

The Edge of Hunger

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The first generation of men in the atomic age have at least one problem in common with the very first generation of modern men on Earth. We both inherited a world in which starvation loomed on the horizon for all people.

The new age finds seven nations in ten struggling with sub-marginal living standards at a time when they already have under cultivation most of their good farm land. Furthermore, eight of ten people in the world are living on or near to a farm and semi-starvation is the rule rather than the exception.

Concentration Effects on Human Life

Coupled with the above situations is the current increase in human numbers on Earth. While man indeed needed to be concentrated in suitable areas to evolve societies, which permitted specialization of human efforts, there are obviously limits of safety to human population densities which must be observed. Most societies on earth already have encountered the quality-quantity barrier.

In spite of this, a human population has been added to this planet during the past four years which equals the number of people living on Earth at the time of Christ. The reason for our real concern is that there has not been a concurrent development in our abilities to generate the essentials of the good life for this new population.

While each of us may know some of the effects of starvation, the majority of the people in the world today are experiencing many of the effects of starvation and the situation for them has existed for most of their lives.

While we do not often regard thinking as a biological process, people in advanced semi-starvation have sluggish intellectual processes. The repercussions of starvation extend beyond physical health and include the whole being.

Modern societies are intellectual societies. Mental processes are increasingly important as machines replace muscle in work tasks. Here again, even though our food supplies and populations would remain fixed, the acuteness of the problems of starvation would become increasingly limiting to human advancement.

The situation is far from being hopeless since solutions are available, but now public action is required to put them into play. The reasons for this become more clear when we probe into the history of our present food supply system.

Brief History of Food Production

The earliest known culturing of plants by man was in the Tigris-Euphrates River valleys about 8,000 years ago, plus or minus a few hundred years. Food production started with the discovery of planting seeds in the ground and having them yield more than were planted. The soil lost productivity in the process. Next, it was found to be replaceable by careful selection and rotation of crops. But to force food production further, fertilizer had to be added, seeds planted even more closely together, the plants artificially watered, and insects and pests controlled.

These were undertaken with variable effectiveness. Next, good land became in short supply, but by then it was possible to successfully farm most land provided capital resources were available and could be applied. As a matter of fact, food could be produced with this system without land, and this was done in hydroponics agriculture. The nutrient needs of plants were provided in a solution pumped to plants standing in water or sand. The system was surprisingly effective. It was very good for plants but not very effective for man.

In the first place, there are physical limits to this system . . . increasing investment does not necessarily result in further food production. When plant populations exceed definite limits, they shade each other, lowering yields. The carbon dioxide content of the air also limits food production on earth and this is not often realized. We must also consider the increased water, nutrient, disease and weed problems. And, all months of the year are not adequate for field production of crops. There are therefore several indications that this particular path to more intensive cropping in soils in the evolution of food production is terminal.

Furthermore, there have been no new food crops of any significance introduced into world agriculture since the discovery of America, and no new method of preserving foods has been found in the past 160 years which is now used by most people. Twentieth Century man has been content to refine age old crops and systems.

Easing the pressure of the present day must occur, but to do it effectively the evolutionary processes in man's ability to produce good food must be quickened. Where could it go? To gain some insight we might review briefly the nature of the world's resources for food production. These are as follows:

Land—Four-fifths of the world's good farm land is already under cultivation.

Water—There is an enormous amount of water in the world but generally man cannot increase his control of it. He is largely at the mercy of the weather.

Plants—There no doubt are more good crops in the world but none of any consequence has been found for 450 years, and these actually were discovered about 1,500 years prior to their introduction into world agriculture.

Animals—There have been notable improvements in the efficiency of refining grain into meat (chickens and hogs) but no new animal crop has been introduced in the past several thousand years.

Relation of Food Needs and Supplies

Let us look at the food problem in another perspective. A person eats about 10 times his body weight a year. Assume we averaged the weight of all people in the world, and we found it to be 120 pounds. Each person would then need about 1,200 pounds of food a year. This number is perhaps not too far from the truth, and we will use it here.

It would also be useful to have some idea of the presently available food supplies in the world. While this information can only be estimated, we now produce in the vicinity of 2.4 trillion pounds annually for the present 3.0 billion people. Distributed to each this would amount to about

800 pounds per person per year, or about two-thirds present needs even in bulk, with no mention being made of quality.

From 25-50 percent of the food produced is lost in storage and distribution. Using the lower figure, the consumed supply must be reduced by one-fourth, leaving about 600 pounds per person.

Even in terms of bulk, to meet human food needs we must about double the supplies available today to feed the people now alive. What are the prospects for even this?

Food Production Must Be Directed to Man's Needs

To double the world's food supplies in the next 40 years, it will be necessary not only to use the most efficient agricultural methods in all parts of the world, but we must also greatly increase the land under cultivation. Using present practices it is inevitable that more grain and less meat be eaten. Yet, it is doubtful that even the best agricultural practices now used will be able to keep the world's population alive if its rapid expansion continues even 20 more years.

Now, the above data facts are merely statistics and are subject to endless discussion and error. These data are subject to each one's interpretation. The real cause for concern is that these facts represent only quantities, tonnages, etc., and do not adequately reflect the true picture. A pound of grain in such statistics has the same weight as a pound of meat but they are not equal as food. The situation is thus worse than statistics would lead one to believe. Because of this, to meet the food needs of the future, new types of food production must be found and these must be turned to the food requirements of man. This is the first departure we must make from the past.

The starvation that is widespread in the world is a special starvation . . . protein starvation. It is protein that is short in the world, and just any kind of protein is not adequate. Man requires a high quality protein—one which contains the proper kinds and amounts of building blocks (amino acids) required to form and repair human protoplasm. Such protein is found in no one plant, but is characteristic of most animals. The tragedy is that present food production is not man-oriented.

The reason for this development is relatively clear. It was not until a century ago that our ideas of food began to crystallize. From the beginning of modern man some 10,000 years ago until the last century, whatever filled man's stomach and kept him alive was called food. A century ago food was found to be composed of three major factors—the carbohydrates, fats and proteins. In the last 100 years, the list has grown to include more than 50 essential chemical compounds. Present understanding of human nutrient needs is adequate to demand shifts in food production.

But, during the whole period in which food production was evolving it tended to become oriented to the most "food" per unit of land by the earlier understanding. In fact, whatever "food" was available in an area became incorporated into local diets. Cultures eventually accepted the idea that the local diet was the *best* and those ideas have been perpetuated ever since. They need not be particularly related to human needs for good health.

Since grains yield the most "food" for the work involved, grain production increased, and eventually man shifted from eating mostly meat

to eating mostly grain. Grain eating people have not led the world's civilizations to date. In fact, the poor have one thing in common the world over—they are the grain eating people of the world.

It is not technologically difficult to produce carbohydrates (the main crop for which is grain) since these are the immediate photosynthetic products in plants. Producing edible oils is somewhat more difficult, yet early men were ingenious in oil production, i.e. olive and palm plantations. It is high quality protein which is difficult to produce and this is the commodity in short supply in the world. Food production systems are not geared to yield this essential component for buoyant human life.

To man, the difference between high and low quality proteins is somewhat analogous to the difference in two jig-saw puzzles, one of which contains all pieces, the other missing several which were replaced with pieces from some other picture. High quality protein contains the essential pieces needed by man; low quality protein does not yield the same picture.

Man's protein intake is a good index to the quality of diets. An intake of 50-60 grams per person per day of which a third at least is from animal sources is considered a working minimum. Some countries have available more than 100 per day. For all countries, however, the average human intake amounts to something in the order of 10-15 grams and this is largely of low quality.

It is highly improbable that we can produce 40-50 grams more per person per day with present practices. A pound of beef steak, pork, fish or chicken only contains 20 percent protein. A pound of meat therefore only has about 90 grams of protein. At rock bottom we need about a four or five fold increase in present supplies now, and a 1,000 percent increase in 40 years! If we are to produce 1,000 percent more animal protein with grain, we would need 2,500 percent increases in grain supplies to yield the protein in the form of chicken flesh, 4,000 percent increase for pork, or 10,000 percent increase to yield the beef, that we will need within the next 40 years. Just 20 years from now, we need a 500 percent increase in grain for chickens, or 2,000 percent increases for pork or 5,000 percent increases for beef. Present technology if applied worldwide would result in a 2.5 percent increase annually and most countries cannot sustain even this. *If we are to look forward to a day when all men might enjoy good health, there must be dramatic improvements in food production technologies.*

In pursuit of this goal, let us rearrange the world resources and look at them from a different vantage point. What is the case then?

—Less than 10 percent of the earth's surface is used for food production.

—Less than one percent of the energy received by the earth from the sun is fixed in photosynthesis.

—Less than one calorie in a million reaching the earth is presently usable as human food.

We must conclude that food production is a very inefficient affair, that it is not particularly geared to man, and that food production is in its infancy.

It is not enough to hybridize crops, produce and apply more fertilizers, develop better farming equipment, decrease spoilage and improve food distribution and improve our knowledge and practice of human

nutrition. Such are under development at the present time and we already see, as the figures above show, not only the limitations in our present approach, but the limitation of our present thinking.

For the future we need a system of food production that would allow a large increase in high quality protein for diets and the system should be operative with the resources men have available. As was true with the legume rotation, for example, the new system must be an improvement in technology. Since 70 percent of this planet's surface is occupied by salt water it would seem reasonable to be able to use it in food production.

Untapped Potentials

Some significant discoveries in the field of atomic energy were the demonstrations that uranium underwent fission under certain circumstances, that such fission events could be sustained, and that the energy released in the process could be harvested. We need discoveries of this order of magnitude in food production.

Fission also occurs in living cells. Fission is the general method of cell division, creating two from one. This reaction, too, under certain circumstances can be sustained. If the cell undergoing fission is a photosynthetic cell, it can also harvest solar energy for us. This process is recognized as the basic energy system for life in oceans and waters.

The cellular system is known, the cells are called algae, and they have been a laboratory curiosity for more time than has been the fission of uranium. In fact, more is known about plant growth from the study of algae than from any other plant. In the course of study it was found that the algae are about five times more efficient in the photosynthetic process than are the higher (seed bearing) plants. Furthermore, the nutrient requirements of algae are essentially present in sea water.

Some strains of algae have phenomenal growth rates. Under certain circumstances, for example, the algae can be forced to grow into very dense populations, approaching 50 million cells per drop; a pound of algae cells could be harvested from a gallon of such a population each week. At this rate, a 50 gallon unit would equal the productive capacity in a year of an acre of farm land planted to soybeans or wheat. In fact dry algae are half protein but like beans and grain are not good human food alone. However, algae can serve as the bulk for animal feeding.

To speculate, a 50,000 gallon unit, about the size of a large double garage, would be equal to feed produced by 100 acres of good farm land in a year, and conceivably could yield more than a pound of chicken flesh a day for 1,000 people after the eighth week of operation and at this rate thereafter.

Furthermore, it might be useful to explore the growth of single celled animals since some also have very great reproduction rates, as do insects, which already serve as animal feed in nature. If these can be fed on algae, and also maintained in a logarithmic growth phase, rather phenomenal production of feed might be possible. This would then permit us to dramatically increase high quality protein supplies to supplement present systems.

Since electric light can be used by algae instead of sunlight in photosynthesis, we might eventually even explore the conversion of hydroelectric power into meat or milk, or, atomic energy can be released and the energy

converted to electricity to light to be converted into food. Since in the latter process a large amount of radiation is also released, and the food produced is perishable, we could pass it back through the radiation to sterilize the food to permit effective storage and distribution. The United States government has already invested many millions of dollars in more than 100 laboratories over the past seven years to perfect this process of food preservation. Adequate technology now exists with which we can now destroy all the parasites, worms and insects which are present in our foods and which constitute a major public health menace to man.

The "closed cycle" generation of food would make us less dependent on fertile land. The system might find widespread application in civil defense since each community could probably assemble workable generators with materials already available locally.

On the other hand, protein starvation at present occurs in the greatest degree in a zone around the earth bounded by 25° North latitude and 25° South latitude. In this belt, photosynthetic rates are very high, but the rates of respiration of plants are also high. The result is a low net accumulation of photosynthetic materials in higher plants. As a consequence, there are small natural animal populations and many people residing in the area as suffering from protein starvation. This belt around the earth has good sunlight and temperatures favorable for single celled plant and animal growths. For example, molds are rich in protein and one difficulty in the tropics is to *keep* molds from growing! Mold growth on and with algae is recognized as a natural process—the lichens. There are many edible lichens, i.e., the rains of manna in the Bible, useful as animal food.

The only time when such innovations can be tried and perfected is when some groups of people are not forced to consume every green shoot that emerges from the earth. Three nations in ten are still in a position to come to the aid of the seven in ten in trouble.

The overall problem we must attack is sub-marginal living standards which presently limit the effectiveness of the majority of the people in the world. Solutions to improving standards of living are hinged on adequate food production and improvements must be based on the resources available to have lasting effects. Since the resource base of nations is relatively fixed, the solution is to be found in expanding our technologies of food production. It is now clear that our ability to increase the food supplies on earth with the resources available to the point where most men could enjoy good health is limited mainly by our present thinking. For the first time in history man now has the technological capability to conquer starvation, which has limited human life since civilization began.

Reviewing the past, we see mankind existing mainly on the edge of hunger. Looking to the future, it appears mankind is on the brink of an historic change. Some might call the change one toward the industrialization of food production.