

The World Food Problem by R.A. Olson

Argument continues in the world press as to the urgency of the food problem. Some economists in equating world food production statistics with population figures have convinced themselves there is more than enough food per capita and, accordingly, no problem. Looking in greater depth than these gross averages, however, we find that there is indeed a prospective problem, and of such a nature and magnitude as to tax all of mankind's talents and resources in its resolution. It is true that certain of the developed countries of the world in the last generation acquired agricultural production capabilities that notably exceeded the resident population's capacity to consume. 'Surplus' in these areas became an ugly word during this period of a generally favorable weather cycle, and restrictions on the amount of

land that could be devoted to grain-crops were imposed to curb this tremendous capacity. A fickle Mother Nature, however, has turned things around during the early 1970's by one or another of her many vacillations in the form of local drought, excess moisture, shortened growing season, or other means, in some of the major producing areas. In consequence, the food grain surpluses are now gone and the world is looking at a three to four week reserve at any given moment. The cost of food products available from exporting countries has doubled and trebled in price during the past two years. The potential for famine exceeds in magnitude anything the world has ever known. It is against this background that the World Food Conference will be held in Rome during November of this year.

THE PRESENT SITUATION

The Food Granary: Stored grain reserves have been the foundation for national strength and stability from time immemorial. The Bible vividly describes their import to ancient Egypt and neighboring states. Recently it had seemed that modern agricultural technology had assured full granaries for satisfying mankind's needs, albeit with some sharing with local regions suffering drought or other calamity, through such channels as the World Food Program and U.S. Public Law 480. The past decade, however, has demonstrated the highly tenuous character of the reserves we had come to accept as inviolate. We find in 1974 there has been a drastic decline from around 25 percent of the total grain consumption held in reserve each year to no more than 8 percent at present, the smallest reserve in 20 years (Figure 1). It seems doubtful that the exporting nations will allow any further depletion. More specifically, the increasing world dependency on North

Water management is being carried out for salinity control in the effective production of Mexipak wheat in Pakistan. ►



American food exports which began as a dribble in 1930 and rose to some 85 million metric tons in 1973, has probably reached a near-term limit until such time as some new technological advance comparable to fertilizer nitrogen is brought to bear. The world granary is almost empty and a very delicate balance between supply and demand exists.

Weather Patterns: Weather and food production are inextricably related. Fortunately, the calamities of weather that adversely affect agriculture rarely strike in many regions simultaneously; and it has usually been possible to compensate for the losses in one state with the bounty from others. Weather conditions were favorable throughout the major food producing regions in 1971, resulting in considerable optimism on the part of international agencies concerned with food that an approaching crisis had been averted for the foreseeable future. The vagaries of weather, however, turned the tables in 1972 when drought in India, China and the Sahelian Zone of Africa combined with severe winter kill of wheat in Russia to put extreme stress on the world's food grain supplies.

Generally favorable conditions again in 1973 (except for the Sahelian Zone) afforded a bountiful harvest of the food grains, but without any corresponding buildup in reserves. The present drought (July/August) in mid-western U.S., an area that has truly become the breadbasket of the world, is yet to have its international reverberations in 1974-75. We

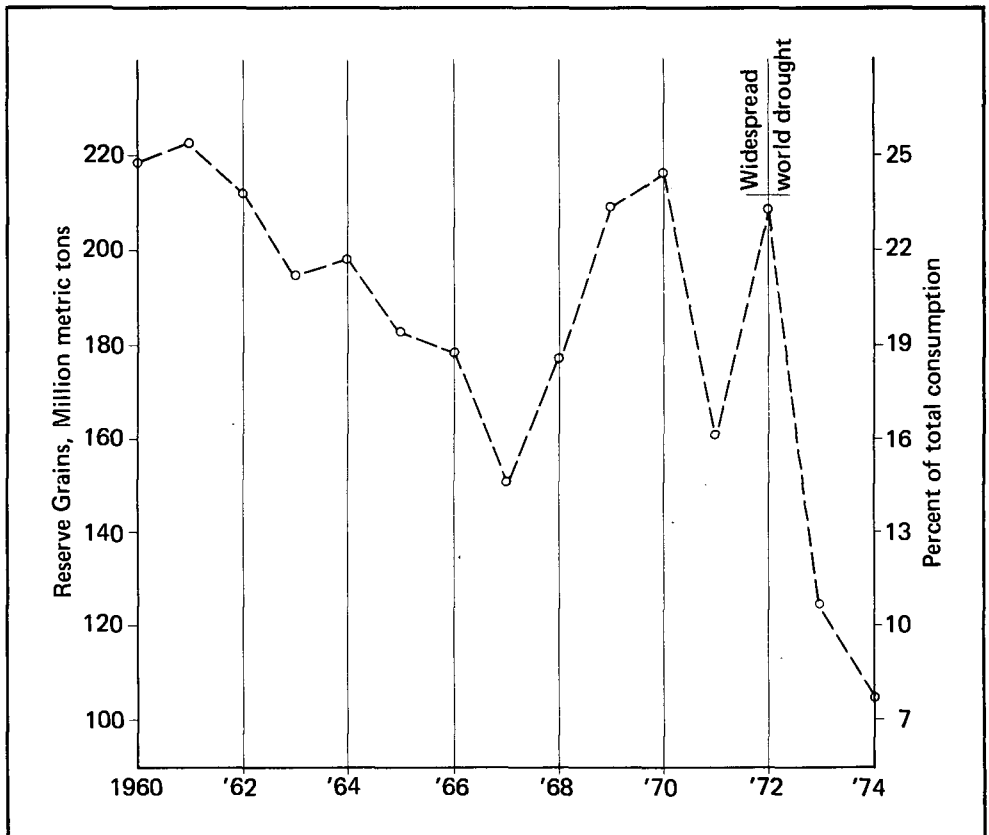


Figure 1. Grain reserves of the world during 1960-74. Includes potential grain production of idled cropland. (Source, as compiled by Lester R. Brown and Erik P. Eckholm for Ceres, vol. 1, no. 2, p.60.)

have good reason to be concerned in this respect as the plains region of the U.S. and Canada is subject to drought cycles with a periodicity of approximately twenty years. The last one occurred in 1955-1956, and the one before that during 1933-38. Should the summer drought of 1974 be the start of another long-term one as in the '30's, the world's people may well be in line for some very lean years.

The Energy Crisis and Food Costs: The sudden recognition in 1973 of the world's dependence on a finite fossil fuel supply has had as great an impact on agriculture as on any human enterprise. The costs for agricultural requisites to food production have pyramided in the past year with elevated fuel costs to the point where most products have doubled or trebled in price. The ton of urea which traded in world commerce for 100 U.S. dollars in 1973 now commands 300 dollars or more. It is the same with herbicides, insecticides, and virtually all other commodities used in agricultural production, including fuel.

The end of the chain, food itself, has similarly doubled and trebled in cost to the consumer within the same short time span. The following figures give an indication of the tremendous fluctuations that have occurred:*

	Wheat (Hard winter, No.2 F.O.B., U.S. Gulf)	Maize (Yellow, No.2 F.O.B., U.S. Gulf)	Soybeans (U.S., C.I.F. Rotterdam)	Rice (Thai, White 5% F.O.B., Bangkok)
	U.S. \$/Metric ton			
1971	62	58	126	129
1972	70	56	140	151
1973	139	98	290	368
1974	208	126	263	569
(1st Quarter)				

* Data compiled by a preparatory committee of the U.N. Economic and Social Council for the World Food Conference, 8 May 1974.

Especially severe consequences for the poorer countries of the world are clearly obvious as the above cost figures are equated with the data of Table I. With finite food resources for distribution, the needs of those countries which can afford to buy will certainly be met first. The average homemaker of the developed country will grumble and pay grudgingly, but without serious problems, still having to commit no more than 15 - 30 percent of income for food. It becomes quite another picture in the developing world where 75 percent or more of income may have to go toward food. Furthermore, with the competition for food that is certain to occur among nations with shortage, the latter homemaker may find none on her country's shelves.

Contributing to the crisis imposed by energy is the increasing world-wide appetite for meat products. Several times the amount of calories and protein in feed grains and supplements must be fed through animals, to provide a gram of metabolic protein, compared to what it would supply if consumed directly by humans. The citizen of an affluent country who makes beef and pork an important part of his diet cannot be condemned for his preferences, but it does have a significant impact on grain consumption there and

TABLE I. World food grains projected 1973-74. *

Region	Projection	Consumption	Exports	Imports
Industrialized		Million Metric Tons		
United States	239	170	69	—
Canada	38	19	19	—
Western Europe	133	159	19	45
U.S.S.R.	152	159	4	11
Eastern Europe	86	94	—	8
Japan	14	33	—	19
Others	26	16	10	—
Developing				
China	157	164	1	8
India	123	129	—	6
Other	227	252	14	39
Total	1,195	1,195	136	136

* Compiled for wheat, rice and feed grains. By Trezise, Philip H. 1974: "Disengagement the time has come for the gradual withdrawal of protectionism". *Ceres, FAO Review on Development*, Vol.7, No.2: p.40.

ultimately on the world's total food supply. The matter points up the need for a modification in cropping systems and eating habits toward a large expansion in grain legume production and consumption for partially satisfying the protein nutrition needs of people, especially in the developing countries.

The Green Revolution and Its Promise: The introduction into the developing countries in the late 1960's of new, higher yielding varieties of wheat and rice as the result of break-throughs of CIMMYT¹ and IRRI² gave hope to a food-hungry world of better things to come. The promise came in large part by the introduction of genes that imparted a short, stiff stem to the plants allowing them to use more nutrients in building heavier heads, without lodging as traditional varieties would when heavily fertilized. A complete package of improved variety, better disease and pest control, increased fertilizer rate, and better water management espoused by Borlaug and others³, resulted in doubled and trebled yields over those experienced in the past. By 1970 several countries, including Mexico, the Philippines and Turkey, which traditionally had been heavy importers of grain, had enough left over from country needs to permit some export. Several other countries including India, Pakistan and Indonesia could begin to visualize prospects in the near future of becoming self-sufficient in food-grain production.

¹ International Maize and Wheat Improvement Centre, Mexico City.

² International Rice Research Institute, Los Baños, Philippines.

³ Borlaug, Norman E. 1971: "Mankind and civilization at another crossroad". McDougal Memorial Lecture, FAO General Conference, 16th Session, Rome.



These Indian workers are providing water for their rice production under most difficult conditions.
Photo: United Nations.

One of the miracle rice varieties that has assisted the "Green Revolution" in the past decade, thriving in Indonesia.



Some problems with this development did surface early with indication of accentuated disease and pest hazard by the reduction in genetic diversity accompanying the widespread use of this limited number of genotypes. Breeding programmes were undertaken for building-in some of the necessary resistances in the countries to which the introductions were being made; but, of course, this would take time. Another problem of equal urgency was soon noted in the logistics of storage and transport of the added production. This, too, could not be surmounted overnight. A third significant issue was sociological in nature. This one came about via the larger, more affluent landholders having the resources to purchase the various requisites enumerated, and thereby becoming more prosperous at the expense of the smaller farmer. Displacement of many small farmers to the further detriment of the overcrowded cities was an end result. Even this was not insurmountable, with recognition by governments of the need for providing credit and subsidies to the small holders.

The real blow to the great promise of the Green Revolution, however, came with the energy crisis in 1973. Suddenly, the all-important fertilizer and pesticides so necessary to the successful performance of the "miracle" varieties multiplied in cost and, moreover, were available in substantially less quantity than had been programmed in many of the developing countries. These short comings had, for the time being, taken considerable steam out of the Revolution.

Impact of the Environmental Crusade: The world's citizens have justifiably become concerned in recent years for the environment surrounding them, as evidence accumulates on the pollution of air and water that man has wrought. Some of these pollutants have proved detrimental to non-target species of birds, terrestrial animals and plants, fish in inland and off-shore waters, and even to man himself. Environmental concerns have brought considerable pressure to bear on various agricultural requisites, including the pesticides, fertilizers, and water used for irrigation purposes. Some highly effective insecticides for controlling certain troublesome pests have been or are in the process of being outlawed, and there has even been a proposal made for a moratorium on the use of fertilizer nitrogen.

Beyond the restrictions imposed on the agricultural chemicals themselves, the concerns manufacturing them have in many cases been forced to make the entire factory operation non-polluting. As a result, some plants have been forced to close down because of inability to meet the standards specified. The net effect of these curtailments is a reduced potential supply of the necessary requisites for modern agricultural production. Admonition by the more outspoken environmentalists to go back to the 'organic way' of farming, dispensing with chemicals to alleviate the pollution problem, demonstrates their complete lack of understanding of the soil-water-nutrient-plant system involved in food production.

Population Growth and the Undernourished: Advancements in the medical field during the present century have resulted in a marked extension in longevity of people, with a commensurate expansion in the birth rate. Whereas it required thousands of years for world population to reach one billion inhabitants by 1800, there were two billion by 1930, a doubling in only 130 years. Now the four billion level is in prospect before 1980, a further doubling in less than fifty years; and all projections suggest between six and seven billion people by the turn of the century. Human expansion is thus proceeding in an exponential pattern, and in 1975 we can count on 75 million more

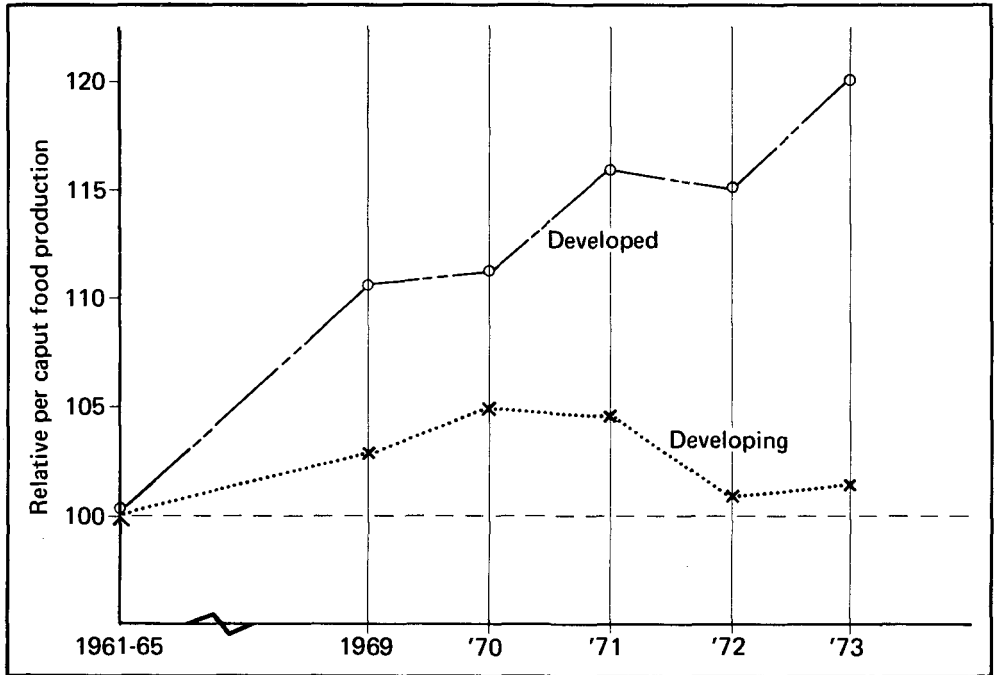


Figure 2. Relative per caput food production in developed and developing countries using the 1961-65 base as 100 for each. (Source, U.N. population estimates and FAO index numbers of agricultural production.)

mouths to feed than there were in 1974. Whereas population growth is at the approximate one percent level in the developed countries, it averages in excess of 2.5 percent in the developing countries, and therein lies the source of the problem in human numbers. Poverty begets poverty and more children, and it requires the combination of education and a higher level of income to break this cycle.

There have been significant world-wide advancements in total agricultural production during the past twenty years, averaging about three percent per year. Some of the technology responsible for the tremendous growth in production per unit area in the developed countries has been transferred to the developing countries and they also have been increasing food production nearly three percent annually. The increase, unfortunately, has barely matched the population growth so that the inadequate per capita food supply has remained static and more undernourished bodies have resulted every year (Figure 2). Admittedly conservative figures of FAO classify ten percent of the world's people as undernourished, in the order of 400 million! That number corresponds with the combined populations of Western Europe and more besides.

Not only quantity but quality of food-stuffs must be taken into account in equating world food supplies with human nutrition. The body must receive a sufficient intake of calories for accommodating the energy requirements of living, along with adequate proteins, minerals and vitamins. The caloric and protein intake are the primary indices of nutritional adequacy, the safe level of which is generally considered to be in the range of 2200 - 2600 kilocalories and 50 - 60 grams protein per day for adolescents and

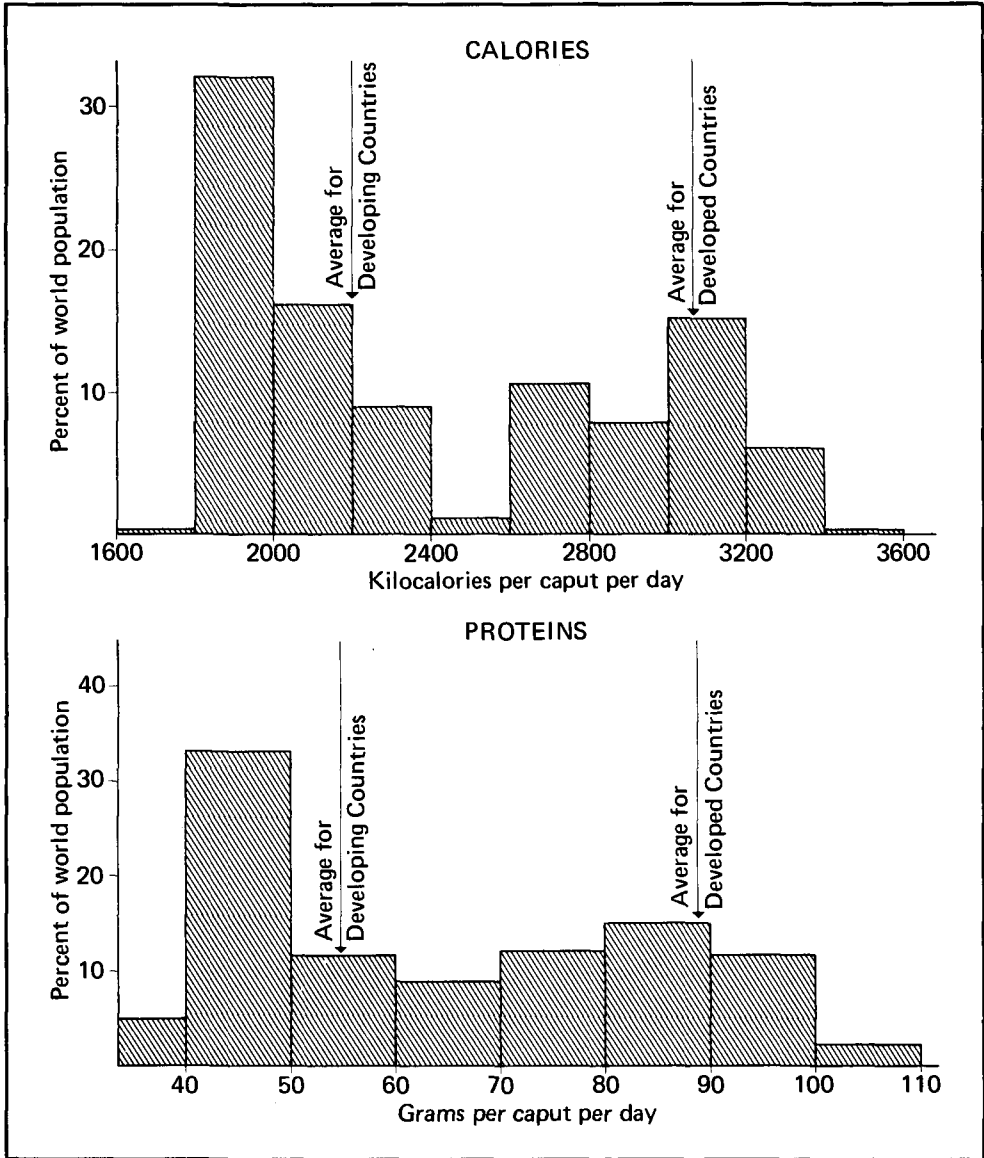


Figure 3. Calorie and protein distribution in food supplies of the non-communist world. (Cummings, Ralph W. and Ralph N. Gleason, 1971. *The Role of Fertilizer in Agricultural Development*. In Olson, R.A. et al., *Fertilizer Technology and Use*, Soil Sci. Soc. Amer., Madison, Wis., p.9.)

adults depending somewhat on region and protein quality⁴. It will be noted in **Figure 3** that the developing countries averaged about 40 percent lower in kilocalories per capita per day than the developed countries, but more in the order of 50 percent lower in protein intake. Unfortunately, it is the non-working mother in advanced pregnancy and young children who are differentially deprived of

⁴ Joint FAO/WHO Ad Hoc Expert Committee, 1973. *Energy and Protein Requirements*: pp. 74 and 80. FAO, Rome.

adequate quantity and quality of foods in food deficit situations, to the detriment of the future physical and mental development of the children; this is not taken into account in such average figures.

THE FUTURE PROSPECTS

Expanded Cultivation of Food Crops: Little of virgin lands remains in the developed countries for expanding the area of crop production. In fact, retractions are occurring in most due to urban sprawl, highway construction and the like. There is an exception in the developing world, however, in consequence of the low agricultural utilization of much of the humid tropics. The bush-fallow (shifting cultivation) system followed over vast areas is extremely wasteful of human energy and of land resource in achieving its objectives of accumulating a few nutrients and controlling some crop pests and pathogens.

It is estimated that upwards of one billion hectares of land in the tropics not now producing crops possess soil properties and climatic regime compatible with economic agriculture⁵. Prerequisites are, of course, that transport facilities must be built into these areas and all of the agricultural inputs provided. Crops produced will be even more dependent on fertilizers than in temperate regions of our wide experience because of the generally low inherent fertility of soils developed under humid tropical conditions. Insect, weed and disease control problems are also accentuated by the high humidity and the year-round warm temperature.

Much research remains to be done for deriving the package of soil/crop management practices required to convert each specific ecosystem involved into a productive agricultural enterprise. The effort will be justified in the realization that the incorporation of just two percent of this reserve land area into effective crop production would provide the food requirements of all of Latin America today. Developments of this kind are already underway in some countries, most particularly Brazil.

Adjustments in Priorities: Full recognition by governments of the developing countries must be given to the most urgent priorities for development. Few of the industrialized states of the world acquired their present status without first satisfying the food needs of the people through agriculture. The food needs will be satisfied only if the roads and rails required for supplying the requisites and for permitting the marketing of produce are provided. In many cases subsidies will be needed for affording better equipment and farming methods and for assuring the use of required fertilizer, pesticides and improved seeds in getting the development underway.

Perhaps most importantly, the developing countries must devote a substantial portion of their budgets to research on problems associated with their agriculture. Experience has shown that a rather limited segment of agricultural technology from the temperate zones can be transposed directly to the tropics. There must be further development and introduction of higher yielding varieties through plant breeding consonant with preserving genetic diversity for maximum disease and pest resistance. The means for ascertaining what nutrients are needed for different crops grown on the soils of the country must be determined, like-wise the appropriate rates to be employed and most

⁵ In "Soils of the Humid Tropics", National Research Council, National Academy of Sciences, Washington, D.C.: p.iii, 1972..

effective time and method of application. Comparable studies are required to validate treatments for alleviating toxicities that exist with many tropical soils.

Appropriate chemical, biological and other methods must be established for the effective control of troublesome animal and plant pests. Improved tillage methods for the tropical environment will require development, better animal lines through breeding programmes will be called for, host-parasite relationships critical to given areas need to be ascertained, etc., across the entire range of agricultural endeavor.

Food aid shipments from developed to developing countries have dropped to one-third the level of the mid 1960's. This fact may be in the best interest of the developing country itself in the long run, putting more pressure on it to develop its own agricultural resources as rapidly as possible. Gifts of food have served in some cases as a dis-incentive to expanded local production and this experience suggests they should be used judiciously in serving the need intended.

A sensible balancing of environmental concerns and controls against the food needs of the time will be required. In this regard the developed countries, in sharing their experiences and giving advice, must use candor. After all, who can say that a sufficient food supply is not the single most important environmental factor governing the physical, mental and social welfare of man and ultimately the quality of life itself?

Increased Production and Use of Agricultural Chemicals: As FAO has expressed for a number of years, 'Fertilizers are the spearhead to agricultural development'. Most soils of the developing countries are either worn out from centuries of use or are, as usual in the tropics, inherently very deficient in native fertility. Except for the element nitrogen, the need for which can be partially met by the growth of legume crops, there is no way to supply the nutrients required other than through application of chemical fertilizers. Thus, Mr. Boerma, Director General of FAO, has stated, "There is not too great a gap between human starvation due to lack of food and crop starvation due to lack of fertilizers".

There must be a world-wide expansion of fertilizer production facilities in meeting the burgeoning food needs. A considerable part of this expansion can and must occur within the developing countries themselves. In particular it seems essential that excess gas now being 'flamed off' at many of the major oil and gas fields of the world rather be put to work as feedstock in the manufacture of fertilizer nitrogen, which has become so critically short and expensive in 1974. The FAO Indicative World Plan (IWP) to 1985 had projected the need for annual increases of 14 percent in consumption of fertilizers in the developing countries. This pace was being reasonably met from 1968 onwards until the past year. It has been estimated by Ewell⁶ that one additional comprehensive fertilizer plant costing around \$ 100 million is needed for every additional six million people. He further suggests that to meet world-wide demand about 8 billion dollars annually should be going into new fertilizer plant construction, twice what is presently being realized.

The IWP of FAO also projected a required annual increase of 11 percent in use of pesticides in the less developed countries through 1985. Here again, world-wide shortages are limiting the supplies reaching the poorer countries with severe consequences in

⁶ Ewell, Raymond, as expressed in an interview for Ceres, Vol. 7, No. 2: p. 56.



An experiment in producing a plant mutation using nuclear technology is carried out at the Agricultural Research Institute in New Delhi, India. Photo: United Nations.

respect to weed competition, diseases and pest attacks on crops. A considerable problem in supply here relates to environmental controls in developed countries on the manufacture of materials that are not readily biodegradable.

Extension of Irrigation in the Dry Regions: Provision of supplemental water through irrigation in the dry regions adds remarkably to the productivity and stability of their agriculture. The chief limitation, of course, is an adequate fresh water supply, which is increasingly in direct competition with human needs for drinking and sanitation. Furthermore, irrigation has high energy demands, particularly with pumping from the ground water.

Surface waters have largely been committed to the limit long since in most dry regions of the world. Locally, however, ground water reservoirs are being discovered and tapped rather extensively for irrigation as in North Africa, and the desert blooms. Any great expansion of irrigation, however, must await the day, if it ever arrives, of economic desalination of ocean water — through atomic energy, perhaps?

Population Control: It goes without saying that the most obvious means of resolving the world food problem is through population control. Certainly this must be accomplished as rapidly as possible since the present numbers are already straining the world's production capacity. All of the developing countries must commit themselves to educational programmes that will make birth control possible, lest people,

like lemmings, must head for the sea as population pressure becomes unbearable. Surely humankind was conceived for a more lofty role than premature drowning or starvation! The education required and the breaking with tradition will take time and even with good progress in this direction, we can probably count on at least six billion inhabitants by the year 2000.

Toward 'World Food Security': In consideration of the potential crisis, greater international collaboration must be developed in meeting the food needs of the world. The first Director General of FAO, Lord Boyd Orr, brought the matter clearly into focus with his statement, "You can't build peace on empty stomachs". An important step has been taken by the U.S. and the U.S.S.R., two of the major producers of food-stuffs with predominant effects on world supplies, through a joint programme of scientific and statistical information exchange in agriculture. This should help in preventing the sudden disruption of food distribution patterns as occurred in 1972. As Earl Butz, U.S. Secretary of Agriculture, has stated, "Food belongs in a category right beside petroleum — it's a very essential commodity. Whatever one country does has implications world-wide and ripples hit the shore in places that are not anticipated. Being an absolute necessity, it takes on many characteristics of a public utility".

The World Food Conference affords a most useful platform for spotlighting world attention on this foremost international problem of mankind. Among other proposals to be reviewed is a system of global food reserves for providing price stability in world food economy, since it is now apparent that excess production of U.S. agriculture can no longer provide such stability. This proposal of FAO's Director General Boerma was provisionally approved by the FAO Conference and now requires serious world consideration and the earliest implementation possible.

We have been bombarded with highly pessimistic reports on the world food situation in the past year. Many are inclined to believe that the predictions of Malthus are at hand. There are, however, several bases for optimism as have been elaborated here, if only the world community will marshal its forces for the common good.