ENERGY
AN ENVIRONMENTAL AND ECONOMIC DILEMMA

3. ENERGY AND WORLD FOOD PRODUCTION[1]

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The world food problem is really two separate problems: (1) threat of famine, shortages and high prices, and (2) current calorie and protein shortages. Even though granaries are now full, people who need food are not always getting it, and chances are that their situation will not improve in the future due to the decreasing availability of petroleum energy for growing, transporting and preparing food.

The history of mankind has focused on the ability to produce food for human energy. Civilization emerged only after man gained the ability to produce and store food. The human race has migrated, fought wars and changed folkways because of food. Its presence or absence has influenced the arts, sciences and overall culture more than any other factor, including religious beliefs.

Because technical changes come slowly and are difficult to achieve, decisions made today and during the next few years will affect what people worldwide will eat in the year 2000. The availability of quality food at low prices has lulled Americans into a false sense of security about food supplies. The food situation today is as serious as it was during the worldwide famines in 1973 and 1974 and probably is much worse in reality due to increasing scarcity of resources and increasing population.

New land brought into production over the last decade places further strain on limited resources, especially fossil fuels. Most new land developed is marginal, demanding extra fertilizer, water and mechanical attention. Often it has eliminated valuable forestry resources and increased soil erosion and water runoff.

An upsurge in production in 1976 was due to more favorable weather than expected. Probably no other period in history has been as productive as the past 30 years. Now, however, the climate may be changing. Whether the earth will become warmer or cooler is still under debate, but the high amounts of carbon dioxide and pollution in the air could certainly lead to climatic change. Food production is bound to be altered.

POPULATION

It is likely that as population increases we will have to be content with merely providing the best diet available to masses of people in the developing world even though it will probably be less than the desired level for good nutrition.

World population is continuing to rise rapidly. As Malthus predicted in the 18th century, population is increasing at a geometric rate. It has doubled in the last 47 years from 2 billion to slightly over 4 billion. Though it took 80 years to add the second billion, and 30 to add the third billion, it took only 15 years to add the fourth billion, and it will be only 9 years or less before we reach the fifth billion. About 200,000 people a day are born on this overcrowded planet.

Unfortunately, the majority of the population increase is in the least developed parts of the world. Most of the wealthy countries are in the world's green belt (Figure 1), where food production has increased much more rapidly than population. In the poor countries, food production has been increasing at about the same speed as it has in the rich countries, but the population has been increasing so much more rapidly that there has been little gain on a per-capita basis.

The expected growth rate for world population is 2.0 percent, whereas the projected growth rate for

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[1] *From presentations by Dale Harpstead, Chairman, Dept. of Crop and Soil Sciences, MSU, and Vernon Sorenson, Professor of Agricultural Economics, MSU, at a seminar for community leaders of Genessee and Lapeer Counties on April 11, 1977, in Flint, MI. The series of four seminars was sponsored by Michigan State University's Cooperative Extension Service. Adapted by Bill Stout and Paul Parker, Department of Agricultural Engineering, MSU.*

Other titles in the series are: No. 1, Running Out of Energy (Extension Bulletin E-1173); No. 2, Energy and Ecosystems (Extension Bulletin E-1174); and No. 4, Developing an Energy Policy (Extension Bulletin E-1176).

COOPERATIVE EXTENSION SERVICE
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production is 2.7 percent (Figures 2 and 3). But with demand increasing as standard of living expectations rise worldwide, increased food deficits are expected. An eventual leveling off of the population curve may occur, but is unlikely before the turn of the century. By that time world population may reach well over 8 billion. If the type of economic growth occurs that the developing countries want, food production must increase by 5 percent each year. That requires a 4.3-fold increase in food production between 1970 and 2000, and there is absolutely no way to achieve this.

Even if population and income stabilize, food production must double, based on the number of people just growing up now. For example, one half of Mexico's current population is under 15 years of age.

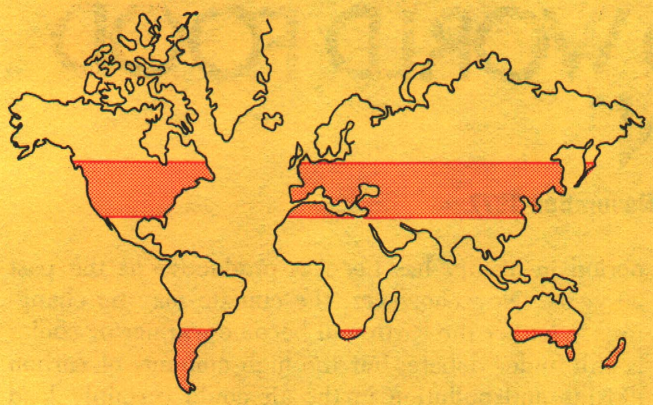

Figure 1—The best agricultural lands are in the "Green Belt" areas (shaded), between 30 degrees and 55 degrees north and south latitudes.

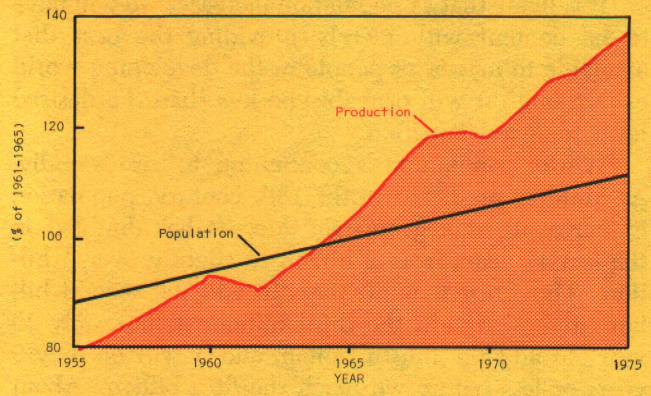

Figure 2—Food production and population in developed countries (USDA).

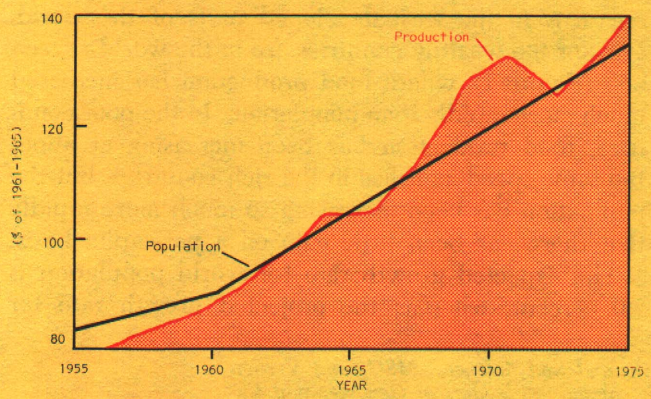

Figure 3—Food production and population in less-developed countries (USDA).

THE IMPORTANCE OF GRAIN

Over half the food consumed by humans comes from cereal grains. It takes about 400 pounds of grain to keep a person "fed" each year in a developing country as opposed to 1,200 pounds of grain to "feed" people in Canada, the United States and some of Western Europe. These differences are directly attributable to our standards of living and eating habits.

Relatively small amounts of meat are eaten on a worldwide basis. Cereal grains, roots, tubers, vegetables and some seed legumes are available to the average person in the world. Tremendous numbers of people must survive from only one of those sources. Relatively few people are privileged enough to live on a diet that contains high amounts of animal protein or proper mixtures of animal and plant products.

Millions of people get absolutely nothing week after week and month after month in the meat, milk and eggs category. Infant mortality is 80 percent in many places. People have to live within a balance of protein, calories, vitamins and minerals. When any of those dietary requirements are deficient, there will be some sort of compensation. When caloric intake is too high, fat cells grow; when more protein is ingested than needed, it is burned up as calories; a deficient vitamin supply will cause nutritional irregularities.

There is little or no substitution among these essentials except that the body will meet its caloric needs first. Failure to meet the minimum requirements of protein leads to a decreased ability to work. A young child's growth and development rate normally depends on adequate protein consumption because proteins, along with vitamins and minerals, make up the building blocks of life.

It has been calculated that 80 million metric tons (mmt) of protein are available in the world.[2] Of that 80 mmt, 48 mmt are available to the less-developed countries and 32 mmt to the developed countries. Of the 25 mmt from animal sources, which supply the highest quality proteins available, 15 mmt are in the developed world and only 10 mmt in the less-developed countries. Though the less-developed

[2]*Altschul, Aaron M. (1975). Worldwide needs for quality protein.* High-Quality Protein Maize. *Dowden, Hutchinson and Ross, Inc., Stroudsburg, PA.*

world comprises two-thirds of the world's population, these regions receive considerably less than two-thirds of either the total protein or the higher quality protein. With further pressures created by energy shortages and rising population, those diet deficiencies could become more catastrophic.

It will take 120 mmt of protein, in addition to the 80 mmt currently available, to meet the minimum protein needs of the world by 1985. Such an increase in protein production is impossible.

In 1973, it was estimated that on an average day, the average American got 16 of 98 grams of protein from cereals, while the average Southeast Asian got 32 of 49 grams of protein per day from cereals (Table 1). Animal sources provided 70 grams and 6.3 grams of protein, respectively, for the American and Southeast Asian diets.

We have glossed over some of these disparities in our evaluations of the world food situation because the problem of supplying sufficient calories alone has been so great. Unfortunately, the same disparities exist in the caloric, vitamin and mineral supply.

Food is also used inefficiently in this country, partly because grains are fed to animals to produce protein and partly as a result of habits of overconsumption. The average American disposes of 3,290 calories per day. This is at least 30 percent more than is required and almost twice as much as is available in some developing countries.

GRAIN RESERVES

Recently, there have been two major shortfalls in grain production, one due to a drop in production in Asia, the other due to an untimely combination of bad weather and increased demand around the world. The burdensome surpluses available in the early 1960s began to disappear, and demand grew faster than supply for a long time.

Growth in demand is directly related to changes in consumption patterns as income rises. First, Europe and Japan moved into a higher income category and switched from a grain to livestock food base. A shortfall in production followed. Since 1970 the inventory of grain has dropped precipitously. Total wheat and coarse grain stocks held by major exporters (United States, Canada, France and Australia) dropped from 19 to 3 percent (Table 2). This rapid decrease in supply, coupled with a high increase in demand, led to rapidly rising prices. The Russian wheat sale forced grain prices even higher.

By the time India purchased wheat in 1972 and 1973, the price had risen to nearly $5 a bushel. The less-developed countries were caught in the middle by this inflation.

The issue of grain reserves has become a widely discussed subject in the United States. Farmers are reluctant to produce reserves because they remember the low prices they got as a result of price support systems and surpluses. In a worldwide grain market, the guarantee of a price is vital if farmers are going to produce. If there are shortages, prices will rise; if there are surpluses, prices will go down.

Table 1—Protein consumption per capita by major food groups in world areas.

	Cereals	Starchy Roots	Pulses and nuts	Vegetables and fruits	Meats, eggs, fish & milk	Total
	Grams per day					
North America	15.9	2.4	4.3	4.9	70.7	98.2
Western Europe	27.0	4.3	2.9	5.2	48.5	88.2
Japan	25.8	0.7	12.7	5.9	31.8	76.9
Central America	31.6	0.5	11.9	2.0	22.8	58.0
South Asia	32.3	0.5	8.6	0.6	6.3	48.8

Source: (FAO).

THE WORLD FOOD CONFERENCE

The conference called for improving world food security by improving information systems, providing food reserves, increasing production (because the world cannot be fed from the granaries of Canada and the United States), improving nutrition and devising trade policies that would help developing countries obtain reserves for humanitarian and price stabilization purposes.

Though rapid price increases are bad for consumers, rapid price decreases are crushing to farmers. Because economic structures differ around the world,

Table 2—World wheat and coarse grain reserves.

	Million metric tons			
Wheat stocks	71.3	80.0	55.9	47.6
Percent of world wheat consumption	33%	24%	14%	14%
Coarse grain stocks	94.9	70.0	52.0	39.5
Percent of world coarse grain consumption	23%	13%	9%	7%
Total wheat and coarse grain stocks	166.2	150.0	107.9	87.1
Percent of world wheat and coarse grain consumption	26%	17%	11%	9%
Wheat and coarse grain stocks held by major exporters	121.6	96.8	57.0	31.4
Percent of world wheat and coarse grain consumption	19%	11%	4%	3%
	1960/61-1962/63	1969/70-1971/72	1973/74	1974/75

Source: (USDA).

it is impossible for all the countries to agree on what should be done.

Emphasis at the conference was on increasing production in poor countries. This issue is being more seriously addressed today in light of the energy resources depletion. Conference members wanted to make more inputs available to rural areas in developing countries and improve the quality of inputs in traditional, small-farm agriculture. They recognized a need to initiate research in poor countries.

PAST STRATEGIES

There is no way of transferring the majority of industrial agricultural technologies into the developing countries. Turning American agribusiness loose in the developing countries will create more problems than it will solve. People often have expectations which far exceed what the land will allow them to produce. Many end up abandoning their farms and moving to cities where they encounter worse problems.

The developing world has relied too heavily on Western technology and Western aid to raise its standard of living. For example, the United States supplied Korea with food for several years. That country then neglected to develop its own agriculture. The short-term results of a policy preventing generous surplus food supplies would have meant death for many poor people in developing countries, but it would also have forced them to confront the situation when there was still a chance to improve it.

Policies that encourage new land and resource development have caused some countries to resort to deforestation to gain more land for food production. Emphasis has also been on colonization of areas not previously used. The United States helped people develop irrigation systems that were supposed to solve all their problems but failed to look at what production capabilities and technological inputs could be made once the dams were in place, the canals open and the land irrigated.

APPROPRIATE TECHNOLOGY

Our best hope is to increase the efficiency of existing systems. Problems in subsistence agriculture result from the lack of resources, size of operations, inability to store food and inconsistencies in weather, price and governmental systems.

Some of the same problems confront the food production system in the United States. Even our system does not always utilize energy efficiently. The food system in the United States uses large quantities of petroleum products, not only in growing food but also for processing, transportation and storage. With fossil fuel reserves dwindling and energy costs rising everywhere, farmers, industrial food processors and homemakers may want to look for less energy-intensive methods.

Some energy technologies which do not depend heavily on fossil fuels are currently being researched for use in developing countries and in the United States. They include solar grain drying, solar heating and methane fuel production from agricultural wastes.

Appropriate technology has been applied in subsistence agriculture. For example, in Africa, a ceramic bottle-like silo provides a simple storage unit for grain.

In the lowlands of Guatemala, corn is worth about $5 per hundredweight at harvest. That same corn, stored in traditional centralized grain silos, could cost the farmer $15 to $18 per hundredweight if purchased back months later. But a tin storage container enables local subsistence farmers to keep the corn in storage themselves and participate in the market system.

Like ourselves, individuals in other parts of the world will choose to operate to their advantage when the option to choose is available and consistent with cultural beliefs. An understanding of our ecology and the values held by other cultures will encourage energy-efficient technology in agriculture worldwide.

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