down, with rumors flying (governmental sources generally minimizing the extent of the catastrophe and antigovernmental sources exaggerating it), it is often difficult to know where the most pressing needs are and what the scale of the need is.

The simple explanation is that the profit is not, in general, to be found in the production end of the business. A major deterrent to corporation farming is the price of prime agricultural land, which has doubled and even trebled in the past few years. Corporations are reluctant to tie up the necessary amounts of capital in land and machinery on which the record shows that the return on investment is likely to be low—perhaps 3 to 4 percent a year if things go reasonably well. Furthermore, farming lends itself poorly to centralized management. Decisions on when to prepare the soil, plant, cultivate, and harvest require training, experience, and a close knowledge of local conditions; and they cannot be made from corporate headquarters. Hired managers may not be disposed to make the exertions—the 18-hour day is a necessity in some circumstances on a farm—or to minimize costs as the owner-operator is.
Food Production: Technology and the Resource Base

Scientific Frontiers: Livestock

S. H. Wittwer

Animals cannot be ignored if one is to consider seriously the food-population-environment issue. They may be providers for the human population or directly competitive with it, as in the case of pets (cats, dogs, and horses) (29).

There are an estimated 100 million cats and dogs in the United States. They compete directly with people for food. The birth rate is 3000 per hour compared with 450 human babies. The annual pet food bill is $2.5 billion—six times that spent on baby food. Of the total, $1.5 billion is spent on dog food alone (30). In addition to the urban problems caused by dog feces and urine and dog bites, wild dogs cause a $5-million cattle loss each year. The cost of pet health care approaches $5 billion and is directly competitive with veterinarian services for farm animals. There is little interest among the new crop of veterinarians to serve cattle, swine, and chickens when cat, dog, and horse hospitals are far more remunerative (31).

Horses for recreation are the most rapidly expanding group of large animals in the United States. The estimated increase is 10 to 15 percent per year. No accurate inventory is available. There are now at least 8 million. They are nonruminant herbivores, and while they consume much roughage, they, along with cats and dogs, compete directly with man for grain.

There are at least four frontiers of technology for improvement of crops for livestock: higher-yielding types, increased nutritive values, improved harvest techniques, and the merger of production and utilization systems. Forages provide more than two-thirds of the feed units consumed by ruminants (37), that is, 75 percent for beef cattle, 65 percent for dairy cows, and 90 percent for sheep. Improvement of corn and sorghum for forage as well as for grain should be an immediate goal.

There are other frontiers for advancements of productivity with livestock (7, 40). A new high of 50,759 pounds of milk in 365 days was achieved in 1974 by Mowrey Prince Corinne, a Holstein cow in Pennsylvania. The lifetime production record of 335,000 pounds is held by OR-WIN Masterpiece Riva of Adrian, Michigan. Increased rates of gain are being registered for crossbred beef cattle. Litter size in swine can be substantially increased (84 percent above the national average) by alterations in the natural hormone balance at the time of implantation. Swine have broken the "2 pounds of feed per 1 pound of gain" barrier. The number of lambs and frequency of lambing in Finnish Landrace sheep and in crosses between this breed and domestic ones are two to three times higher than average performance heretofore. Twinning in beef cattle could be a reality in 10 years.

Fertilizer as a resource in crop productivity is no longer a luxury item for high-value crops. Thirty to 40 percent of the increased agricultural productivity in the United States in recent years is directly attributable to increased fertilizer usage (50). For developing nations it may be 50 percent (51). A fourfold increase in the cost of imported oil has precipitated a threefold jump in the price of nitrogen fertilizer. Increased food and feed prices are partially compensating for the additional cost of fertilizer. Recent shortages of fertilizer, arising from a rapidly rising demand (which could be a good sign), have intensified difficulties of expanding crop production, especially in developing countries.

Conclusions

Despite a growing population and increasing demands of that population for improved diets, it appears that the world is not close to universal famine (3, 53). There is enough food now produced to feed the world's hungry (54). That people are malnourished or starving is a question of distribution, delivery, and economics, not agricultural limits. The problem is putting the food where the people are and providing an income so that they can buy it.

As to the future, there are clouds on the far horizon. Only increased scientific and technological innovation, coupled with a change in human behavior and in national policy with regard to increased investments in agricultural research, can avert a growing food and population crisis. Only scientists develop new technology. Only farmers produce food. Motivation and incentives are important both for scientific discovery and food production.

Agricultural research is also a process. There is no finite beginning or end. It is a continuing search to unravel mysteries.

We must force the pace of agricultural development, but technology must be tailored to local conditions. This can be done by scientists who also know how to farm. Individual dedication and sustained government commitments are important.

Rapidity of information transfer and of acceptance of technology is also crucial (55). There is a wide gap between progress in research and the point of application for human benefit (Table 5). What accounts for the vast time differences in rapidity of technology acceptance?

Table 2. Food grains, ranges of protein and lysine. The assistance of F. C. Elliott with this table is gratefully acknowledged.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Protein (%)</th>
<th>Lysine (%) in protein</th>
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</thead>
<tbody>
<tr>
<td>Corn</td>
<td>8-15</td>
<td>1.6-4.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>8-20</td>
<td>1.7-4.1</td>
</tr>
<tr>
<td>Rice</td>
<td>6-15</td>
<td>1.9-4.4</td>
</tr>
<tr>
<td>Triticale</td>
<td>10-19</td>
<td>2.4-5.5</td>
</tr>
<tr>
<td>Sorghum</td>
<td>8-20</td>
<td>0.9-3.3</td>
</tr>
<tr>
<td>Barley</td>
<td>9-27</td>
<td>2.0-5.3</td>
</tr>
<tr>
<td>Oats</td>
<td>13-26</td>
<td>3.0-5.0</td>
</tr>
</tbody>
</table>

Table 1. Average and record yields (1 bushel = 0.036 m³; 1 acre = 0.405 ha; 1 pound = 0.45 kg).

<table>
<thead>
<tr>
<th>Food</th>
<th>Average, 1974</th>
<th>Record</th>
<th>Record/average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (bushel per acre)</td>
<td>56</td>
<td>72</td>
<td>307</td>
</tr>
<tr>
<td>Wheat (bushel per acre)</td>
<td>60</td>
<td>28</td>
<td>216</td>
</tr>
<tr>
<td>Soybeans (bushel per acre)</td>
<td>60</td>
<td>24</td>
<td>110</td>
</tr>
<tr>
<td>Sorghum (bushel per acre)</td>
<td>45</td>
<td>48</td>
<td>296</td>
</tr>
<tr>
<td>Oats (bushel per acre)</td>
<td>4</td>
<td>38</td>
<td>212</td>
</tr>
<tr>
<td>Barley (bushel per acre)</td>
<td>47</td>
<td>420</td>
<td>1400</td>
</tr>
<tr>
<td>Potatoes (bushel per acre)</td>
<td>47</td>
<td>19</td>
<td>54</td>
</tr>
<tr>
<td>Sugar Beet (ton per acre)</td>
<td>10.3</td>
<td>50</td>
<td>4.9</td>
</tr>
<tr>
<td>Milk production per cow (10⁵ pounds)</td>
<td>230</td>
<td>365</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Weather Variability, Climatic Change, and Grain Production

Weather variability is a much more important consideration in grain production than a cooling trend.

The Relation of Weather to Grain Production

Most of the world grain production is in the middle latitudes where summer temperatures average between 70° and 75° Fahrenheit (21° and 24°C). The grain belts are limited at lower latitudes by high summer temperatures and at higher latitudes by the length of the growing season. The highest yields of grain usually occur in summers of lower than normal temperature for a particular area. There are two important factors that are associated with this relationship. One is that higher rainfall is usually associated with the cooler than normal weather. The other is that cooler weather permits greater storage of photosynthetic—i.e., the products of photosynthesis are lost to a greater extent in warmer weather because of the higher rates of respiration.

The average temperatures for the summer months in the U.S. corn belt are as follows: June, 72°; July, 76°; and August, 74°F. The highest yields of both corn and soybeans have occurred in summers with lower than normal temperatures in July and August. Figure 1 shows the relationship of June, July, and August temperature to the yield of corn in the U.S. corn belt. The optimum daily average temperature is 72°F in each of the summer months. The optimum range is not less than 50°F at night nor greater than 86°F in the daytime. When the temperature rises above 90°F, the weather is unfavorable for corn. The same is true for soybeans.

As one considers all of the factors of human influence on climate it has to be concluded that there is little likelihood that the change in temperature trend around 1940 was caused by human activity.

Table 1. World production of cereal grains projected to 1985 compared to production during 1969 to 1971. The USDA projections are based on four alternative assumptions* (5).

<table>
<thead>
<tr>
<th></th>
<th>1969 to 1971</th>
<th>1 2 3 4</th>
<th>Annual increase to 1985 (%)</th>
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<tr>
<td></td>
<td>1969-1971</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>World</td>
<td></td>
<td>2.4 2.7 2.2 2.8</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td></td>
<td>2.4 2.6 2.3 3.3</td>
<td></td>
</tr>
<tr>
<td>Developed</td>
<td></td>
<td>2.4 2.8 2.1 2.5</td>
<td></td>
</tr>
<tr>
<td>Deficit in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>countries</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The four alternate assumptions are as follows. Assumption 1: Economic growth has been temporarily slowed, but resumes strong expansion in the late 1970's and early 1980's. However, under this alternative, continued high internal prices limit expansion of world trade. Assumption 2: There is a high, worldwide demand for imports. Under this alternative, income grows at a faster rate, in both developing and developed countries, than with assumption 1. In addition, there is progress toward removing barriers to trade in the developed world, and the centrally planned economics increase their efforts to improve diets. Assumption 3: Demand is low, economic stagnation continues into the late 1970's, and recovery does not occur until the 1980's. Assumption 4: The developing countries' import needs are reduced because they increase their investments in food production by embarking on a policy of increasing the bundle of inputs used to produce food.
Efficiency of Feed Conversion

T. C. Byerly

Air-dried feeds vary in digestibility by ruminants, from about 40 percent for wheat straw to about 80 percent for corn. Pigs and poultry digest corn as well as ruminants do, but their ability to digest roughages is limited. However, when pigs are fed pure cellulose, they may digest about 50 percent of it. In that cellulose is a principal constituent of roughage, it may be assumed the pigs do digest some when it is a component of roughage (8). Poultry, except geese, probably digest little roughage.

Mayer (18) compared the efficiency of conversion of food calories into tissue calories by rats, chickens, cattle, and pigs of weanling age. All of them had an efficiency of about 35 percent.

Digestible protein is transformed into milk or egg protein at similar rates of efficiency by all classes of livestock. But within each class, the amount of milk or eggs produced per female in a given period greatly affects the apparent efficiency since the maintenance requirement of the female may be divided among as many or as few units of milk or eggs as are produced during the period (Table 2).

Conclusions

Under optimum conditions, young healthy individuals of each livestock species may convert about one-third of the digestible protein in its feed into tissue protein in its body. Of this tissue protein, we use about half as food.

Lactating mammals and laying hens, genetically selected for high production and fed an adequate diet ad libitum, may convert as much as 50 and 30 percent, respectively, of ingested digestible feed protein into food protein.

Beef cattle, sheep, and wild ruminants convert to food protein the roughage supplied by plants and plant materials not eaten by man. Increasing use of nonprotein nitrogen compounds as a substitute for feed protein for beef and dairy cattle and for sheep can spare increasing quantities of feed protein for human food without curtailing our meat and milk supply (37). Substantial improvement in efficiency of feed conversion can be achieved through further research (38).

Fig. 1 (left). Digestible protein in livestock feed used to produce each kilogram of protein in meat, poultry, eggs, and dairy products eaten in the United States.
Table 1. Livestock and livestock products produced in the United States in 1949-50 and 1959-60, and the feed concentrates used in total and percent output (\(I\)).

<table>
<thead>
<tr>
<th>Product</th>
<th>Production (billions of pounds)</th>
<th>Feed concentrates fed millions of tons</th>
<th>Pounds fed per pound of production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk cows (milk)</td>
<td>116.7</td>
<td>122.4</td>
<td>18.6</td>
</tr>
<tr>
<td>Sheep (liveweight)</td>
<td>1.3</td>
<td>1.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Hogs (liveweight)</td>
<td>19.9</td>
<td>20.2</td>
<td>46.6</td>
</tr>
<tr>
<td>Eggs</td>
<td>7.4</td>
<td>7.8</td>
<td>18.1</td>
</tr>
<tr>
<td>Chickens (liveweight)</td>
<td>2.9</td>
<td>1.6</td>
<td>8.5</td>
</tr>
<tr>
<td>Broilers (liveweight)</td>
<td>1.9</td>
<td>6.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Turkeys (liveweight)</td>
<td>0.8</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Other cattle (liveweight)</td>
<td>21.2†</td>
<td>28.7†</td>
<td>13.7</td>
</tr>
</tbody>
</table>

* Agricultural Statistics (U.S. Dept. of Agriculture). † All beef and veal.

Table 2. Annual feasible production and efficiency of several livestock species—milk and eggs (3, 4, 25, 26, 38).

<table>
<thead>
<tr>
<th>Animal</th>
<th>Livestock (kg)</th>
<th>Milk or egg production (kg)</th>
<th>Energy in product (Mcal)</th>
<th>Metabolizable energy in feed eaten (Mcal)</th>
<th>Energetic efficiency (%)</th>
<th>Protein in product (kg)</th>
<th>Digestible protein in feed eaten (kg)</th>
<th>Protein efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>700</td>
<td>10,000</td>
<td>7,500</td>
<td>17,000</td>
<td>44</td>
<td>350</td>
<td>744</td>
<td>47</td>
</tr>
<tr>
<td>Goat</td>
<td>60</td>
<td>500</td>
<td>375</td>
<td>1,500</td>
<td>25</td>
<td>17.5</td>
<td>40</td>
<td>144</td>
</tr>
<tr>
<td>Ewe</td>
<td>65</td>
<td>200</td>
<td>245</td>
<td>1,400</td>
<td>17.5</td>
<td>13.5</td>
<td>30</td>
<td>144</td>
</tr>
<tr>
<td>Sow</td>
<td>200</td>
<td>1,000</td>
<td>1,225</td>
<td>3,700</td>
<td>33</td>
<td>55</td>
<td>144</td>
<td>38</td>
</tr>
<tr>
<td>Hen</td>
<td>1.8</td>
<td>17.1</td>
<td>25.6</td>
<td>128</td>
<td>20</td>
<td>1.95</td>
<td>5.4</td>
<td>36</td>
</tr>
</tbody>
</table>

An International Grain Stabilization Reserve

In the 1960's and early 1970's, the world's exportable grain reserves were carried almost exclusively in North America. There is no reason why the United States and Canada should bear this burden alone, for the benefit of the world as a whole. What is needed is an international arrangement by which this responsibility would be shared among both exporting and importing countries. This could be done on the basis of a formula that takes into account a country's national income and its role in grain trade. The U.S. share should be about one-third.

A proposal for internationally coordinated grain reserves was put forward, in very general terms, by the Director General of the U.N. Food and Agriculture Organization (FAO) and endorsed at the World Food Conference last year. It is to be hoped that the governments will follow up on it before the memory of the fuel crisis recedes from the public mind.

Note: The upper part of each bar shows the food per offspring needed to maintain the mother.
Soils of the Tropics and the World Food Crisis

P. A. Sanchez and S. W. Buol

The Laterite Exaggeration

Probably no greater misunderstanding about soils exists than the concept that there is a uniquely tropical soil-forming process that leads ultimately to laterite. When European and American soil scientists traveled to the tropics during the 19th century, they were intrigued by the presence of laterite. Back home they wrote and lectured on this phenomenon. In the process, vast areas of the tropics with soils similar to those found in the temperate regions were essentially ignored. Thus, tropical soils came to mean those soils high in sesquioxides which harden irreversibly on exposure. Latosols and lateritic soils erroneously became known as soils in the process of developing into laterite. Even relatively recent publications in widely read journals (4) conclude that most tropical areas, when cleared of vegetation, will become worthless brick pavement in a few years.

In 1933, Hardy (6) emphasized that laterites have a limited areal extent in the tropics. Reliable estimates of soils that will harden into laterite on exposure are not available for the entire tropics. Regional estimates by soil scientists and calculations based on maps provide the following estimates of the areal occurrence of laterites: 2 percent for tropical America (7), 5 percent for central Brazil (8), 7 percent for the tropical part of the Indian subcontinent (3), 11 percent of tropical Africa (3), and 15 percent for sub-Saharan West Africa (9). On the basis of these and other estimates, we venture that the total area of the tropics in which laterite may be found at or close to the soil surface is of the order of 7 percent.

There is no need to remind the reader of the dismal statistics on the subject of world food shortages. Massive food exports from the developed countries into famine areas should only be considered as short-run measures. In the long run, political and practical considerations dictate that developing countries must feed themselves. Is this likely to happen in the remainder of this century? Assuming significant gains in birth control, there is increasing evidence that, in certain tropical countries blessed with some high base status soils and cursed with vast areas of low base status soils, this is agronomically possible.

We submit two fundamentally different strategies to achieve this goal: intensive agriculture in high base status soils and extensive agriculture in low base status soils.

Prognosis for Increasing Food Production in the Tropics

We are cautiously optimistic that soils of the tropics can make a major and sustained contribution toward world food production when they are well characterized and understood and economically realistic management systems are used. Most of the improvements in the near future can be expected from increasing yields in the high base status soils, but in the long run the conquest of the low base status soils is the larger issue. Ongoing research projects in various regions of the tropics support these statements. Unlike classic plant breeding programs, many problems concerning soils are site-specific, and recommendations have to be compatible with practices at the local levels. Therefore, more sites are needed for practical soil management research. This was demonstrated at a recent seminar on soil management in Colombia (40), when a delegate from Nigeria recommended that burning should be eliminated in clearing tropical forests, while work in Peru demonstrated the dramatic fertilizing benefits derived from burning. This apparent discrepancy was explained by the fact that the ash raised the soil pH from 6 to 8 in Nigeria, causing iron deficiency, while in Peru the ash raised the soil pH from 4 to 4.5, supplying needed bases to the soil.

Pronouncements concerning the effectiveness of soil-related practices have to be carefully evaluated according to soil properties. A single tropical soil elixir is not available.

Summary

The properties and potential of soils of the tropics are poorly understood. The old idea that laterite is formed when tropical soils are cleared is true of only a small proportion of the area. In most features, soils in the tropics are similar or equivalent to soils in the temperate regions. Specifically, soil organic matter contents, commonly believed to be low in the tropics, are essentially similar to those of the temperate regions. While the basic concepts about physical and chemical behavior developed in the nonglaciated temperate regions are directly applicable to the tropics, the development of soil management practices for sustained food production involves different strategies because of environmental and economic constraints. A major distinction is made between the development of high base status and low base status soils. With the former, soil management practices should be aimed at maximizing the potential of high-yielding varieties and improving intercropping systems with relatively intensive fertilizer inputs. With the low base status soils of the vast savanna and jungle areas energy-related inputs should be optimized by (i) selecting crop varieties and species more tolerant to nutritional deficiencies or toxicities, (ii) applying fertilizers at lower rates than those recommended by classic marginal analysis, and (iii) increasing the efficiency of applied fertilizers in such soils.
The principal plant known today which has the highest yield of yearly, averaged photosynthesis is sugarcane (6). The overall efficiency is about 0.6 percent and this will be compared with several other types of plants later.

I want to suggest the use of sugar as an industrial raw material and also to suggest its end uses. You could burn sugar—it is carbohydrate, as is cellulose, and has the same caloric content. However, there are more efficient methods than burning, and one is to convert the sugar and cane cellulose into alcohol. In this process (shown in Table 1), the thermal efficiency is very good, with practically no loss in going from sugar to alcohol. It takes 12.9 pounds (1 pound ~ 0.45 kilogram) of sugar to make 1 gallon of alcohol, that is, 64 cents worth of sugar at 1971–1972 price of sugarcane to make 1 gallon of alcohol. It costs about 20 cents to convert the sugar, making a total of 84 cents per gallon for alcohol by fermentation.

As an illustration of how the economics of this kind of chemistry has affected the sources of alcohol in the last 50 years, the industrial ethyl alcohol production since 1940 is shown in Fig. 3. From 1940 to 1945 (during World War II) the alcohol was made mostly by fermentation from molasses, sulfite liquors, and grain (natural sources of carbohydrate). When petroleum became available as a cheap source of alcohol around 1950, it took over, entirely, the alcohol market.

Sugarcane makes 4 tons of sugar per acre (1 acre ~ 4.05 x 10^6 square meters) per year, from which is obtained 2 tons of ethanol and 1.2 tons of ethylene, with an overall efficiency of 0.23 percent of incident sunlight, if only the sucrose is counted. There is, however, an equal amount of cellulose in the cane, in the form of bagasse (the cellulose residue of the sugarcane), with a yield of 4 tons of bagasse per acre per year. The total therefore appears to be 8 tons of carbohydrate per acre of cane, raising the efficiency of solar energy conversion (agricultural solar energy conversion) for cane to about 0.5 percent. Sugar beets give 2.3 tons of sugar per acre, with 0.7 ton of pulp per acre, per year; but beets, unlike sugarcane, do not grow all the year round.

The rubber story is very similar to the industrial alcohol (ethanol) story, and, in a sense, is even a little more spectacular. After World War II, synthetic rubber (that is, butadiene and styrene) made from petroleum practically eliminated rubber plantations as a source of this material. The rubber growers then began to improve the yield, which at the end of World War II was only about 400 pounds of rubber per acre per year (8). The figure today is about 2300 pounds of rubber per acre per year. About one-third of the rubber used today comes from natural sources, and two-thirds from synthetic sources.

Today the yield of rubber (which is already a hydrocarbon with no oxygen in it) is about 1 ton per acre per year, which is about half the yield of cane, and only about 20 percent less in terms of ethylene potential. The rubber growers are very optimistic that they can, and will, be able to raise the yield of rubber from 1 to 3 tons per acre per year (7). If they are able to harvest 3 tons of rubber per acre per year (that is, 3 tons of hydrocarbon), this type of plant may also become a seriously considered possibility for a direct photosynthetic source of hydrocarbon for use in chemicals and materials.

Another special situation seems to be developing in Nebraska which has about 7 million bushels of spoiled grain per year. This should yield more than 20 million gallons of alcohol, which, as a 10 percent additive to gasoline, would give 200 million gallons of "gasohol." This is the name used by the Nebraska legislature to designate a composition which would qualify for a 3-cent state tax credit (9).

As a final comment on the natural photosynthetic sources of hydrocarbon, let me remind you of our use of about 2 million barrels per day of oil equivalent as a source of chemicals and materials. If we were to try to supply this entire need from sugarcane we would require about 60 million acres of cane if we used only the sucrose and only about 30 million acres if the cellulose could be used as well, a capability soon to arrive (10). In 1971 there were 0.7 million acres under cane cultivation and about 1.4 million acres in sugar beets in the United States.

The consumption of power alcohol in Europe in 1937 amounted to more than 500,000 tons. This was all before Arab petroleum came to Europe. Science 183 p 645

Table 6. Amounts (in millions of tons) of dry, ash-free organic solid wastes produced in the United States in 1971.

<table>
<thead>
<tr>
<th>Source</th>
<th>Wastes generated</th>
<th>Readily collectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure</td>
<td>200</td>
<td>26.0</td>
</tr>
<tr>
<td>Urban refuse</td>
<td>129</td>
<td>71.0</td>
</tr>
<tr>
<td>Logging and wood manufacturing residues</td>
<td>55</td>
<td>5.0</td>
</tr>
<tr>
<td>Agricultural crops and food wastes</td>
<td>390</td>
<td>22.6</td>
</tr>
<tr>
<td>Industrial wastes</td>
<td>44</td>
<td>5.2</td>
</tr>
<tr>
<td>Municipal sewage solids</td>
<td>12</td>
<td>1.5</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>50</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>880</td>
<td>136.3</td>
</tr>
<tr>
<td>Net oil potential (10^4 barrels)</td>
<td>1098</td>
<td>170</td>
</tr>
<tr>
<td>Net methane potential (10^4 cubic feet)</td>
<td>8.8</td>
<td>1.36</td>
</tr>
</tbody>
</table>

[Source: L.L. Anderson, Bureau of Mines]

Under optimum conditions, as much as 99 percent of the carbon content is converted to oil—about 2 barrels per ton of dry waste. In practice, more than 85 percent conversion is normally obtained, but because some of the oil must be used to provide heat and carbon monoxide for the reaction, the net yield is about 1.25 barrels per ton of dry waste.

The product is a heavy paraffinic oil used 5.5 billion barrels a year in 1971 (42 gallons each).
"Food is bound to go where people can afford to buy it," said one U.S. economist. "The task is to get the agricultural economy rolling in these countries so that you're attacking the root cause of hunger—poverty.

Pessimists point out that this root cause is as old as civilization itself and promises to be much harder to overcome than any technological limitations.

"It is relatively easy to envisage a doubling or tripling of world food output based on known reserves of land and water, achieved through vastly increased inputs of energy and fertilizer," writes food authority Lester R. Brown in "By Bread Alone." But he adds: "The critical issue is at what price the additional resources will be brought into use."

Already, some scientists fear the soaring cost of fuel for irrigation pumps and shortages of fertilizer made from natural gas are threatening to abort the so-called green revolution that gave hope to hungry nations during the 1960s.

**Poverty and births.** Most scientists believe the ultimate answer has to lie in controlling demand for food by reducing population growth—especially in the poor countries.

Recent studies have shown, however, that the best way to cut birth rates is to ease the effects of malnutrition and poverty, which often make desperate people regard children as an asset in the struggle to survive. For birth control to work in the poorest nations, demographers say, adequate food, education and jobs must be provided, too.

Experts agree that getting destitute countries on their economic feet would require more subsidies, direct and indirect, from wealthier nations.

World Bank President Robert McNamara, whose organization finances much of the development abroad, gave this estimate of costs during a Public Broadcasting Service television appearance: "I'd say 2 to 3 per cent of the gain in real income, if diverted to the developing countries, would make the difference between misery and a good life."

World Bank officials explain that would figure out to a 40 per cent increase in foreign aid, to an average of 15 billion dollars a year, with most of it to come from the U.S., Western Europe, Canada, Australia and Japan.

**Leader in farming.** While the Soviet Union is widely recognized as second only to the United States in over-all economic output, not so well known is the fact that in some ways it is the world's biggest farming nation.

It actually produces more wheat and grain than any other country. There is more livestock here than in the U.S. Milk production is claimed to equal that of America, Britain and West Germany combined. Potato and cabbage crops are not surpassed anywhere.

Soviet farmers, however, lag far behind the West in efficiency. One third of the nation's total work force is on the land, compared with only 1 worker in 25 in the U.S.

On almost any one of nearly 50,000 collective and state farms here, the average worker is only one tenth as productive as his American counterpart.

Russians on the average eat 25 per cent more meat than they did a decade ago—but still consume only half as much meat as the average American. And U.S. shoppers, despite inflation, pay only about half for meat.
Only the men in the Kremlin know how much wheat they intend to buy in 1975. Upshot: sudden caution, a harder line, by U.S. policy makers.

The close to 10 million tons already purchased in this country by Soviet buyers will add 1.5% to the price of food to Americans in the months ahead. That forecast by Don Paarlberg, chief economist of the U.S. Department of Agriculture, is based on studies fresh from the computer.

A better measure. Soviet buyers have been told to stand in line until a better idea of the size of the U.S. corn crop can be gained from a fresh crop report on August 11. There was hope, preceding the report, that a spate of showers over drought-hit sections of Iowa, Missouri, Kansas and Nebraska would bring the corn harvest in at close to 6 billion bushels. That would be an all-time record to go along with the bush-busting 2.2 billion bushels of wheat now virtually assured.

Secretary Butz has told the Russians that they cannot expect to come charging into the U.S. market for huge purchases in a year when their crops fail and then take very little the next. The following table shows the ups and downs of Soviet purchases of American grain over recent years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat (metric tons)</th>
<th>Corn (metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>11.8 million</td>
<td>6.2 million</td>
</tr>
<tr>
<td>1973</td>
<td>2.7 million</td>
<td>1.0 million</td>
</tr>
<tr>
<td>1974</td>
<td>2.9 million</td>
<td>0.9 million</td>
</tr>
<tr>
<td>1975 (as of Aug. 8)</td>
<td>4.5 million</td>
<td>4.7 million</td>
</tr>
</tbody>
</table>

In 1972, Russians entered the American market quietly. Dealing with private grain exporters, they walked off with 19 million tons at bargain prices, helped by a subsidy of 40 cents a bushel on wheat.

This played hob with regular U.S. customers such as Japan, which year in and year out takes around 6 million metric tons of corn and 3 million of wheat. The Japanese, along with Western European customers and those elsewhere in the world, had to scramble for supplies and paid sharply higher prices as a result of the Russian deal. Soviet buyers had picked U.S. bins so clean that export curbs were placed on soybeans before the 1972-73 marketing year was out, a move that severely strained Japanese relations with America.

This year, Soviet buyers again entered the market quietly and early to cover the deficit in their grain supply. The shortfall grew to about 30 million tons as hot, dry weather parched crops through May and June in the spring-wheat area that accounts for two thirds of the bread-grain harvest.

Secretary Butz insists that the U.S. should not resort to price gouging in world agricultural markets. Secretary of State Henry Kissinger agrees that American food should not be used as a bludgeon, stating: "We regard our good fortune and strength in the field of food as a global trust."

Still, the feeling persists and grows in this country: Why should the U.S. always play the good guy in a world where others miss few chances to cash in? (Dig at oil countries)

MOSCOW

Massive Soviet purchases of American grain are more the fault of economic managers in Moscow rather than the peasants on drought-hit farms.

That is the opinion of Western agricultural specialists who insist that, even in dry years such as 1975, the Soviet Union could be exporting grain instead of buying it, if only the country made proper use of its farms and farmers.

Though Russia is one of the world’s biggest farming nations, it is not naturally blessed with great agricultural riches. Except for the Ukraine and parts of Belorussia, neither climate nor soil compare with the U.S., Western Europe, or even Canada, which shares with Russia the disadvantage of a far-northern location.

This year’s grain crop may total only 185 million metric tons, 30 million tons below planners’ targets and even less than last year’s disappointing harvest. To see why this has happened, take a look at how Soviet farms operate in good weather and in bad.

Collective and state-farm managers spend far more time receiving directives and sending reports than organizing field work. The Communist Party newspaper, Pravda, recently reported the plight of a collective-farm chairman who had received nearly 800 directives just by telephone so far this year. The paper-work river widens and deepens as it flows through district and provincial offices toward Moscow.

Mechanization is supposed to solve Russia’s chronic farm-labor shortage. Yet in peak planting and harvest seasons, as many as one third of all machines in a district may be standing idle because there are no spare parts. Central planners are acutely aware of the need for spares—Pravda complains about it constantly—but the management system seems unable to match up parts with machines that need them.

Many livestock herds were killed off after 1972’s near-disastrous harvest, and Soviet planners do not want the same thing to happen again.

U.S. NEWS & WORLD REPORT. Aug 18, 1975
Food," said a 1944 slogan, "will fight the war and win the peace." Right now food is the subject of a war of words. On one side are the "health food" stores and their vociferous supporters, including "diet doctors" and show business personalities. The target of their attack is the big companies that make up the bulk of the multi-billion-dollar food industry—who seem too bewildered to fight back and, instead, often try to make a fast buck by invoking their critics' slogans on behalf of special lines of products designed for nature lovers. Condemnation of the food industry is de rigueur for liberal columnists; on April 20 Nicholas Von Hoffman hinted darkly that we were all being poisoned. Caught in the crossfire between Granola and Sugar Frosties, between enriched white bread and the stoneware, chemical-free, whole-grain variety, between prime beef and sunflower seeds, scientists of the "nutrition establishment" have tried to straddle the fence's uncomfortable ridgepole. A few have even tried to buck the "health food" crowd; the Food and Nutrition Board of the National Academy of Sciences did so, and its members were thereupon termed "tools of industry" by Senator William Proxmire.

On April 17, Ralph Nader's Center for Science in the Public Interest (which might better be called the Center for Lawyers in the Performing Arts) held a carefully planned, well-heralded "Food Day." The Advisory Board included Hubert Humphrey, middle-aged Consciousness III types like William Sloane Collins and George Wald, organic food journalists, some genuine academic nutritionists like Jean Mayer of Harvard (who, as will be seen, ducked out before Food Day arrived), Julian Bond, Norman Cousins, Fred Harris, and Robert Redford.

Food Day's main feature was an attack on what Naderite Michael Jacobson called "The Terrible Ten." As one might expect, the attack was based more on politics than on nutrition; five of the foods were strictly brand-name special products. The others were basic foods; one of these was Wonder Bread, targeted as "an ordinary enriched white bread"—but alas, made by a division of ITT, "which also owns Sheraton Hotels and makes military supplies." (Eat Wonder Bread—kill an Arab!) The Wonder Bread bakers state on the label that their bread contains no preservatives; the story behind this is that sodium propionate has been hounded out of many breads by the health food movement. Sodium propionate, which prevents molding, is naturally present in (for instance) Swiss cheese, and is metabolized normally by the body into carbon dioxide and water; without sodium propionate, bread molds.

Next on the list was bacon, dubbed "possibly the most dangerous food in the supermarket"—because of nitrosamines, which are formed from nitrates used in curing bacon. As it happens, nitrosamines are also formed in the digestive tract from nitrates; the nitrates in a day's swallowed saliva are equal in quantity to those in several pounds of bacon. As if this weren't enough, nitrates are produced during digestion from nitrates, which are normally present in vegetables. ("Organic" carrots have been found to contain far more nitrates than regular carrots.)

Further down the Terrible Ten list, prime grade beef came in for a clobbering because cattle eat grain "that could otherwise be consumed by hungry people." But in fact, more than half the food consumed by beef cattle is roughage (somebody ought to tell Ralph Nader about their digestive systems)—corn cobs, stalks, forage, and hay; and they can also convert synthetic urea into animal protein. Corn is an animal feed grain that is highly deficient in protein, and in many nations its consumption by people is small; in the U.S., less than 5 per cent of the corn crop is used as human food. If the cornfields in America were replanted with wheat, the yield per acre would be far less.

But the winner of illogic was table grapes—listed as a terrible food because "growers refuse to sign UFW contracts."

As Food Day approached, the "organic" crowd apparently persuaded the sponsors to condemn chemical fertilizers and pesticides, a proscription which, if it were realized, would guarantee starvation in much of the world. This was too much for Harvard's Mayer; he bailed out, writing to Jacobson, "The inane material you have on agriculture in your Food Day pamphlet is obviously going to make the organic nuts [sic] very happy, but it has nothing to do with feeding the world and cheaper costs of food. If you don't understand modern agriculture, just stay out of it and don't encourage people to believe that small organic farms are going to give us all the food we need for the world." Jacobson retorted, "I simply have not been able to check every word that leaves the office." That's for sure.

Meanwhile, the winged words flew all over the country throughout Food Week. A speaker on WCBS charged the Boeing Aircraft Company with the sinister crime of growing potatoes. (In view of the current farm price of potatoes, perhaps Boeing was after a tax dodge.) On AM America, Mrs. Gussow, a champion of organic foods who has boasted of her lack of "undergraduate conditioning" in nutrition, was introduced as an expert in nutritional science. The schools of the country were flooded with warnings against the Terrible Ten. Senator Schweiker showed up on a Public Broadcasting program to tender his views on sugar. Senator Kennedy pushed a bill forbidding the use of diethylstilbestrol for beef cattle—which would require the substitution of more than a million tons of corn for the sake of preventing, at most, one case of cancer in the entire U.S. during the next 2,500 years.

Thousands died of starvation in India and Bangladesh that week, whose lives might have been saved by that corn. Or by American dog and cat food. Or by the food that wasn't produced because the Arabs burned up natural gas that could have been used to make ammonia. Or by the bread that will be moldy because of the "organic" campaign against preservatives.