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Food Sources of Tomorrow

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Outline

I. Our world's "carrying capacity"

   A. Is the United States having to decide who will live and who will starve?

   B. Our food reserves have been consumed.

II. Development of new food sources

   A. The proposed methods of food yield increases can bring no solution to the crises in the near future.

   B. If the world population growth rate stays at it's present rate, we have no conceivable answer.

III. The hungry millions

IV. The technology to feed the world exists today.

   A. The cost to put the operation into effect is high.

   B. The fortunate people of the world must sacrifice.

V. Extension of cultivated farmland is technically feasible.

   A. The price is high

   B. The amount of additional farmland to feed the world during the next decade would drain biological resources.

   C. Increased yields on present farmland

      1. Grafting

      2. Conserve fertilizer

VI. The sea is not a food panacea.

   A. The myth of sea farming

   B. Harvesting plankton is questionable.

   C. Sea herding has potential, yet pollution is a detriment.

   D. Seaweed culture

   E. Fish stocks need to be harvested rationally.

   F. Warm deep sea water is favorable for biological growth.

VII. Culturing single celled organisms

A. Acceptance as a food will be difficult.

B. Petroleum as a substrate limits SCP.

VIII. Food alternatives and enrichments

A. Insects are high in protein and are readily available.

1. Antburgers

2. Grasshopper stew

B. High protein grain is being developed by breeding.

C. Lysine - enriched wheat is being tested.

D. Oilseed protein concentrates may be good additives to cereal foods.

1. Incaparina

2. CSM

3. Vita Soy

E. Other unorthodox means of providing more food sources.

1. Herding different animals

2. Converting aquatic weeds to cattle feed.

3. Cattle feed from wood

4. Extracting protein from leaves

5. Culturing algae in sewage treatment plants

F. Great problems must be overcome.

1. Cost

2. Acceptability

IX. Yeasts are a potential source of protein.

X. Converting cellulose to glucose to be used for fermentation of protein.

XI. How can we feed the hungry people of our world today and tomorrow?

A. Decrease meat consumption by affluent people.

B. Cut down on food consumption by Americans.

C. Regular weekly fasting by Christians.

D. Limit intake of grainbased alcohol.

E. International cooperation in predicting and fighting famine.

Food Sources of Tomorrow

In one of the most astonishing assessments of the world food situation yet delivered, 5 scientists told the House Subcommittee on Fisheries and Wildlife Conservation and the Environment that the World Food Conference had failed to come to grips with the underlying causes of the present food crisis. They declared that the United States had already begun a policy of triage, deciding which people shall live and which shall starve on the basis of political considerations.

University of Wisconsin ecologist Grant Cottam, said that the delegates had failed to face the possibility that the world's "carrying capacity" may have already been exceeded. "In recent years," he explains,"We have managed to survive without serious famine only because of the presence of a large food reserve . . . with no reserves left, there is no way we can avoid massive famines. The earth simply cannot continue to support an exponential population growth." He estimates the food shortage this year will be equal to the needs of 130 million people.[1]

We must strive to develop unorthodox foods and try to find ways to make them acceptable to diverse peoples. It is rather clear that few of the suggestions being considered today will be major factors in the world food picture during the decade or two ahead. By 1990 hopefully mankind will be able to reduce its numbers to the point of the best ecologically, economically, nutritionally, and esthetically desirable state, so that these new foods can be integrated into our normal food supplies.

It is certainly evident that no conceivable increase in food

supply can keep up with the current population growth rate for long.[2]

All food experts agree that the world will never be able to feed its people properly unless the population growth rate of 2.4% a year is cut to practically zero. The $250 million spent each year to promote family planning is clearly inadequate. Some think it will be necessary for governments to adopt coercive population control - including forced sterilization to head off disaster. It is not likely that such drastic methods will be adopted.[3]

The most pressing factor now limiting the capacity of the Earth to support Homo Sapiens is the supply of food. Today in the United States a "balanced diet" is emphasized in school curriculum and by general public information. The American and European diets - once based on a relatively few foods, have grown in the past generation to include foods from all over the world. The limited traditional diets of most people in underdeveloped countries where malnutrition is widespread, could be basically adequate. Their nutritional deficiencies result from insufficient supplies, poverty or from ignorance.

We live in a hungry world. There are about 450 million well-fed people living in comparative luxury as against 2,400 million under-nourished.[4]

The technology to feed the world already exists. Agronomists are confident that in the next few years, for example, it will be possible for an American farmer to harvest his crop with an amazing hay baler that can wrap 20 tons per hour in polypropylene, a plastic that cattle can eat, which is fortified with vitamins and minerals. However, to cure the world's hunger pangs it will take a lot of money - perhaps billions of dollars every year for many years. Also, it will require a sacrifice in living standard on the part of the more fortunate 1/3

of the world's population to help the other 2/3's become self-sufficient in food.[5]

George Borgstrom, a food scientist at Michigan State University agrees that our natural limits of carrying capacity have not been properly gauged. He says that by calculating the amount of land needed to produce enough protein to feed people now alive and adding to it one billion people expected to exist over the next decade, the actual drain on biological resources will be several times greater than calculated. The only way we can accomodate our population (unless world dietary habits change drastically) would be for much of the world's remaining forests to be cut down to yield more cultivated land, which will increase the already present danger of ecological disaster.[6]

At present only 11% of the world's total land surface is under cultivation. Some agronomists believe that the other 6.6 billion acres could be cultivated into farmland. They are talking about the remote jungles or the Amazon River basin and parts of tsetse-ridden West Africa. Such an expansion of cultivated land is not out of the question - technically.

The problem, again, is cost. Most of the land that is tillable at feasible prices is already being farmed. It would take $4 billion a year to add 20 million acres to the world's farmland by 1985. "If you are willing to pay the price, you can farm the slope of Mt. Everest," commented Lester Brown.[7]

Even with our new technology in use bringing in record harvests, these increases have barely kept pace with the rapid growth of population. Scientists continue to search for more answers. One experiment involves grafting wheat to soybean roots, since wheat requires

nitrogen and soybeans generate their own nitrogen. But such developments would require large supplies of water to make then effective.

The key to increased food production in the developing countries is cheap energy. Suggestions have been made that Americans cut back on the use of fertilizer for lawns, golf courses, and house plants in order to send massive shipments abroad for agricultural purposes, but neither the United States or any other affluent country in the world seems ready for this kind of sacrifice.[8]

One outstanding myth of the food and population crisis is that mankind will be saved by harvesting the "immeasurable riches" of the sea. Unfortunately, the notion that we can extract vastly greater amounts of food from the sea in the near future is just an illusion (promoted by the uninformed.) Biologists have carefully measured the riches of the sea, considered the means of harvesting them and have found them wanting as a solution to the food problem.

The basis of the food-from-the-sea myth seems to be the theoretical estimates that fisheries can produce many times their current yields. However, the most recent analysis by J. H. Ryther of the Woods Hale Oceanographic Institution, puts the maximum sustainable fish yield at about 100 million metric tons which is a little less than twice the 1967 harvest of 60 million metric tons. Some other marine biologists think a yield of 150 million metric tons would require moving down the food chain from the big fish to the harvesting of plankton. All signs at the moment indicate that this will not be feasible or profitable in the near future, if ever. More calories of fuel and human energy would be spent on harvesting the plankton than could be gained. The expenditure of money would be colossal in relation to the yield and the product would require much processing to be made palatable as human food. In addition, harvesting plankton

would result in the depletion of desirable stocks of larger fish living further up the food chain. The most careful analysis indicates that the world harvest might be increased to 70 million tons or so by 1980. However, this increase would actually be a small decline in relation to population, unless the human population growth were to decrease in the next decade.

What about "farming" the sea? Unfortunately, the impression that sea farming is here today, or around the corner is illusory. It is true, we can increase our yields from sea-herding. It is on an upward trend right now. The potential of fresh-and salt-water herding is considerable although its potential is small compared to the scale of the world food problem and increasing pollution now threatens our hope of ever realizing this potential.

About the only planting and harvesting of marine plant crops done today is some seaweed culture in Japan and this is really best viewed as an extension of land agriculture into shallow water. Perhaps, if the sea is finally emptied of its fishes and shellfishes, phy to plankton farming could be attempted. The crop would be very expensive and much flavoring treatments would have to be used with it. For the near future, it doesn't look like sea-farming will provide an answer.

Our plans for increasing the fish yield from the sea disregard the effects of pollution and are based on the idea that fish stocks will be harvested rationally. However, reviewing the past, we'll continue to harvest young and old fish and large and small fish at the same time disregarding the fact that the large fish must eat the small fish to live. Also, we can expect pollution to reduce the size of all fish population if it continues at it's present rate.

So, we see that the sea is far from being a food panacea, for it may not even be able to continue to support the yield we now extract from it. There is a real possibility that the total yield will decline rather than grow and from observations, we will be fortunate if by 1980 the fish yield from the sea is as high as it is today.[9]

Deep sea water which has absorbed the heat from the warm surface water is more favorable for biologic growth. It is rich in nutrients which are often exhausted almost completely by the high rate of photosynthesis in the surface waters. It is practically free of organisms which produce disease and also free of man made pollutants. For example, a shellfish culture has had major pollution disasters in the past years along the continental Atlantic coast.

An experimental station has been in operation on the north coast of St. Croix (one of the Virgin Islands.) Here the ocean floor slopes sharply (4000 meters deep) and reaches 1,000 meters, 15,000 meters offshore. Three polyethylene pipe lines supply water from 870 meter depth in the amount of 159 liters per minute. This water would supply the nutrients needed. This clean, unpolluted water would be free of paracites and hostile microorganisms which could endanger cultured animals which may be passed on to humans.[10]

Another proposed solution to the world food problem is the protein-rich material that can be produced by culturing single-celled organisms on petroleum or other substrates. It is a theory that much if not all of the world's protein deficit in the past two decades could have been made up with protein from such sources. It is thought that single cell protein (SCP) could be made sufficiently pure for human consumption by 1980, but the cost of it may not be economical. The main problem is that people would have to be convinced that SCP is food.

On the whole, people are extremely conservative in their food habits. The hungriest people are those who recognize the fewest items as food. They have always existed on a limited diet. Even though most Americans have a varied diet, many would choose to starve rather than eat grasshoppers or snakes - which are perfectly nutritious, but not generally accepted as food in our culture. Also, since the most frequently used substrate is petroleum, we cannot look to SCP as a long term user either, because the supply of petroleum is limited and in demand for other uses.[11]

With a little practice antburgers or grasshopper stew could make a very satisfying lunch. According to Roy Snelling and C. L. Hogue, entomologists from Los Angeles Museum of Natural History, insects could be a cheap protein alternative to beef, chicken or fish.

Insects are abundantly available, but scientists say that people don't realize that they are very high in protein and can be very delicious. Mr. Snelling and Mr. Hogue have taste-tested a wide variety of insects from ants to beetles and moths. They found that bugs are more nutritious and that pound per pound grasshoppers have triple the protein of steak.

Some species of ants are especially sweet and can be eaten uncooked while beetle eggs are tasty roasted in coconut oil, Snelling says. "It's no worse that eating crab or lobster," he observed, "They're ust smaller that's all."

Snelling does draw the line at eating the eggs of some creatures. He reports that most insect larva is delicious, but that caviar is not fit to eat.[12]

Other ways of providing a protein substitue are being considered. Work is being done on the production of grains with higher quality

protein s necessary for human nutrition. It is being done by breeding new varieties of grain and by fortifying grain grown from traditional varieties. This is very important, and if successful, it could make a considerable contribution to the improvement of the human diet. Lysine-enriched wheat has shown to be beneficial to rats and human babies under controlled conditions. It is not known yet whether its benefits merit large-scale introduction or not.

New protein foods are being produced by adding oilseed protein concentrates to foods made from cereals. The best known of these is Incaparina, (developed by INCAP). It is a mixture of corn and cotton-seed meal enriched with vitamins A and B. Another is CSM formula (corn, soya, and milk), a mixture of 70% processed corn, 25% soy protein concentrate, and 5% milk solids. A third is Vita Soy, a high protein beverage now being marketed very successfully in Hong Kong. These and all similar products should be viewed as "futurehopes" not current ones. As valuable protein and vitamin supplements, they hold much promise, but the economics of their production and distribution are not well worked out.

Even more important is the question of their general acceptability. Incaparina has been available in Central America for more than 10 years, but its influence has been insignificant in spite of its world wide publicity. The principal problem is thought to be its bland taste and texture. Efforts should be continued to promote Incaparina and other protein-rich products made from oilseeds. The press cakes that remain after oil is squeezed out of soybeans, cottonseed, peanuts and sesame seeds are perhaps the most accessible untapped source of protein for human consumption.

Other unorthodox ways of providing more food are being discussed. These include herding animals not presently being herded, such as the South American Capyhara (a rodent), the American eland (an antelope), converting water hyacinths and other aquatic weeds to cattle feed, making cattle feed from wood, extracting protein from leaves and little fishes and culturing algae in the fecal slime of sewage treatment plants. Some of these hold promise, at least to help local situations. But all are subject to serious problems. For instance, herding native antelopes instead of cattle might improve meat yields from the African plains, but local herders base their culture on their relationship with their cattle. The economy, social structure and their entire lives revolve around their animals. They will not take kindly to antelope herding. Even though water hyacinths are abundant and contain protein that is high in lysine, their dry weight is only 5% of their wet weight which presents problems even in it's processing into animal feed. Also an attempt to herd manatees, which eat hyacinths, has proven unsuccessful.

Could fish protein concentrate (FPC) serve as a valuable protein source? It may help. Its chief advantage might be that it would exploit fish stocks that are largely unexploited at present; but its disadvantage is that these often supply food for stocks of fish that we do catch now. FPC is subject to all the problems of fishing in general and the processing is complex and demands an expensive factory. Also its acceptability is a definite problem. Extracting leaf protein from forests presents some ecological problems. The reaction of people in undeveloped countries and developed countries can well be imagined when they are introduced to proposals that feed them protein grown on sewage.[13]

Yeasts (brewer's yeast, dried Baker's yeast, and dried torula

yeast) are the major single-celled organisms grown commercially by fermentation at the present time. Yeasts are a good source of B complex vitamins and are made up of 50% protein. United Nations officials consider SCP as one potential source of protein along with soybean meal, fish meal, and other alternatives to meat protein.

A major advantage of SCP is the fact that it multiplies so rapidly and efficiently as they convert sugars into protein. For instance, a bull weighing 1,000 lbs. can synthesize 1 pound of protein per day, whereas 1,000 lbs of yeast, ideally, can produce 50 tons of protein in the same amount of time. Another advantage of SCP is that organic wastes can be used as a raw material for fermentation. Thus, it would be possible to reduce wastes and contribute to the solution of the world protein shortage at the same time.

Two Louisiana State University researchers, under contract to the federal Solid Waste Management program of the United States Environment Protection Agency built a pilot plant for the production of SCP. They used bagasse, a waste produced in growing sugar cane, as the raw material. It was reported that 36 million tons of bagasse were produced worldwide each year, with 13 million tons produced in the United States. At the present time, this waste material causes environmental problems. About 30% of the bagasse is not burned. Some is left in the field to rot while some is used in the manufacture of by-products.

The researchers chose a type of bacteria called Cellulononas which was fermented into the bagasse. The bacteria was fed to a small group of rats. The growth rate was normal and their amino acid content showed normal except for low methionine and tryrosine content. According

to Clayton Callihan, one of the project's investigators, there is no prospect for large-scale fermentation of bagasse even though the pilot study proved successful. No sugar producer at this time is willing to fund such a costly experiment.

The first step in the army waste treatment process consists of producing a large quanity of cellulose. This enzyme is then added to municipal waste where it breaks cellulose down into glucose. The glucose syrup recovered can in the future be used to ferment protein. Army researchers conclude that "the enzymatic hydrolysis of such energy rich material as cellulose to glucose is technically feasible on a very large scale by 1980."

The technical means to convert organic waste material into protein are actively being developed. The use of SCP as a human food supplement has its problems.

Two are important factors to consider when introducing large quantities of a new food source into the human diet. They are knowledge of their nutritional quality and their potential toxicity.

It has been found that some SCP is deficient in cystine and methionine, two amino acids necessary in the human diet. So it would be necessary to use SCP as a supplement to a diet containing these amino acids to make up the deficiency.

As for toxicity, some SCP contain large quantities of nucleic acids. Large quantities of purine would be converted in the human body to uric acid, possibly overburdening the kidneys with uric acid and other wastes. Thus, it would be necessary to establish a limit which can be safely ingested. Some people have found yeast difficult to digest so that it would not be a suitable protein source for everyone.

Despite problems, SCP still remains one potential protein supplement for humans, particularly in those areas of the world where food

shortages occur.[14]

Some experts believe a way to feed the world's hungry would be a cutdown on intake of animal protein in the affluent world. It takes 7 pounds of grain to produce a pound of beef. "If Americans would decrease the meat they eat by 10%, it would release enough grain to feed 60 million people." contends Harvard Nutritionist Jean Mayer.

In addition, it is estimated that Americans waste up to 25% of the food they buy. If the amount of food that contributes to obesity is taken into account, that figure goes as high as 50%. Yet all proposals to get Americans to cut down on their food consumption met much opposition from the food lobby. As for mandatory food rationing, one Agriculture Department official remarks, "I think we would have food riots on our hands."[15]

As Christians, we must of course do what we can to see that our government acts with compassion, courage and wisdom in addressing the food crisis. This author believes it is time to cultivate some of the old virtues. The time has come to fast. He suggests we call upon Christians to fast once a week, on a regular, disciplined basis, with the food money donated to organizations that will provide food for the needy here and abroad. Also he suggests we should twice weekly go without meat and even limit our intake of grainbased alcohol. The problem of world famine is a moral one. We Christians cannot expect others to sacrifice unless we start paying our own dues.[16]

Most food experts believe that a vast program of international cooperation is necessary to solve the current crisis. There is talk of setting up a worldwide system to give early warning of conditions that could cause famine.

There is a growing realization in the latter third of the 20th

century that the nations of the globe are essestially interdependent, the will to act cooperatively will not exist. Severe inflation, a wide range of domestic problems and resurging nationalism have caused many countries to turn inward. When they do look abroad, their view is ruled by national self interest and balance-of-power politics. Under these circumstances, global cooperation may prove to be the most difficult solution of all.[17]

Footnotes

[1] "Food and Population: Thinking the Unthinkable," Science News, Vol. 106, (Nov. 30, 1974), p. 340

[2] Paul R. and Ann H. Ehrlich, Population Resources Environment: Issues in Human Ecology, (W. H. Freeman and Co., San Francisco, 1970), p. 112.

[3] "How to Ease the Hunger Pangs," Newsweek, Vol. 84, (Nov. 11, 1974), p. 62.

[4] Paul R. and Ann H. Ehrlich, op. cit., p. 65.

[5] "How to Ease the Hunger Pangs," loc. cit.

[6] "Food and Population: Thinking the Unthinkable," loc. cit.

[7] "How to Ease the Hunger Pangs," loc. cit.

[8] Ibid.

[9] Paul R. and Ann H. Erlich, op. cit., p. 101, 109.

[10] Donald F. Othmer and Oswald A. Roels, "Power, Fresh Water, and Food from Cold, Deep Sea WAter," Science, Vol. 182, (Oct. 12, 1973), p. 121 - 125.

[11] Paul R. and Ann H. Erlich, op. cit., p. 109 - 110.

[12] "Take an Ant to Lunch," Science Digest, Vol. 76, (Dec. 1974), p. 22-23.

[13] Paul R. and Ann H. Erlich, op. cit., p. 110 111.

[14] Janice Crossland, "Ferment in Technology," Environment, Vol. 16, (Dec. 1974), p. 17 - 20.

[15] "How to Ease the Hunger Pangs," loc. cit.

[16] "A Modest Proposal for Fasting and Meatless Days," Christian Century, Vol. 91, (Nov. 27, 1974), p. 1116 - 1117.

[17] "How to Ease the Hunger Pangs," loc. cit.

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