reproductive potential of about 10 percent per annum [and more recent reports indicate an even smaller rate, perhaps 4 to 5 percent (*11*)]. If in their calculations of profit and loss, the owners of the whaling fleets were to utilize an annual rate of discount of 20 percent or greater, they would therefore opt for complete extermination of the whales—at least as long as whaling remained profitable. This would occur whether they were competing, or cooperating, in the slaughter (*24*).

Summary

The general economic analysis of a biological resource presented in this article suggests that overexploitation in the physical sense of reduced productivity may result from not one, but two social conditions: common-property competitive exploitation on the one hand, and private-property maximization of profits on the other. For populations that are economically valuable but possess low reproductive capacities, either condition may lead even to the extinction of the population. In view of the likelihood of private firms adopting high rates of discount, the conservation of renewable resources would appear to require continual public surveillance and control of the physical yield and the condition of the stocks.

Appendix

To prove the theorem stated above, we will show that Eq. 9 has no solution in case $\delta > 2f'(0)$ and $p > B$; this implies that $\hat{x} = 0$ maximizes the total present value, since $\hat{x} = \bar{x}$ would give both zero rent and zero present value.

Since $H(x)$, the right-side expression in Eq. 9, is a decreasing function of p, it suffices to consider the case $p = B$. Then by the generalized mean value theorem of elementary calculus,

$$H(x) = -C'(x)\frac{f(x)}{C(0) - C(x)} = \frac{C'(x)f'(\xi)}{C'(\xi)} \qquad (0 < \xi < x) < f'(\xi) < f'(0)$$

Thus $\delta - f'(x) > 2f'(0) - f'(x) > f'(0) > H(x)$, so Eq. 9 has no solution as claimed.

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$$\int \exp(-\delta t)\, h(t)\, \{p - C[x(t)]\}\, dt$$
for $h(t) \geqq 0$ is equivalent to maximization of the simple expression $P_1(x) + P_2(x)$ described here.
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NEWS AND COMMENT

World Food Situation: Pessimism Comes Back into Vogue

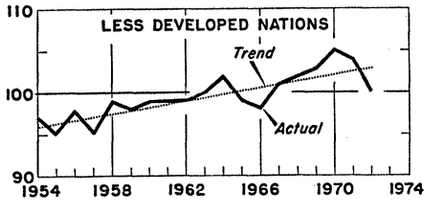
Last month, for almost the first time in living memory, the July crop report prepared by the U.S. Department of Agriculture (USDA) rated a spot on the CBS evening news. To consumers perplexed by rising food prices, the prediction of record crops was doubtless welcome, if maybe deceptive, news. To economists concerned about the world food situation, the relief was of a different order—a poor harvest in the United States could mean disaster for some countries that depend on American food exports.

The world food situation is more serious now than at any time since 1965–1967, when an armada of American grain shipments saved perhaps 60 million Indians from possible starvation. The immediate cause is a bout of freakish weather that has visited droughts on some parts of the world, floods on others, and gave a 1972 harvest that was much worse than expected. All countries except India have now bought enough grain—though often at ruinous prices—to cover their immediate needs. But world grain stocks are down to their lowest level in 20 years, and whether or not there will be enough food to go around next year depends on the success of the crops now in the ground. "It's basically a question of weather, and there's not much that any country or technology can do," says Dale Hathaway, an agricultural economist at the Ford Foundation. And even the institutionally optimistic seem more worried in private than they will admit to publicly. "Abundant 1973–74 season grains crops will be of crucial importance to ease the present tight situation and to avert very serious scarcities," states an internal situation report prepared on 28 June by the World Bank. In India, the report notes, "a normal monsoon season is a necessity this year, if widespread disaster is to be averted."

The omens so far are that crops will be good around the world—as long as the weather stays favorable and epi-

demics hold off. But the touch-and-go nature of events has rekindled anxieties about the world food situation. The Malthusian nightmare, that mass starvation will be the ultimate population control, is only one, and that the most distant, of several specters. Beyond the immediate question of whether this year's crops will produce enough food to avoid major price disturbances, political instabilities, and famines, there is concern that the present alarms and scarcities may reflect not just last year's bad weather, but a fundamental deterioration in the world food situation. Already there are those who foresee a period of food scarcity, in which those with food to sell will have a useful political weapon in their hands. Governments of developing countries will find this year that the soaring prices of food grains and freight rates have driven their imported food bills up by 60 percent or roughly $2 billion, a drain on foreign reserves which, should it continue, threatens to retard economic development and make the gap between rich nations and poor grow faster still. Much besides the threat of famine, therefore, hinges upon the ability of developing countries to make crop yields grow faster than people.

The salient fact about the world food situation is that for the past 20 years food production has increased at a rate just slightly faster than that of population—2.8 percent versus 2.6 for the developing countries—resulting in a very slight improvement in per capita production and, presumably, in average diet. As the optimists justly point out, there has been no major famine in the world since 1943—probably the longest famine-free period in recorded history—and people on average are eating better than at any time in the past. On the other hand, an average diet works out at meager rations and for those below the average means too little to eat. The present extent of malnutrition in the world is a matter of debate because of arguments about how it should be measured. But according to the Food and Agricultural Organization (FAO) of the United Nations, perhaps 20 percent of the population of developing countries, or 300 to 500 million people are undernourished in that they receive less than the recommended intake of calories. Alan Berg, World Bank deputy director for nutrition, estimates that, of the children born today in developing countries, roughly 75 million will die before their fifth birthdays from malnourishment or



Per capita food production in less developed nations (percentage of 1961–1965 average).

associated illnesses. The World Health Organization reckons that on average 3 percent of the children under 5 in low-income countries suffer from severe protein and calorie malnutrition, which amounts to about 10 million children worldwide. Severely malnourished children have smaller than average brains with fewer brain cells, an effect which may be irreversible.

The food situation over the last two decades has evidently been tolerable, if not precisely ideal. Countries with a food deficit have been able to buy cereals at reasonable and stable prices from the grain-exporting countries (chiefly the United States, Canada, Australia, and Argentina), and those without the necessary cash have been able to depend on concessional sales from the U.S. government under the P.L.480 program. In short, the remarkable feature of the world food situation, in retrospect, has been its general stability. Perceptions of it, however, have followed a strangely erratic course over the last decade, lurching from pessimism to optimism and now back toward gloom again.

In the mid-1960's doomsaying was the fashion. The USDA forecast that the concessional food needed by developing countries would eventually exceed what the United States had available to give away. Strikingly enough, the date calculated for this dire event turned out to be 1984. "This would lead to a breakdown of the world food economy with consequences that would range from catastrophic famine in many areas to an elemental struggle for the control of food resources," a joint USDA–State Department press release explained at the time.

The USDA projections formed the basis for *Famine 1975!*, a well-written and widely read tract by brothers William and Paul Paddock. The Paddocks took the USDA's figures but assumed a slightly faster rate of population increase and concluded that 1984 would arrive 9 years ahead of time, in 1975. (William Paddock, an agricultural consultant based in Washington, D.C., still stands by the book's conclusion of 6 years ago—that "the timetable of food shortages will vary from nation to nation, but by 1975 sufficiently serious food crises will have broken out in certain of the afflicted countries, so the problem will be in full view. The Time of Famines will have begun.")

The famine talk of the mid-1960's and the predictions that, in the mixed cliché of the time, the stork would overtake the plow, suddenly lost credence in the face of a new phenomenon, part agricultural and part public relations. The Green Revolution, with its "wonder wheat" and "miracle rice," swept the headlines like wildfire and the wheat and paddy fields of Asia at a rather slower rate. Developed at agricultural research centers in the Philippines and Mexico, the new strains of rice and wheat did indeed produce yields many times greater than native varieties under certain conditions. The promising performance of the new strains in India and Southeast Asia suggested that the rate of food production could be increased from 2 to 4 or 5 percent within a few years. "If the Asian agricultural revolution continues," wrote one of the prophets of the Green Revolution in 1968, "it could well become the most significant world economic development since the economic rebirth of Europe following World War II. . . . It may also strengthen [national leaders'] faith in modern technology and its potential for improving the well being of their people."

Aided by favorable weather, the new Mexican wheats produced bumper crops in the Punjab, India announced she would become independent of all foreign grain imports by 1973, the Philippines planned to become a major exporter of rice, and in the general euphoria even the FAO began to talk as if the real food problem would be one of surpluses, not scarcities. But from this high point, enthusiasm about the Green Revolution has slowly subsided, dipping occasionally into positive vilification. The Green Revolution was oversold, is a myth, will turn into red revolution, are some of the verdicts heard today.

The basis of the criticisms lies essentially in the fact that modern agricultural technology is no quicker or less painful to apply in the developing world than it has been in the advanced nations. In the United States since

1940, some 30 million people have left their rural homes for the town. The new strains of wheat and rice which are the spearpoint of western agriculture require fertilizer, irrigation, and the learning of new skills, all of which rich farmers can acquire more easily than the poor. The land on which the new strains are planted has in some places become so valuable that landowners are evicting the tenants to farm it themselves.

The rice and wheat varieties which still form the backbone of the Green Revolution are of limited application. The rice will grow only on irrigated land, which forms but 30 percent of the crop land in Asia. The wheat has done wonders for crop yields in India and Mexico but in neither country is it the major cereal crop.

After the optimism about the Green Revolution began to appear overblown, it required only a few bad harvests to set the pendulum swinging back toward despair. The strange events of 1972 have done just that. Although bad weather and an unlucky combination of circumstances were the principal cause, the resulting havoc was quite disproportionate, a rude demonstration of the system's possible fragility. First, the Soviet Union had another bad harvest, confirming once again that Marx was a city boy. This time, instead of killing off its meat herds, the Russians bought 30 million tons of grain on the world market. The amount represents some 3 percent of the total world grain production, yet it was enough to send grain prices soaring to historic heights and to double world freight rates. Other countries too were in the market, Indonesia and the Philippines for rice, India for grains. (India had accumulated a 9 million ton surplus of grains after a succession of good years, but gave 2 million tons to Bangladesh last year, used up the remainder, and this January had to buy 2 million tons on the world market at the cost of some $200 million.) Drought in the countries bordering the southern edge of the Sahara caused a bona fide famine, which has affected between 1 and 10 million people. The Peruvian anchovy fishery failed almost completely last year (and may be permanently damaged because of overfishing); since the anchovies were the source of much of the world's supply of fish meal, livestock owners turned heavily to grains and soybeans to feed their animals, creating further pressure on prices.

The outcome of these various demands on international market prices was dramatic. Between July 1964 and July 1972, the price of U.S. red winter wheat never exceeded $65 per metric ton. By January of this year it had hit $104 per ton. Thai rice, available for $137 per metric ton in July 1972, is now selling for $250 per ton, when available at all. The wheat stocks held by the world's four major exporters are down to an estimated 30 million metric tons, the lowest in 20 years. U.S. granaries hold less wheat than at any time since 1967, when a fifth of the American wheat crop was shipped to India. Another long-standing hedge against food shortfalls, the 50 million acres kept out of production by the U.S. government, is also about to disappear; from next crop year, federal payments for set-aside acres will cease.

Long-Term Prospects

In the short term it looks as if the scarcities that followed in the wake of the 1972 harvest will ease off, stocks will be rebuilt, and prices will subside to nearer their normal levels. The longer term prospects for the world's food situation depend on the viewer's perspective. Broadly speaking, there are three schools of thought—optimists, pessimists, and skeptics.

The optimists' position is essentially the economic thesis that agricultural production will expand to match demand. In a series of forecasts dating back at least to 1967, the Economic Research Service of the USDA has consistently predicted that the supply of most crops in 1980 will exceed the demand. Demand represents only what people can afford to buy, not what they need, but the ERS forecasts state that per capita nutritional levels in developing countries "may be expected to improve." On this view, the income of people in developing countries is likely to be the primary constraint on food intake for the foreseeable future, and production will match up to whatever the market can afford. "The United States could double or triple food production if the price was right," says ERS analyst Anthony S. Rojko.

U.S. food surpluses, whether sold or given away, may help to avert shortages in particular countries, but can cover only a fraction of the expected increase in food needs of the developing countries. These nations must meet the major part of the food requirements themselves. According to Don Paarlberg, director of agricultural economics at the USDA, developing countries must nearly double their historic rates of growth of food production if they are to break their dependence on food aid, reach minimal levels of consumption by 1980, and achieve higher rates of economic growth. Paarlberg is optimistic that this will be done, in large measure through science and technology, but even he puts a limit—two or three decades—on the period for which agriculture can continue to meet the needs of a world population growing at present rates. (According to U.N. medium estimates, world population, now 3.9 billion, is expected to grow at a rate of 2.0 percent a year, reaching 4.5 billion by 1980 and 6.5 billion by the turn of the second millennium.) During the pessimistic period of the 1960's, Paarlberg pointed out in a recent attempt to counteract the prevailing gloom, USDA analysts continued to project, correctly, an increase in the per capita supply of food: "Now, in the seventies, the mood has again turned pessimistic and again our analysts project improvement in dietary levels. Let us hope they are right again."

The official optimism of institutions such as the USDA and the World Bank is in effect supported by those skeptics who believe that the basic data on which to arrive at any assessment of the world food situation are seriously inadequate. For the bulk of the world, "underdeveloped statistics go hand in hand with economic underdevelopment," observes Thomas T. Poleman of the department of agricultural economics at Cornell University. Poleman believes that the figures for agricultural production, population, and nutritional requirements in developing countries are not known with any certainty, a state of affairs that neo-Malthusians—such as the FAO—have exploited to the advantage of their own case. Recommended nutritional requirements are constantly being revised—and revised downward—because the organizations charged with preparing them have "consciously erred on the side of caution." The extent of malnutrition, Poleman considers, is "not nearly as great as people are saying, or the population would not be increasing. The FAO and World Bank assume that persons in tropical countries have about the same food requirements as overnourished Americans."

Although few people professionally concerned with the world food situation would describe themselves as pessimists, there are a number of reasons

for which many have become less than entirely cheerful about the prospects for 1980.

► The Indicative World Plan drawn up by the FAO postulated that there could be a slight improvement in world diets by 1980 if the agricultural production of developing countries met certain specified goals. So far, the progress made in meeting even the very modest goal of the FAO's plan offers little cause for enthusiasm. Between 1962, the base year of the plan, and 1975, agricultural production in developing countries was supposed to increase at the rate of 3.4 percent per year. In fact, the average growth rate between 1962 and 1970 has been only 2.8 percent per year, dropping to 2 percent in 1971 and to −1 percent in 1972. Underlying this poor record were a number of disturbing trends. Yields per acre increased at only 0.3 percent (compared with a 3 percent increase in advanced countries), and much of the growth was obtained by bringing new land under cultivation. One of the few goals successfully met is that for farm machinery, which has been considerably exceeded. This, since it adds to rural unemployment, is a mixed blessing. These results are termed disappointing by FAO assistant director general Eric Ojala. "One can be pessimistic about even the targets of the Indicative World Plan not being met," Ojala says.

► Although the trend of agricultural production in developing countries has been steadily upward, there is no guarantee that it will continue to rise. Future gains may be harder than those already made—the best land has already been put under plow, the most convenient water sources already tapped. In cereals, the backbone of most people's diet, the maximum yields have nowhere near been reached in developing countries. Production of protein, however, seems to be bumping up against certain constraints. The recent fall-off in the growth of the world fish catch suggests that some species are being pressed up to or beyond their sustainable limits. Production of beef is still limited by the fact that a cow produces only one calf per year. Soybeans, a third major source of protein (and the leading export product of the United States, exceeding even sales of items such as computers or aircraft), are proving resistant to improvement; yields per acre have increased at only 1 percent per year since 1950, compared to 4 percent for corn.

► This year's projections by the USDA Economic Research Service forecast that the world's capacity for production of cereals will increase faster than consumption, but the projections explicitly assume "normal weather conditions." The weather may not be so obliging. The United States, for example, is visited by a drought that, for the last century, has arrived every 20 years as regularly as clockwork. The drought is due right now, and according to J. Murray Mitchell, a climatologist with the Environmental Data Service, may already have started. There has been a "disturbingly persistent" deficiency of rainfall in the Dakotas and west Minnesota which may be the beginning of the drought. On a global basis, there has been speculation that last year's freakish weather, and the general cooling of the last 30 years, may represent a return to the mini-ice age of the 16th and 17th centuries. Mitchell rates such a development as possible but not probable, believing the cooling to be only temporary. Whatever the long-term behavior of the weather, margins of safety are such that even a few bad years in succession could push the world food supply into a crisis situation. Despite the scientific prowess of the world of the 1970's, notes FAO director general Addeke H. Boerma, "the chances of enough decent food for millions of human beings may simply depend on the whims of one year's weather."

► In the 17th century, Ireland supported a population of 2 million. Then the potato was introduced, the agricultural capacity of the land increased, and by 1835 the population numbered 8 million. Came the potato blight and 2 million Irish starved, 2 million emigrated, and 4 million were left in the customary destitution. The high-yield strains of rice and wheat could cause a similar disaster for the populations they support because they are genetically more uniform than the native strains they replace and hence more susceptible to an epidemic. The plant breeders who devise the new strains are well aware of the problem, but the epidemic of southern corn blight, which devastated part of the United States crop in 1970, illustrated the difficulty of solving it. Prevention and control of such epidemics is a hard enough task for the United States and requires skilled manpower that developing countries using the new seeds may not possess.

► The need for food dictates that the high-yield strains be adopted as quickly as possible; on the other hand, if the Green Revolution is pushed too fast it may cause an intolerable degree of social change. Modern agricultural techniques not only increase the gap between rich and poor farmers, but are more likely to reduce jobs than create them. Yet rural areas, in which the bulk of the population increase is to occur, are where jobs are most needed. The problem of unemployment, states the FAO Indicative World Plan, "looms as far more intractable than that of food supply. With it come not only human misery, but social unrest and political instability." And the World Bank, which now coordinates funding for the six international research centers that are the spearhead of the Green Revolution, is under no illusion as to its consequences: "Far from reducing social tensions in rural areas, the spread of the new technology is likely to sharpen them, and lead to great demand for the implementation of measures, such as land reform, for the redistribution of wealth and income," warns a Bank working paper.

Rich Take Protein from Poor

► Whatever the real extent of malnutrition in the world, there seems to be no certain prospect of substantial improvement, and a fair chance of degradation, in the immediate future. Protein has become a seller's market. In recent months there has been a clear trend of richer countries pulling protein away from the poor, although it is too early to tell the nutritional consequences. Efforts to improve nutrition in developing countries have remained token programs, according to Nevin Scrimshaw of M.I.T., not because of governmental indifference, but because of the difficulty of finding a delivery system. On the other hand the new awareness of the problem, says Alan Berg of the World Bank, has led many governments to put nutrition high on their agenda and should change things for the better. The undernourished are at particular risk from fluctuations in the world food situation. Developing countries, economists are wont to say, can always "tighten their belts" in bad years when the price of foreign food is too high; for those on the margin, a further tightening may mean the forfeiture of existence.

If the optimists have the better record in the debate so far, they also have the harder case to make. Future increase in world demand for food is

easy to predict and quite inescapable: it derives from population growth plus the desire of the affluent in advanced countries for meat instead of grain. (As a rule of thumb, it takes 7 pounds of grain to produce 1 pound of beef, a ratio which not only magnifies the affluence factor but leads to the peculiarly unfelicitous situation of bread being priced out of the poor man's mouth in order to feed the rich man's cow.) The matching increase in supply is harder to envisage and is far more vulnerable to unforeseen constraints or catastrophes. Moreover, the best that the optimists are offering is the maintenance or slight improvement of per capita diets for another few decades, which, they say, should be time enough to lick the population problem. That may not be enough to satisfy people's rising expectations. Nor is it a happy position to take that the Green Revolution may buy enough time for someone else to find a technological fix for the population problem. The only fix that has worked historically is economic development, and economic development in the developing countries, at least in those without oil, depends on a rate of growth of agricultural production that will both avoid the need to import food and provide enough exports to finance further development. To this extent, agricultural production is not the passkey to some magic cure for the population problem; it is the cure.

Famine Not the Only Constraint

The cure is not working too well at present. Agricultural production in the developing countries is increasing far more slowly than called for in the FAO plan and will have to grow at an unprecedented rate (more than 4 percent a year) for the rest of the decade if even present diets are to be maintained by 1980. Maybe this will happen. The early successes of the Green Revolution demonstrated that agriculture need not be an economic backwater but could contribute to development. Under Robert McNamara the World Bank has recently met the goal of quadrupling its loans for agriculture. And the events of the last year have made their impression. "What they have done is to sober up some governments, including the heads of state, so that they may start to take agriculture seriously," says Dale Hathaway.

Yet even if a serious effort is made and growth rates improve substantially, the risk of rural unemployment, income inequalities, and social unrest seems likely to grow in more or less equal proportion. The "difficulty of subsistence," which Malthus saw as the necessary check on population, may not be the first constraint to come into operation.

For the moment, however, the general world food situation seems quite stable, experts are agreed that 1972 was probably just a bad year, and, in the negative way that FAO director general Boerma likes to spread comfort about, "there is little likelihood of immediate, widespread famine." In the longer term, the world's agricultural capacity is clearly not yet stretched to its limit, and any deterioration in diet is likely to be quite gradual.

—NICHOLAS WADE

Mental Health: Establishment Balks at Innovative Psychiatrist

Any doctor who tangles with the politics of established medicine is likely sooner or later to get his wings clipped. Nowhere is resistance to change stronger than in small rural counties. Georges Reding, a psychoanalyst who spent 4 years setting up a community mental health program in Franklin County, New York, has learned this firsthand. Reding says he was forced out by the county government last year on the vague grounds that he had mismanaged the program's finances and spent too much money. More to the point, he antagonized small, but politically powerful, elements of the medical community. Even though he was supported by the county's mental health board, Reding's outspoken criticisms of some local doctors—he called one a "quack" and told another he should be restrained from the practice of medicine—proved too much for the county legislators. So, the county mental health program was forced to close, even though the board found no fault with its aims and achievements.

Reding's approach to medicine in general is a threat to the establishment. He is a psychiatrist who believes that a mental hospital is no place for a mentally ill person.

In line with this philosophy, Reding inaugurated a project that he believes to be unique in this country: the systematic placement of patients suffering acute psychiatric emergencies in the medical wards of general hospitals, rather than putting them in psychiatric wards or sending them to the state hospital. Mental health experts have been talking for years about the need to phase out mental hospitals and reduce psychiatric hospitalizations, but the belief still persists that the mentally ill should be segregated from people hospitalized for medical reasons. Reding's premise is simple. You go to the hospital when you are sick. "You don't admit people because of diagnosis, you admit people because of the acuteness of their condition." Therefore, in many cases there is no rationale for segregating people according to diagnosis.

Franklin County, whose biggest town is Malone, is a sparsely populated, economically depressed area near the Canadian border. Before Reding arrived, it had been the custom to send acute psychiatric cases to the regional state mental hospital because none of the three county hospitals has psychiatric facilities. When he became director of the county's mental health services, Reding arranged instead for the admission of such patients to the general hospitals.

In a recent article in the *New England Journal of Medicine*, he reports that the average hospital stay was brought down to about 8 days—a striking contrast to the average length of stay in state hospitals, which is 41 days, and to the average stay for people referred through the community mental health center system, which is 14 days.

Reding says that a total of 344 patients were admitted to the Franklin County hospitals over a 4-year period.