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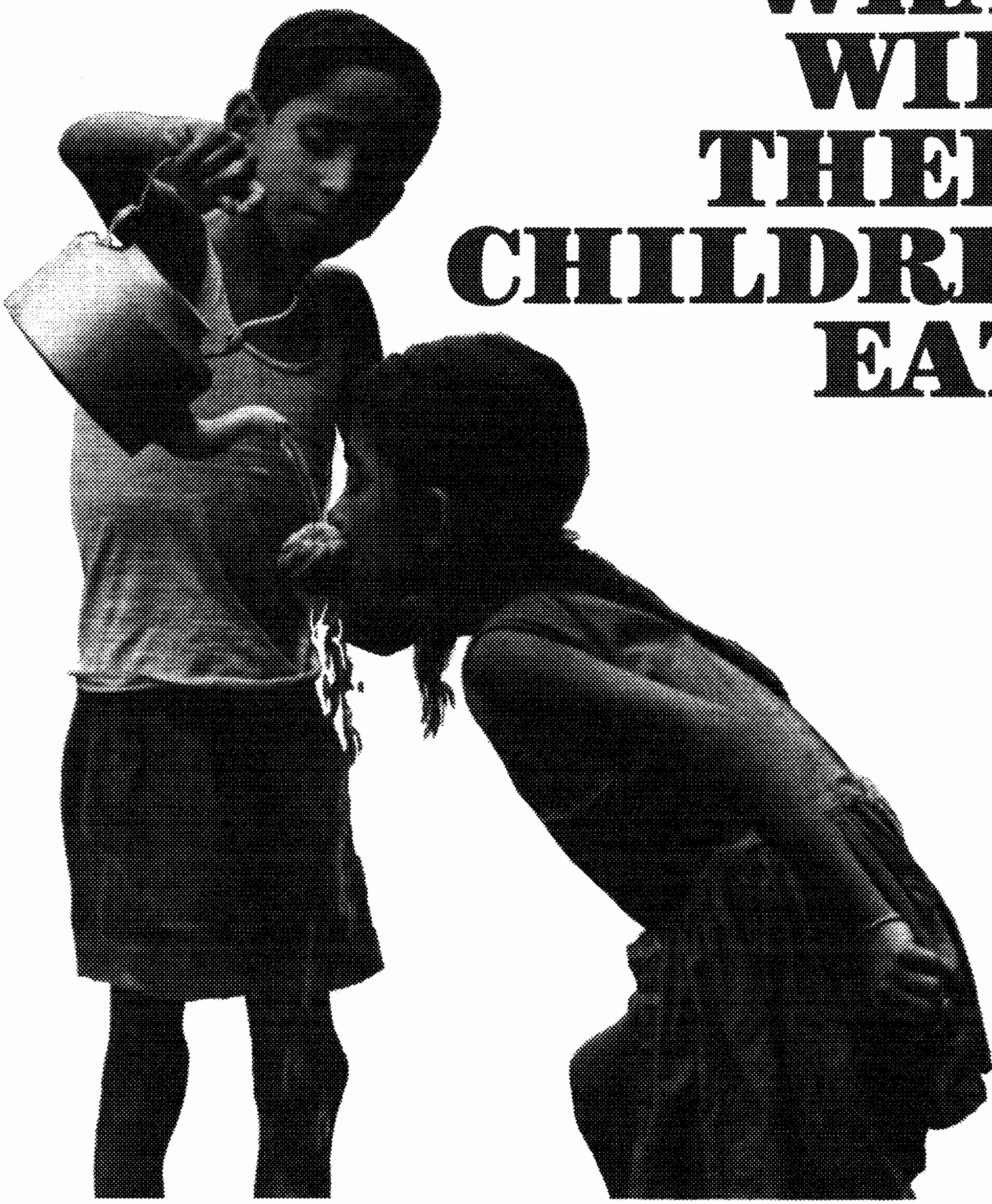
WHAT WILL THEIR CHILDREN EAT?



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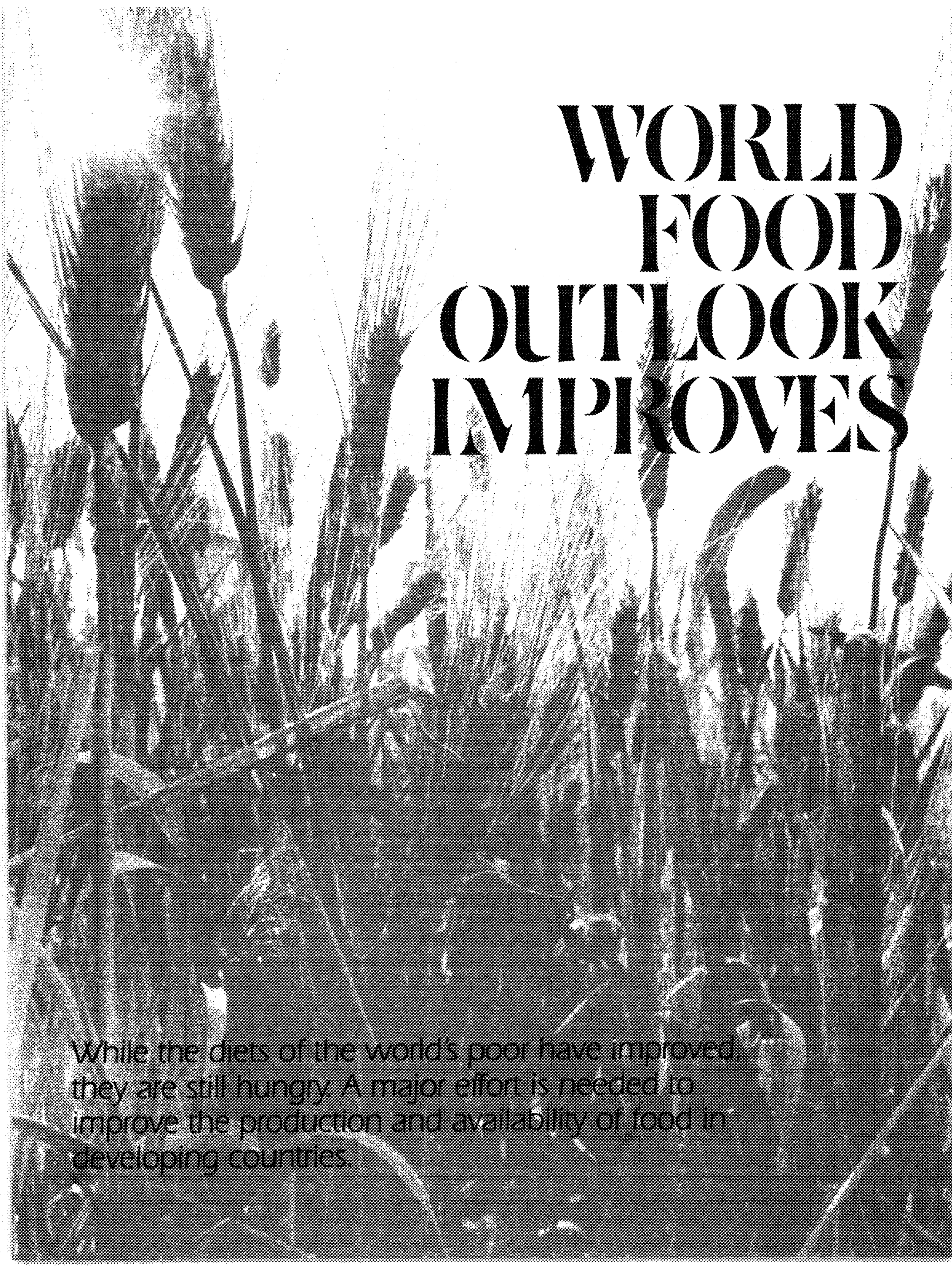
WORLD FOOD OUTLOOK IMPROVES



While the diets of the world's poor have improved, they are still hungry. A major effort is needed to improve the production and availability of food in developing countries.

This article was provided by D. Gale Johnson, Provost, University of Chicago.

Whatever else history may record as achievements of the 20th Century, it may say that that century saw the elimination of the dread scourge of famine from the face of the earth. Except when caused by war and civil unrest, famine has already been largely eliminated. There remain very few pockets of population that do not have access to the world's food supply to compensate for shortfalls in local production. Much of the world's accomplishment in eliminating famine is due to revolutionary improvements in communications and transportation and increases in the annual stability of food production.

The poor people of the world now have more adequate diets than at any other time in this century.

By the poor people of the world, I refer to the majority of the peoples of Asia, Latin America and Africa who are poor by the standards of North America and Europe. 80% of the world's poor population of 2 billion live in rural areas and villages.

The most compelling evidence that these poor are now better fed is the remarkable increase in life expectancy in the developing countries over the past 30 years. In 1950, life expectancy at birth in the developing world was 35-40 years; today it has reached or surpassed 52 years.

Improvement in food consumption was not solely responsible for the increase in life expectancy, but there can be little question the change would not have been possible without some improvement in the level and security of food supply. Much of the increase in life expectancy occurred through a reduction of infant and child mortality, the period of life where adequate food is an important factor in survival.

The available data on per capita food production in the developing world indicate that there has been a modest improvement over the past quarter century. During that period per capita food production has increased by approximately 0.5% annually. Caloric consumption has increased somewhat more than production due to increased net grain imports by the developing world. While there are those who view the increased level of grain imports by the developing countries as a problem, the increase in net grain imports has increased per capita caloric consumption by more than 100 calories per day (or about 5%) for all developing countries.

The slow growth in per capita food production in the developing countries was not due to a slower growth of total food production. The production growth rates in developing and developed countries were nearly identical. The difference in per capita food production was due solely to growth in population — approximately 2.5% annually in the developing countries and only slightly more than 1% in the developed countries.

It was a major challenge to the agricultures of the developing countries just to keep up with such rapid growth of population. Similar sustained rates of population growth have never been witnessed before, not even during the period of major immigration into the United States.

I do not want to leave the impression that the improvement in nutrition has been uniform. In general, Latin America and East Asia have had the largest increases in per capita food production; South Asia has seen very moderate improvement in the past 15 years. In much of Africa per capita food production has declined since the early 1960's.

A continuation of recent food production trends and population growth rates for the rest of the century will result in little improvement in per capita food production in the developing countries.

I have seen no valid evidence that indicates that the production trend cannot be maintained. There are those who believe that the Green Revolution of the late 1960's has had its full effect and there is nothing to take its place. But the new varieties (primarily rice and wheat) developed during the Green Revolution were suitable for only a minority of the cropland of the developing countries, primarily areas with very good irrigation, and the improvement and adaptation possibilities have by no means come to an end.

There is now evidence that

population growth rates have begun to decline in the developing countries. In 25 countries the crude birth rate declined by from 15-40% between 1965 and 1975; included were India, China, the Philippines, Costa Rica and Colombia. Due to age composition and further declines in mortality, it will be some years before there are actual declines in population growth rates, but we could well see some rather dramatic reductions before the end of this century in many countries.

Natural and human resources are adequate for a significant increase in the rate of growth of food production.

Crude comparisons of the agriculture of the United States and of the developing countries depict the latter as backward and inefficient. But modern agriculture is a recent phenomenon. Animal power was the major form of power in North America as recently as 50 years ago.

40 years ago grain yields in the industrial countries and in the developing countries were the same — 1.15 tons per hectare (a corn yield of 18 bushels per acre). By 1973-75 grain yields in the industrial countries were 3.0 tons per hectare; in the developing countries 1.4 tons. Grain yields in excess of 2 tons per hectare are a recent phenomenon — a consequence of the agricultural revolution of the past four decades. In years of average weather during the first half of this century, grain yields in the United States averaged less than 1.5 tons per hectare compared to 3.5 tons in recent years. Corn yields increased even more — from 1.4 tons per hectare before 1940 to more than 5.5 tons in recent years. Of the industrial countries only Japan achieved significant grain yield increases in the 19th century. Japanese grain yields are now 5 tons per hectare.

Differences in productivity are not due to differences in basic human characteristics. Farmers, even poor and illiterate farmers, are intelligent and interested in a better and fuller life, if not for themselves then for their children. What does distinguish such farmers is that they own little besides their native intelligence and physical capacities.

There is abundant evidence that farmers in developing countries will adopt new ways of doing things if the new ways are superior to the old. Millions of farmers in the developing countries rapidly adopted the new high yielding varieties of grain (often in response to quite modest yield differentials) and an increase in the use of fertilizer, insecticides and herbicides during the past decade.

Are the differences in productivity due to differences in natural endowments, particularly soils and climate? Forty years ago, none of the new high yielding varieties, such as hybrid corn, were then in use to a significant degree. Relatively little fertilizer was applied to grains, and the methods of land preparation and cultivation had changed little since the 19th century. Natural conditions in the country groups resulted in similar yields.

Even if grain yields were similar at one level of knowledge and technology, it may not follow that at other levels the yields would remain similar. There have been different rates of growth of yields in the United States since the 1930s. Yields have increased more in the humid than the dry areas and in the warmer than the cooler areas.

While it is possible that there are fundamental restraints on yields in the tropical and semi-tropical areas of the developing countries, such restraints may not be important. Maximum yields have been obtained under experimental conditions in several tropical areas in recent years. While it may be many years before such yields are obtained on farms, the experimental yields indicate that natural conditions alone are not responsible for relatively low yields in the developing countries.

Corn yields, in experimental trials in 1975 in such widely dispersed areas as Nepal, India, Ivory Coast, Panama, Costa Rica and Turkey, ranged from 4 to almost 9 tons per hectare. This compares to actual farm yields in the United States of 6 to 8 tons. The new varieties of rice grown in South and Southeast Asia have yield potentials of 5 to 8 tons per hectare. These compare favorably to actual yields achieved in Japan and the United States.

The differences in productivity or yields are not entirely due to either human or natural conditions. One important source of difference is the greater investment in research in agriculture in the industrial countries. Agricultural research expenditures have increased tenfold. In 1970 only 15% of the world's publicly supported agricultural research was undertaken in the developing countries.

Modern science applied to agriculture problems made possible the highly productive agricultures of North America and Western Europe. There is no reason why science will not have the same revolutionary impact on agriculture and the food supply in the developing countries.

Science has influenced our agriculture within the lifetimes of many of us. When I grew up on a farm the technology that was used was almost wholly the accumulated experience of generations of farmers.

The rebuilding of world grain stocks and recent increases in per capita food production in developing countries may mean that little effort will be made to realize the potentials for expanded production and availability of food in developing countries.

During the 1970s there has been a great deal of price instability in international markets, usually attributed to instability of production. This is, at best, a half truth. A major factor in the price increases in 1973 and 1974 and the price declines since 1975 was the agricultural policies of numerous governments.

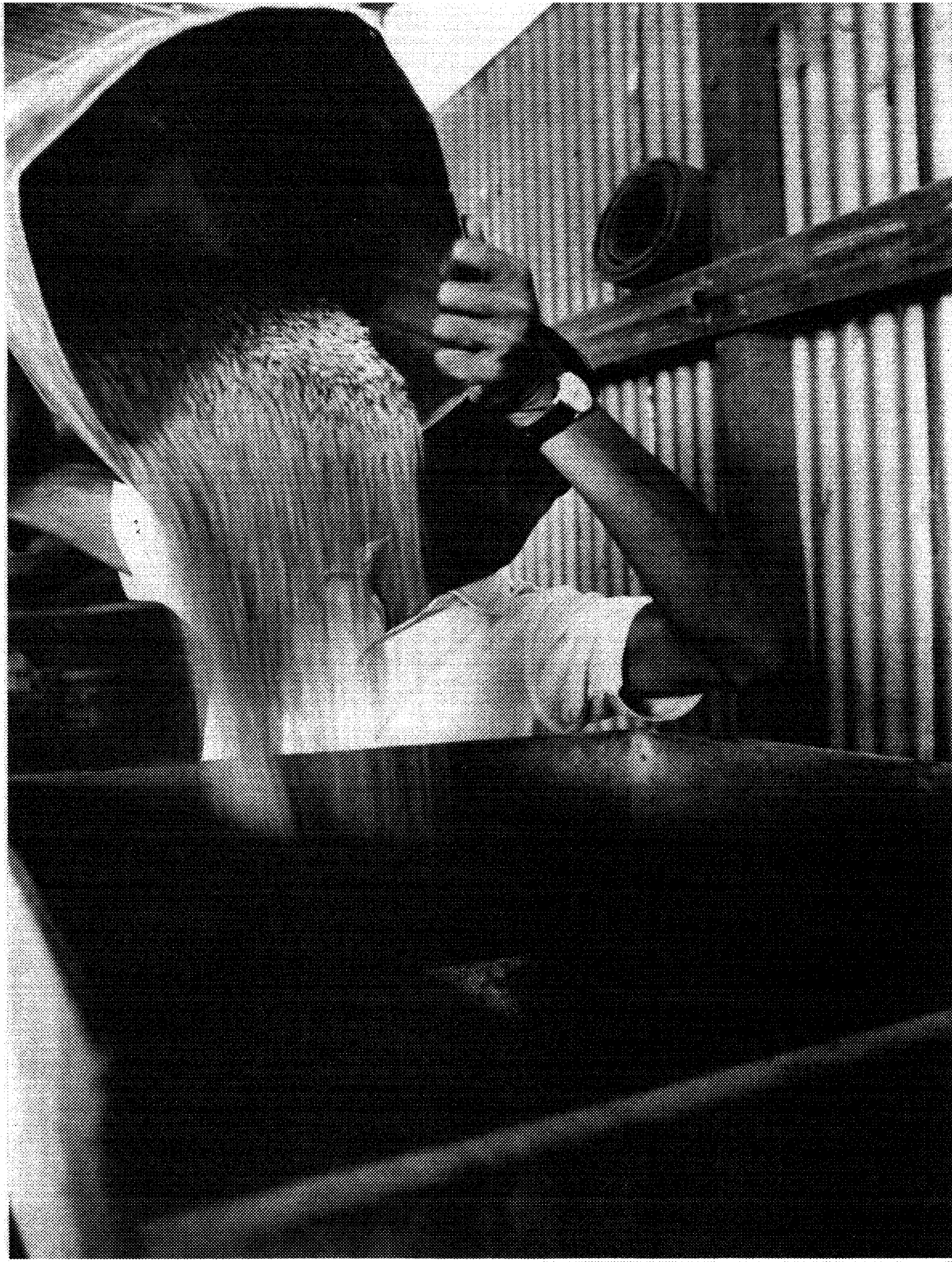
At least half of the world's grain is consumed in countries that stabilize their internal prices to consumers and producers by varying their net trade, insulating their consumers and producers from virtually all variations

in world supply and demand variations. When international prices are high, their consumers have no incentive to reduce consumption and their producers no incentive to expand production. When international prices are low, consumers are not encouraged to increase consumption — nor are producers given a signal to reduce production. All of the variability in supply and any random shocks to demand (such as those that result from business cycles) are imposed upon those countries whose domestic prices vary with international prices.

Since the world food situation looks good, is it reasonable to turn our attentions to more pressing matters? In my opinion the answer is an emphatic no. The food problems of the poor people of the world are long-run problems, and only continuous efforts will make any difference in how adequate their diets are in the future.

In 1965 and 1966 there were poor crops in South Asia. Had it not been for food aid, there would have been mass starvation in India and Pakistan. The new high yielding varieties were introduced into the area in 1966, spread quickly and food production reached new peak levels. International grain prices fell and new technology drastically reduced the price of nitrogen fertilizer. At the time, Norman Borlaug, who received the Nobel Peace Price for his contributions to the development of high yielding varieties of grain suitable for the developing countries, told us that the Green Revolution "has won a temporary success in man's war against hunger and deprivation; it has given man a breathing space."

Relatively little was done to take advantage of the opportunities to improve the nutrition of the world's poor people after 1967 and before



the food difficulties of 1973.

Once again the world has some "breathing space." Will it be used more effectively than it was a decade ago?

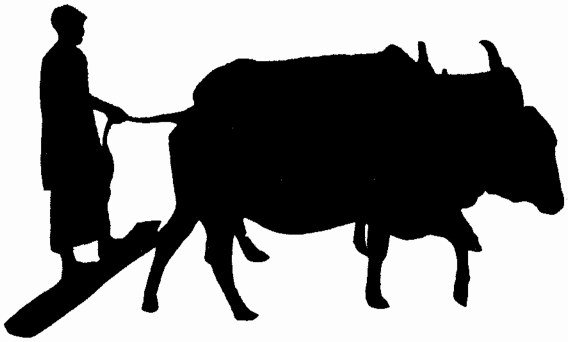
I fear it is more likely that the current ease in the world food situation will lead to complacency.

Developing countries will see no need to significantly change their priorities. There is no evidence that the industrial countries that give a high priority to their domestic price stability have modified their views. Nor have any of the industrial countries taken any significant steps to reduce their barriers to the agricultural and manufactured exports of the developing countries. In fact, in all too many cases, such as textiles, shoes and sugar, protectionism has increased during the past year. In spite of the attention given at the 1975 World Food Conference in Rome to ways and means for increasing food production in the developing countries, I know of no new initiatives that have been taken since then.

There are no quick fixes that will make a difference in the improvement of nutrition for the world's poor people. Continuous concern and action are required. In everything that is undertaken, measurable results come years later. When there is no crisis, it is difficult to mobilize attention and effort for results that will not be apparent until well after the next election.

The nutrition of the world's poor people has improved and will continue to improve in the years ahead. This does not mean that progress will be uninterrupted or that it will be uniform among countries. The outstanding performance of farmers in the developing countries over the past three decades is a basis for optimism for the future. There are indications that developing countries are gradually modifying their policies in the direction of providing more adequate incentives for farmers.

There will be substantial improvements in per capita food supplies and in incomes in the developing countries if there is the political will to give appropriate priority and continuing commitment to efforts to expand food production and agricultural productivity. Approaches must be pragmatic and not ideological. The decision makers must recognize that the most important resources of their rural areas is not their forests, mines, oil, or land but rural people, and the improvement of their welfare is an important objective.



New means of achieving agricultural growth must be used in the developing countries to meet future food needs.

Who Will Feed Tomorrow's Hungry?

This article was excerpted from "The Prospect for Agricultural Growth" by Vernon W. Ruttan, Professor, Department of Agricultural and Applied Economics, University of Minnesota. The paper was presented at a conference of the International Union for the Scientific Study of Population in Helsinki in August, 1978.

The 1970's have been unkind to the reputations of prophets who tried to plot world food production and scholars who tried to understand agricultural development.

Perspectives have shifted from a sense of impending catastrophe engendered by the world food crisis of the mid-1960's; to the euphoria of the potential of the "Green Revolution"; to the crunch on world grain supplies resulting from poor harvests in 1972-74.

The pessimism that dominates discussions of the prospects for meeting world food demand over the next several decades stems from three sources:

- The rapid growth in demand for food due to population and income growth in the developing countries.
- A series of recent projections that indicate a widening gap between production and demand.
- A belief that the technical changes necessary to meet projected food demand will contribute to a decline in the welfare of the rural population.

Projections prepared by the International Food Policy Research Institute suggest an increase in the staple food deficit of the developing countries from approximately 12 million metric tons in the mid-1970's to 70-85 million metric tons by 1990.

Deficits of this size, if compensated for by commercial imports, will represent a $14-17 billion drain on developing nations' foreign exchange earnings at 1975 price levels. The LDC's would face great difficulty in financing food imports of this magnitude without severely compromising other development objectives. The projected deficits will have to be reduced through some combination of slower growth in demand, greater food aid, and faster growth in domestic production in the LDC's.

During the rest of the 20th century, we must develop and carry out more effective agricultural development strategies than have been available in the past.

Rural institutions in most developing countries do not yet have the ability to increase agricultural productivity to match the growth in demand, or the capability to make effective and equitable use of the new sources of income that improvements in agricultural technology can make available.

The problem of agricultural development is not one of transforming a static agricultural sector into a modern, dynamic sector, but rather one of stepping up the growth of agricultural output and productivity consistent with the growth of other sectors of a modernizing economy.

Historically, there have been six basic models for growth and change in agriculture.

Expansion of the area cultivated or grazed — the Frontier Model — has represented the dominant source of increase in agricultural production. The most dramatic example in Western history was the opening up of the new continents — North and South America and Australia — to European settlement during the 18th and 19th centuries. With the advent of cheap transportation during the latter half of the 19th century, the new continents became important sources of food and raw materials for Western Europe.

Few areas of the world remain where development along the lines of the Frontier Model will represent an efficient source of growth during the last quarter of the 20th century. The 1960's saw the "closing of the frontier" in most areas of Southeast Asia. In Latin America and Africa the opening up of new lands awaits the development of technologies for the control of pests and diseases (such as the Tsetse fly in Africa) and improvement of problem soils.

The 20th century can be viewed as a transition from a period when most of the increase in world agricultural production sprang from an expansion in area cultivated to a period when most of the increase comes from using a given area of land more efficiently.

The Conservation Model of agricultural development evolved from advances in crop and livestock husbandry — increasingly complex land and labor-intensive cropping systems, the production and use of organic manures, and physical facilities to more effectively utlize land and water.

Within this framework, agricultural production in many areas could increase about 1% a year over long periods. But modern growth in LDC demand typically falls in the 3-5% range.

In the Urban Industrial Impact Model, industrial development stimulates agricultural development by expanding the demand for farm products; by supplying the industrial inputs needed to improve agricultural productivity; and by drawing surplus labor away from agriculture. The importance of a strong non-farm labor market as a stimulus to higher labor productivity in agriculture has been confirmed repeatedly.

The diffusion of better husbandry practices was a major source of growth in agricultural productivity even in early societies. Agricultural development, in this view, is through more effective dissemination of technical knowledge and a narrowing of the productivity differences among farmers and regions. The limitations of the Diffusion Model became increasingly apparent as technical assistance and community development programs failed to generate either rapid modernization of traditional farms and communities or rapid growth in agricultural output.

The inadequacy of policies based on the Conservation, Urban-Industrial Impact, and Diffusion Models led, in the 1960's, to the view that the key to transforming a traditional agricultural sector into a productive source of economic growth is investment designed to make modern high-payoff inputs available to farmers in poor countries.

Peasants in traditional agricultural systems were viewed as rational, efficient resource allocators. They remained poor because there were limited technical and economic opportunities to which they could respond. The new, high-payoff inputs were classified into three categories: (a) the capacity of public and private research institutions to produce new technical knowledge; (b) the capacity of industry to develop, produce, and market new technical inputs; and (c) the capacity of farmers to acquire new knowledge and use new inputs effectively.

The High-Payoff Input Model remains incomplete as a theory of agricultural development. Typically, education and research are public goods not traded through the market place. The model does not include the mechanism by which resources are allocated among education, research, and other economic activities. It does not explain how economic conditions bring about an efficient set of technologies for a particular society. Nor does it specify how input and product price relationships induce investment in research consistent with a nation's particular resource endowments.

The limitations in the High-Payoff Input Model led to efforts to develop a model in which technical change in agriculture is treated as originating within the development process, rather than as a separate factor operating independently. The Induced Innovation Model was stimulated by historical evidence that different countries had followed alternative paths of technical change in the process of agriculture development.

During the last two decades the institutional capacity to generate technical changes adapted to national and regional resources has been established in many developing countries. More recently these emerging national systems have been buttressed by a new system of international crop and animal research institutes. These have become both important sources of new knowledge and technology and increasingly effective communications links within the developing world.

In the developing countries a fundamental source of the continuing low levels of land and labor productivity in agriculture has been the lag in shifting agriculture from a natural resource base to a scientific base. This lag is also an important source of regional productivity differences in many countries.

The elimination of both the international and domestic differences in agricultural productivity will require reallocations of research resources and development investment in favor of agriculture and rural areas. It was a major step forward when the allocation of research resources in developing

countries broke away from the mold established in the developed countries and began to emphasize technologies designed to raise output per unit of land — to release the constraints imposed by an inelastic supply of land.

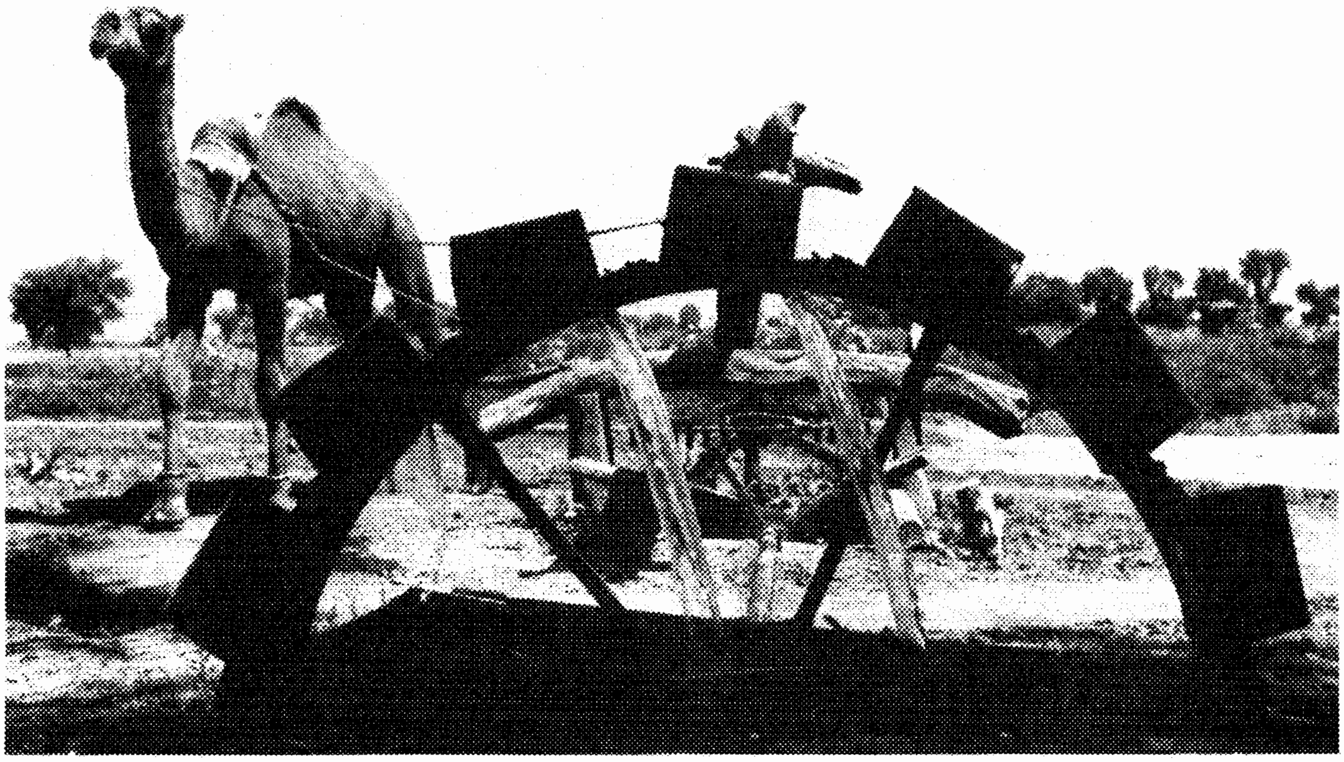
It is now time to take the next step — to focus attention on the most abundant resource available in most poor countries — human labor.

In spite of the limited land resources in the LDC's, they could achieve levels of output per worker comparable to the European levels of the early 1960's through a combination of investment in human capital; investment in the experiment station and industrial capacity to make modern technical equipment available to their farmers; investment in labor-intensive capital formation characterized by livestock and perennial crops; and by land and water development.

In an agricultural system based on natural resources, few gains are to be realized from education in rural areas. Rural people who have lived for generations with essentially the same resources and the same technology have learned from long experience what their efforts can get out of the available resources. Children acquire worthwhile skills from their parents — formal schooling has little economic value in traditional agriculture.

As soon as new opportunities become available, however, this situation changes. Technical change requires new husbandry skills; additional resources such as new seeds, new chemicals and new equipment from non-traditional sources; new skills in dealing with both natural resources and with factor and product markets; and new and more efficient market institutions linking agriculture with the non-agricultural sector.

In most developing countries the productivity potential remains largely unexploited. High-yield crops are available for few commodities in few areas. Irrigation systems remain underdeveloped and poorly



maintained. Fertilizer and other input prices remain high because of biased trade policies, inefficient industries, and costly transportation and marketing. Rural education is only beginning to supply the human capital needed to disseminate, screen and adopt new technical inputs in local farming systems.

The progress of agricultural technology cannot be left to an "invisible hand"—the undirected market forces that will guide technology along an "efficient" pattern determined by "original resource endowments" or relative factor and product prices. New knowledge leading to technical change is the result of institutional development. The public sector agricultural research institute was one of the great institutional innovations of the 19th century.

The problems of agricultural development faced by the developing countries in the immediate future cannot be adequately described in terms of a Malthusian race between food production and population. The developing countries are confronted with very severe trade-offs between meeting the food needs of expanding populations and providing improvements in the quality of life.

They are confronted with demands for institutional innovations that will direct scientific and technical efforts to respond to the stress that is being placed on resource endowments. The development of institutional innovations that can assure both equitable contribution to growth and equitable participation in the fruits of growth will represent a continuing source of stress on relatively fragile political institutions.

Poor People's Crops

The seeds of a new "Green Revolution" may be growing unnoticed in poor people's gardens in the developing world.

A friend recently told me that he had discussed the winged bean with an influential Filipino family. "They were incredulous that such a miraculous plant could exist," he said. "So, on a hunch, I took them out back to the servants' quarters. There, climbing along a fence, was a winged bean plant laden with pods.

" 'But that's just seguidillas,' they said, disappointment echoing in their voices. 'It's only a poor man's crop!' "

Some of the Third World's best crops may be waiting in the poor man's garden, ignored by science. Merely to have survived as useful crops suggests that the plants are inherently superior. They are already suited to the poor man's small plot and to his mixed farming, his poor soil, his diet, and the way of life of his family or village.

It is a universal phenomenon that certain plants are stigmatized by their humble associations. Scores of highly promising crop plants around the world receive no research funding, no recognition from the agricultural community — they are ostraçized as "poor man's crops."

For information on a poor man's crop one has to turn, more often than not, to botanists and anthropologists; only they will have taken an interest in the plant. Often there has been no agricultural research on it at all — no varieties collected or compared, no germination or spacing trials, no yield determinations or even nutritional analyses. Yet the crop actually may be crucial to the lifestyle — even the survival — of millions of people.

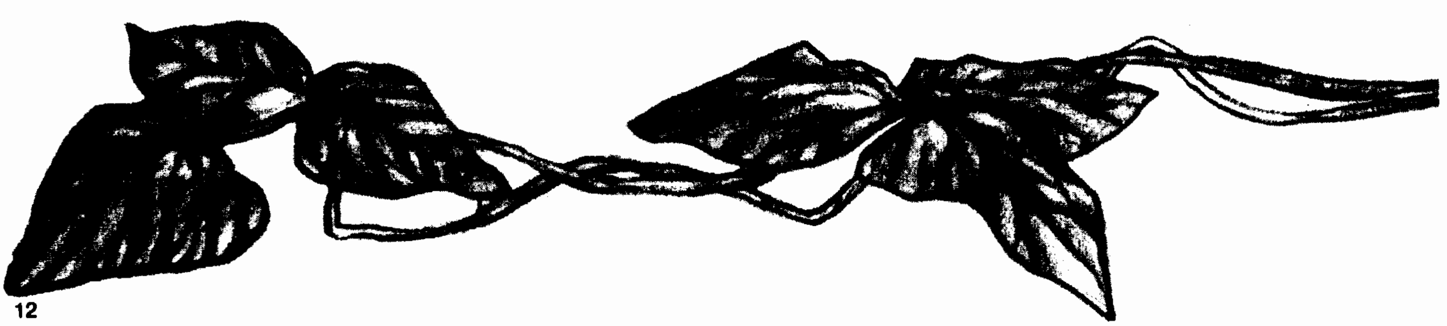
In a questionnaire sent out by the National Academy of Sciences for its studies of underexploited tropical plants, neglected tropical legumes, and trees for firewood plantations, respondents named over 2,000 species that deserve greater recognition. Most of these could be called poor man's crops; almost none have been given scientific attention.

Just 50 years ago, the now-cherished soybean was itself a poor man's crop. In the United States, it was spurned by researchers for more than a century after Benjamin Franklin first introduced seeds from the Jardin des Plantes in Paris. To be a soybean advocate then was to risk being considered a crackpot. Early in this century, Americans still considered the soybean as a second-rate crop fit only for export to "poor men" in the Far East. But in the 1920s, University of Illinois researchers established a comprehensive soybean research program that helped sweep aside this discrimination. The soybean acquired new status as a "legitimate" research target, and its development gained so much momentum that now it probably provides the world with more protein than any other plant species.

Nowhere is the neglect or poor man's crops greater than in the tropics — the very area where food is most desperately needed. The wealth and variety of tropical plant species is staggering, but most agricultural scientists are unaware of the scope of their potential. The neglect of tropical botany and

This article was provided by Noel Vietmeyer, Professional Associate, Board on Science and Technology for International Development, National Academy of Sciences.

(The initial study of underexploited tropical plants was sponsored by the Agency for International Development.)



agriculture occurs largely because the major scientific research centers are located in temperate zones.

Five examples of "poor man's crops" were brought to my attention by the National Academy of Sciences studies. Each of these plants appears to be an uncut gem that awaits the polish of research to bring out its full quality.

Marama Bean

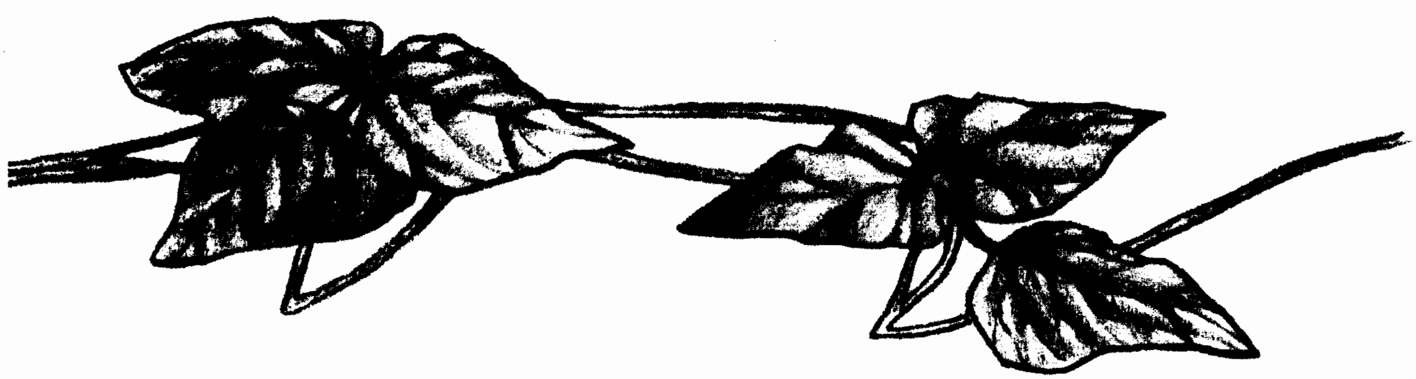
A native of the drought-ridden, semi-desert regions of the Kalahari and neighboring sandy regions of southern Africa, the marama bean rivals the soybean and peanut in nutritional value. It feeds some of the poorest of the earth's people: the Bushmen and isolated Bantu tribes in Botswana, Namibia, and the Republic of South Africa, who still subsist solely on wild fruits and plants, game, and birds.

This creeper sends several viny stems as far as 6 meters over the sandy soil. In early autumn, the plants are clad in golden yellow blossoms that give rise to large flat pods containing spherical brown beans. The beans have a hard shell, but the seeds inside are cream-colored, with firm, oily flesh. When roasted, these seeds have a rich, nutty flavor like that of roasted cashews or almonds. Africans often pound and boil them to make a porridge or soup.

The seeds appear to be exceptionally nutritious, with a protein content essentially the same as that of the soybean. 33% of the marama seed is a light-colored, pleasantly-flavored oil. In nutritional energy, the marama bean rivals the peanut as one of the best food energy sources in the plant kingdom.

In addition to its seeds, the marama bean provides another rather astonishing food. Below ground it produces a tuber that can weigh as much as 40 kilograms and grow to a meter in diameter. Africans of the Kalahari region dig up the young tubers when they weigh about a kilogram. Baked, boiled, or roasted, they have a pleasant, sweet flavor and make a good vegetable dish. The tuber is succulent, sometimes containing as much as 90% moisture. In arid and semiarid regions, it is an important emergency

Globe Amaranth Blooms



source of water for humans and animals.

With all of its attributes, the large-scale cultivation of the marama bean should have been investigated long ago. Given its due share of research, particularly plant breeding, it could become a valuable new crop for semiarid lands everywhere.

Winged Bean

Perhaps no other crop offers such a variety of foods as the winged bean. Yet it, too, is a little-known poor man's crop, used extensively only in New Guinea and Southeast Asia. Taken together, the winged bean's products are impressively palatable and nutritious, and appear to meet many dietary needs of the tropics, especially the wet tropics where protein deficiency is great and difficult to remedy. Every bit of the winged bean plant is eaten. Leaves, pods, shoots, and flowers all go into the cooking pot, and when the season is over the villagers dig up the fleshy, tuberous roots and roast them. Any stems that remain are fed to livestock.

The winged bean grows easily and quickly in tropical climates. Bacteria in its masses of root nodules (many hundreds have been counted on a single plant) convert nitrogen from the air into nitrogenous compounds that the plant uses to build the protein that pervades virtually every part of the plant.

A bushy pillar of greenery with viny tendrils, blue or purple flowers, and heart-shaped leaves, the winged bean resembles a runner-bean plant. It forms succulent green pods, as long as a man's forearm in some varieties. The pods, oblong in cross-section, are green, purple, or red and have four flanges or "wings" along the edges. When picked young, the green pods are chewy and slightly sweet. Raw or boiled briefly, they make a crisp, snappy delicacy. Pods are produced over several months and a crop can be collected every two days to provide a continuous supply of fresh green vegetables.

If left on the vine, the pods harden and the pea-like seeds inside swell and ripen. When mature, the seeds are brown, black, or mottled. In nutritional composition they are essentially identical to soybeans, containing 34-39% protein and 17-20% of a polyunsaturated vegetable oil. The protein is high in the critical amino acide lysine.

In addition to the pods and seeds, the winged bean's leaves and tendrils make good spinach-like potherbs. Its flowers, when cooked, are a delicacy with a texture and taste reminiscent of mushrooms.

But perhaps the most startling feature of the plant is that, in additon to the food it produces above ground, it also can grow fleshy, edible tuberous roots below ground, making the winged bean a combination soybean-potato plant. The tubers have firm, fiberless, ivory-white flesh and a delicious, delicate nutty flavor. While not all types produce tubers big enough to eat, those that do are potentially important as root vegetables in the humid tropics where sweet potatoes, yams, cassava (manioc), and other roots are already staples. The winged bean tubers are uniquely rich in protein — they can contain more than 10 times the protein of cassava.

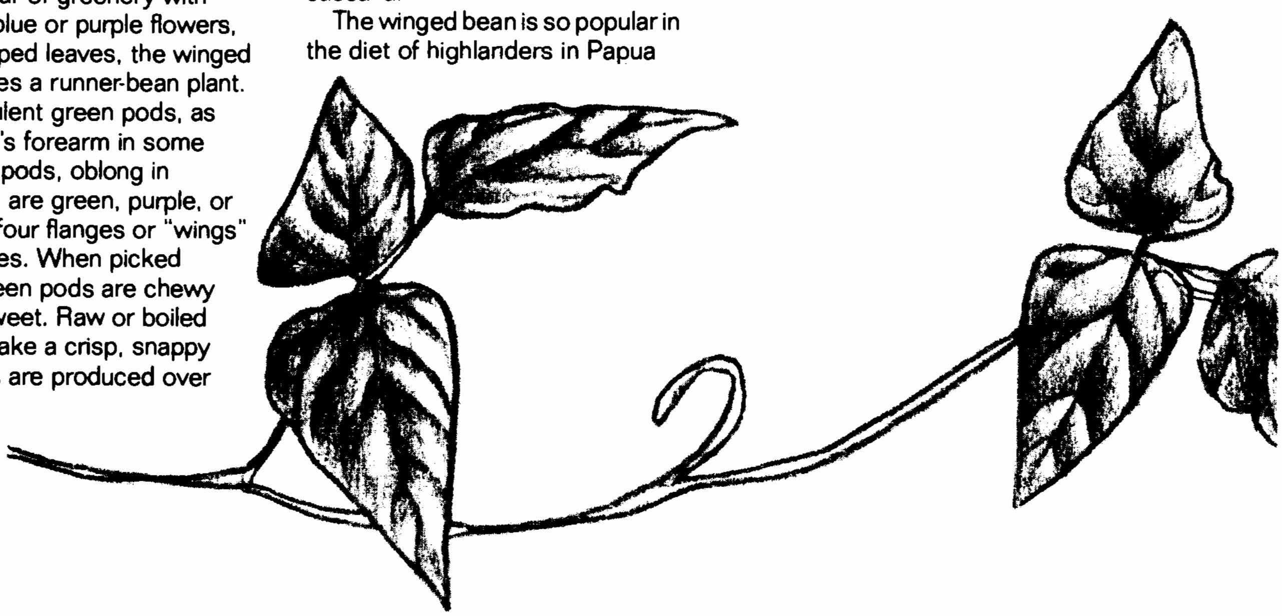
The winged bean is so popular in the diet of highlanders in Papua New Guinea that tribes often hold winged bean sing-sings (festivals). The plant is also well known to villagers in Indonesia, Malaysia, Thailand, the Philippines, and Burma.

It was not until 1973 that the first concerted efforts to investigate the crop's potential were begun. In 1975, the plant was given worldwide recognition in a National Academy of Sciences booklet, and so many researchers and landowners have introduced it in so many countries that a special newsletter, *The Winged Bean Flyer,* is now published just to keep up with their findings.

So far this long-humble crop is withstanding the scrutiny of modern science and most research results are positive. The winged bean seems to be well on its way to becoming a sort of tropical soybean, a highly nutritious vegetable specially suited to the small plots, market gardens, and backyards of the poor majority in some of the world's most malnourished zones.

Tarwi

Practically unknown outside South America's Andean region, tarwi is a common crop of the Indians of Peru, Bolivia, and Ecuador. Indeed, corn (maize), potato, quinua (another neglected poor man's crop), and tarwi together form the basis of the highland Indians' diet. Pre-Inca people domesticated this lupin at



least 1,500 year ago, and today in Cuzco, the Inca capital, baskets of tarwi seeds are a common sight in the markets.

Tarwi is extremely rich in protein, richer in fact than peas, beans, soybeans, and peanuts. It is a very important contribution to the nutritional well-being of the Andean regions where meat is a luxury.

Tarwi remains grossly neglected by science, although about a dozen researchers as far-flung as Peru, Chile, England, the Soviet Union, South Africa, and Australia have recently initiated tarwi investigations.

Like other poor man's crops, tarwi is hardy and adaptable. It is easily planted and tolerates frost, drought, a range of soils and many pests. It grows vigorously, sometimes 2 meters high, and produces masses of foliage and showy purplish-blue flowers. Held high above the leaves are many tiers of seed pods, each containing beanlike seeds that are white, speckled, mottled, or black.

The seeds are exceptionally nutritious. Protein and oil make up more than half their weight. Individual seeds containing up to 49% protein are known, though an average seed contains about 46%. Oil content varies from 5% to over 20%, averaging about 14%.

Tarwi protein is digestible, and has a nutritional value equivalent to soy protein. Tarwi oil is light-colored and acceptable for kitchen use. Thus tarwi appears to be a ready source of protein and vegetable oil for humans and animals, as well as for the manufacture of textured protein products, high-protein meal for food and feed, and cooking oil and margarine.

The tarwi has one fundamental drawback: The unprocessed seeds are bitter, due to the presence of toxic alkaloids. The Indians soak the seeds in running water for a day or two until the alkaloids, which are water-soluble, have been washed out.

From the fragmentary research already completed, it seems that tarwi strains with almost no alkaloids are available in nature; such strains can also be created artifically with radiation. Much follow-up research is needed to confirm and consolidate these initial findings. Low-alkaloid tarwi varieties bred for specific locations and needs could become a major crop for the Andes — as well as for cool tropical highlands and temperate regions all over the world.

Bambara Groundnut

Bambara groundnut plants look and grow like peanuts. But unlike the peanut, which is one of the most intensively developed crops in the world, the bambara groundnut has received little research attention. Yet, along with peanuts, cowpeas, pigeon peas, and haricot beans, it is one of rural Africa's most popular grain legumes, and one of the top five most important protein sources for much of Africa. A staple from Senegal to Kenya and from the Sahara to Madagascar, the bambara groundnut remains one of the most scientifically neglected of all crops.

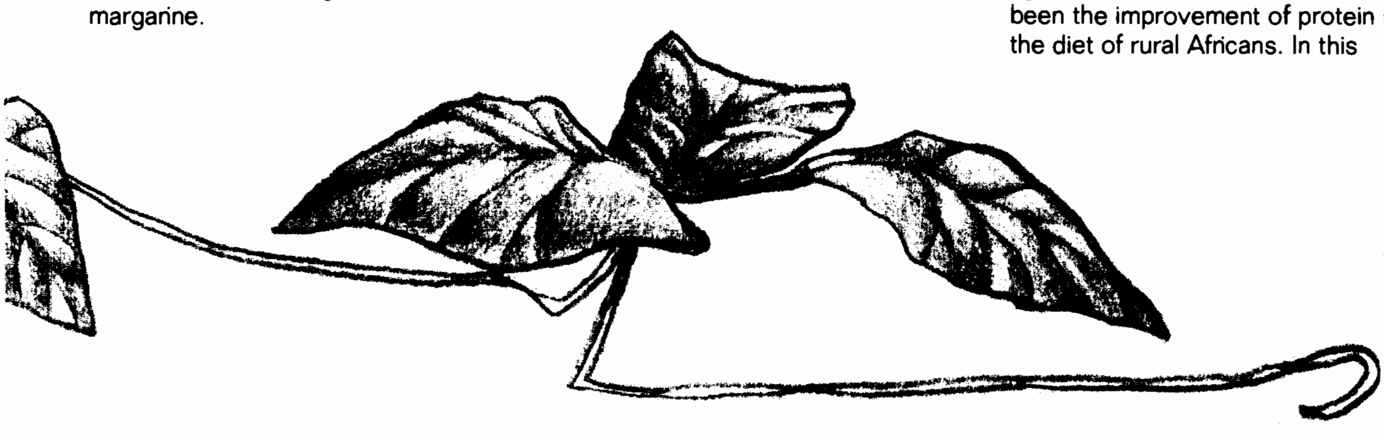
The crop is cultivated like the peanut. As the plant matures, its flower stalks bend downwards and push the flower head slightly into the soil. The round, wrinkled pods, each containing two seeds, then form underground.

The seeds make a nutritionally complete food. They have less oil and protein than peanuts but are richer in carbohydrate, which makes for a well-balanced diet and provides as much food energy as a good cereal grain. Unripe seeds are eaten fresh but the ripe seeds are hard and must be roasted, boiled, or ground to flour to be edible. They then become sweet and pleasant tasting and Africans often prefer them to peanuts. Sometimes the roasted seeds are ground into a nutritious flour that can be incorporated into many dishes. The protein has a high lysine content, which makes the bambara groundnut a good supplement for cereal diets.

Bambara groundnut grows best where peanuts or sorghum thrive, but it is one of the most adaptable of all crops and tolerates exceptionally harsh conditions. This adaptability allows it to survive and produce under conditions too arid for peanuts or sorghum. The plant needs bright sunshine and high temperatures, and it appears particularly valuable for hot, dry regions where diseases, poor soils, or the threat of drought make growing other legumes too risky.

Although yields are low when the plants are scattered in an African farmer's small plot, evidence suggests that, with good management and dense stands, the bambara groundnut can match yields with better known grain legumes such as beans and peanuts.

A chief preoccupation of agronomists and nutritionists has been the improvement of protein in the diet of rural Africans. In this



regard, the bambara groundnut deserves more of their attention. A particular research challenge is to improve the digestibility of its protein, which would bring an immediate, sweeping benefit to rural areas over most of the continent.

Amaranths

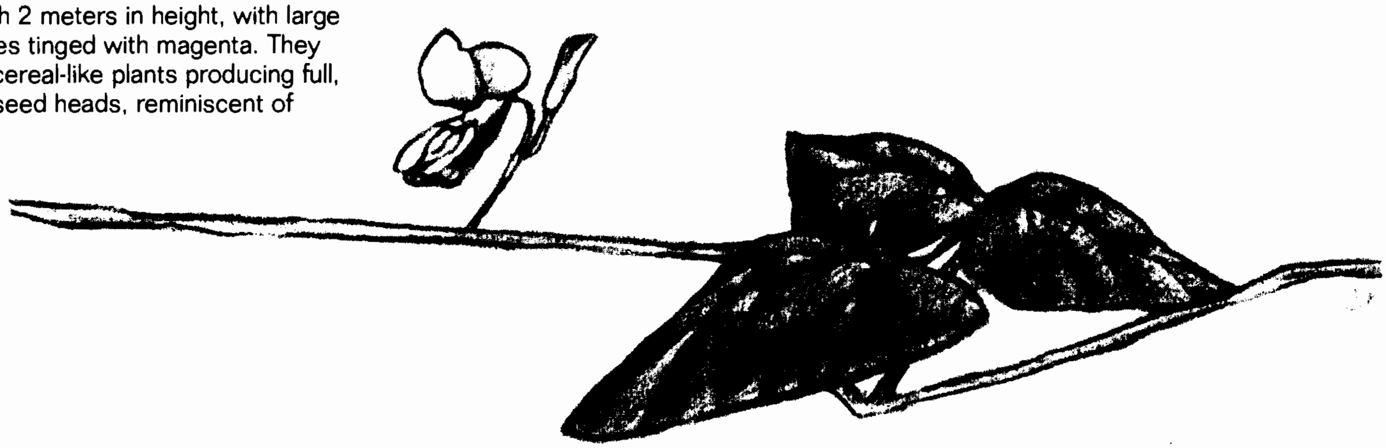
At least five amaranths are poor man's crops. All are half-wild, multi-purpose, New World plants that are rich sources of vegetable protein, food energy and fiber.

Amaranths — major grain crops in the tropical highlands of the Americas at the time of the Spanish Conquest — reached Asia, New Guinea, and Africa in Spanish Colonial times and were spread and assimilated by poor men themselves without outside help. Today they are important to rural farmers in Central and South America and to hill tribes in Asia, New Guinea, and parts of Africa.

Amaranths belong to a small group of plants whose photosynthesis is exceptionally efficient. The sunlight they capture is utilized more effectively than in most plants and amaranths grow fast. Vigorous and tough, amaranths have been termed self-reliant plants that require very little of a gardener. They germinate and grow well under adverse conditions. They are easily cultivated and adapt well to the rural farmer's small plots and mixed cropping, can be harvested by hand, and are easy to cook.

Amaranths are annuals which reach 2 meters in height, with large leaves tinged with magenta. They are cereal-like plants producing full, fat, seed heads, reminiscent of

Amaranth



sorghum. (A related ornamental amaranth is called Prince of Wales' Feather because of its brilliant crimson seedhead.) The seeds are small but occur in prodigious quantities. Their carbohydrate content is comparable to that of the true cereals, but in protein and fat amaranths are superior to the cereals.

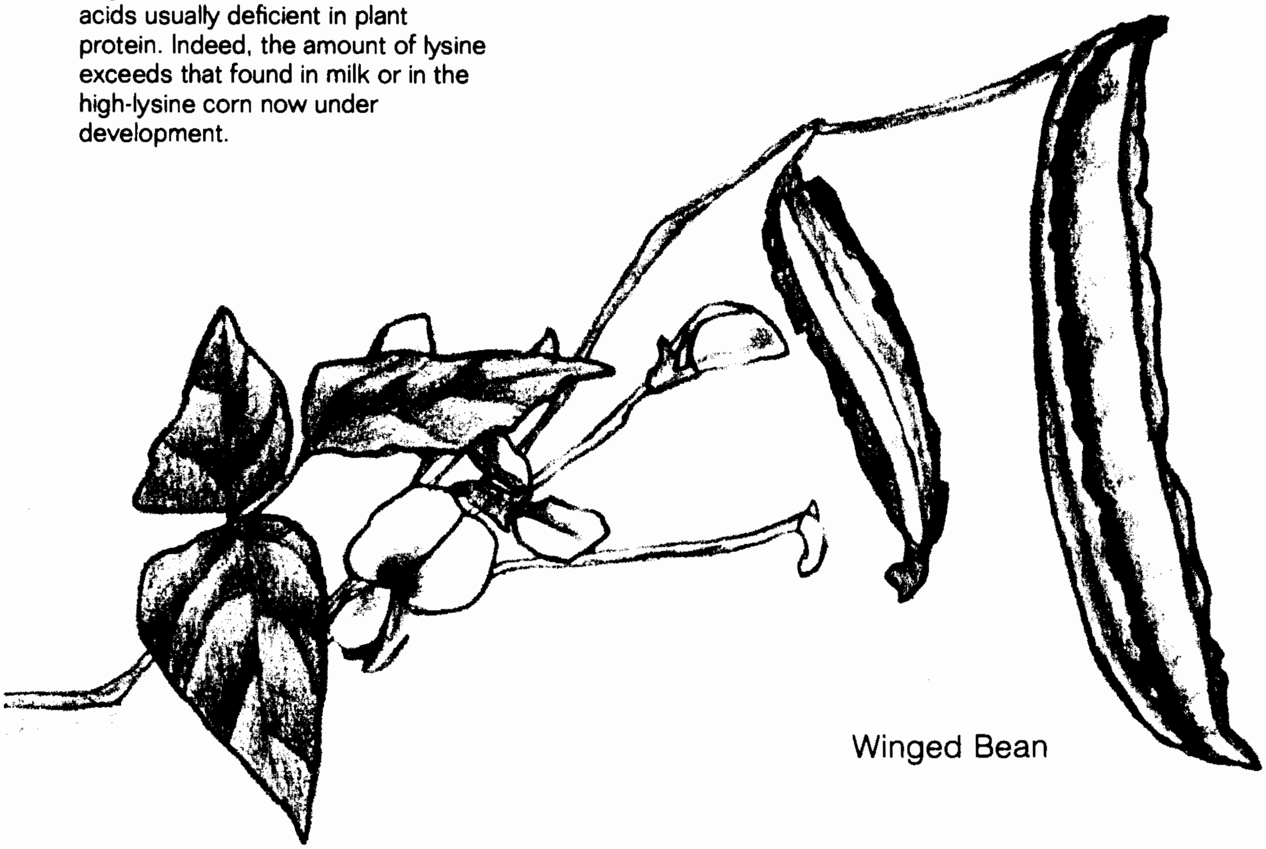
When heated, amaranth grains burst and a popcorn-like confection is made from them (call *alegrias* in Mexico, *laddoos* in India and Pakistan). In many areas the grains are more often parched and milled into a flour high in gluten and with excellent baking qualities. Bread made from this flour has a delicate nutty flavor. Pancake-like chapatis made from it are a staple in the Himalayan foothills.

Recently W.J.S. Downton, an Australian researcher, has found that the grain of at least one amaranth is rich in protein and exceptionally rich in lysine, one of the critical amino acids usually deficient in plant protein. Indeed, the amount of lysine exceeds that found in milk or in the high-lysine corn now under development.

In addition to their seeds, some species have edible and nutritious leaves that are widely eaten as a boiled vegetable. Two species are common potherbs in Asia and are grown and eaten in the western world under the names Chinese spinach or Malabar spinach.

The species discussed here are just a handful of examples of worthy plants overlooked by researchers. To study, improve, and establish such crops will be an exciting task, one that should be the responsibility of agricultural research stations in developing countries. It is pioneering work of worldwide importance in a field where the wealthy laboratories in industrialized countries are at a disadvantage: they don't have the plants. However, it is very hard to get grants for research on poor man's plants. Funding agencies resist; the plants are unknown to most of them; and the literature to support any claims may be sparse.

Nonetheless, it is now time for agricultural research facilities throughout the world to incorporate poor man's crops into their research efforts. Third World agricultural development needs this balance, for only when his own crops are improved will the poor man be able to feed his family adequately. In future decades it may be — as in the case of the soybean — the neglected poor man's plants of today that are feeding the world.



Winged Bean

NEW FR OLD

Once considered a "trash crop," the humble soybean has gained friends and admirers as a source of cheap protein to feed the world's hungry. U.S. farmers grow more than

This article was provided by William Shurtleff of the New-Age Foods Study Center. He is the author of the **Book of Tofu**

During the 1970's, 15 million died each year of starvation and malnutrition-caused diseases. 75% of those who died were children. This is 41,000 deaths each day and over 1,700 each hour. In the 15 minutes it will take you to read this article, 428 people will die of starvation.

Malnutrition causes millions of premature deaths each year and in some societies 40% of the children die before the age of 5, mostly from nutrition-related causes. The survivors often suffer such severe and chronic malnutrition that their physical and mental growth is permanently retarded.

Malnutrition and infectious diseases commonly occur in the same child and each magnifies the other. Infection can precipitate malnutrition and malnutrition increases susceptibility to infection. The vicious circle soon becomes a downward spiral as malnutrition leads to poor work, education and health, which in turn generate more poverty and malnutrition. This is the cycle of suffering which is quickly becoming the dominant reality of daily life for poor people throughout the world.

Regardless of their analysis of the causes of hunger and starvation, most experts are quick to emphasize that the key nutrient in shortest supply is protein.

Protein is particularly essential in the diets of children; it provides the building blocks that allow full development of the body and brain. Severe protein malnutrition can lead to kwashiorkor, a dreadful condition in which the child's belly is greatly swollen while the face is hollow and the limbs as thin as matchsticks. If treated soon enough, protein malnutrition can be cured by a protein-rich diet.

In the search to find ways to bridge the growing protein gap with reliable sources of low-cost, high-quality protein, a growing number of scientists, research scholars, agricultural economists, and nutritionists are predicting that soybeans will be a key protein source for the future. Already the most abundant and economical source of protein for feeding the world, soy holds even greater promise for the future.

For over two thousand years, soy protein foods have served as the protein backbone of the diet of the people of East Asia—one-fourth of the world's population.

Soybeans are the least expensive source of protein in virtually every country of the world. At a time when there is a steady increase in the number of poor and protein-deficient people, as well as the number of people trying to live more simply and economically, the soybean's low cost will unquestionably be a prime factor favoring its increased use as a protein source.

Soy is an excellent source of key nutrients. The whole bean contains 35-38% protein, more than any other traditional, unprocessed food. And soybeans have the highest quality protein, containing all the amino acids needed by the body.

In widely used soyfoods such as tofu, tempeh, and miso, the protein quality is approximately equal to that found in chicken or beef. And because soy protein foods contain an abundance of lysine, the amino acid deficient in most cereal grains, they are an outstanding protein booster. Served with grains, soy can increase the amount of usable protein by up to 42%.

A given area of land planted in soybeans can produce much more usable protein than the same land planted in any other conventional farm crop—33-36% percent more

FOOD OM WAYS

75% of the world's soybean crop — raising 1.3 billion bushels in 1976. Almost half of that crop was exported, earning almost $4 billion in foreign exchange.

and the **Book of Miso**, published by Autumn Press. The illustrations are by Akiko Aoyagi.

protein than second-place rice and 20 times as much as if the land were used to raise beef cattle or grow their fodder.

Soybeans can be — and are — grown on a variety of soils under a remarkably wide range of climatic conditions — from equatorial Brazil to Japan's snowy northermost island of Hokkaido. They are relatively resistant to diseases and pests and are widely grown without fertilizers.

Perhaps no other plant serves as the source of so many different foods as the soybean. In countries like China, Japan, Indonesia, and Korea countless generations of farmers, craftspeople, and cooks have engaged in a vast experiment to find the best ways of transforming soybeans into delicious high-protein foods and savory seasonings. Modern soy protein foods have been developed in the West.

Worldwide, there are five basic patterns of direct and indirect food use of soybeans: (1) as unprocessed whole dry or fresh green soybeans; (2) as soy flour; (3) as traditional East Asian low-technology foods; (4) modern high-technology processed foods and (5) as fodder for livestock.

The East Asian pattern developed thousands of years ago in cultures that have long had to live with the realities of high population density and therefore obtain most of their proteins directly from plants. By using soyfoods in balanced combination with rice and other grains to create complementary protein and by developing high-protein soy-based seasonings (such as miso and shoyu) having meatlike flavors, the people have created a diet that makes optimum use of the earth's ability to provide them with tasty natural foods that are nutritious and low in cost.

Even in the modern and technologically advanced parts of Japan and other East Asian countries, these foods are still prepared using fairly labor intensive cottage industry or intermediate technologies requiring low energy input and creating little or no pollution. The work is often seen as a craft (although in some cases it is raised to the level of an art or even a form of spiritual practice).

In recent years, the principles of East Asia's traditional soy protein technologies have been skillfully applied to both medium and large-scale production, resulting in lower costs and, in some cases, improved uniform quality. This traditional pattern may well be the pattern of the future in developing countries.

Tofu or "bean curd" comes in 12-to-16 ounce cakes having a consistency like that of a soft cheese or very firm yogurt. Discovered by a Chinese prince in 164 B.C., tofu is presently the single most important soy protein food for more than one billion people in East Asia and is prepared fresh each morning at 38,000 shops in Japan. Remarkably versatile, tofu can be used in many Western-style recipes including creamy dressings, dips and spreads; hors d'oeuvres, salads, sandwiches, soups and sauces; egg, vegetable and grain preparations; barbecued and deep-fried specialties, casseroles, and even desserts. Other available varieties include silken tofu, deep-fried tofu cutlets, burgers and pouches, grilled tofu, Chinese-style firm tofu, wine-fermented tofu, and dried-frozen tofu.

Soymilk is now increasingly popular throughout East Asia. 150 million bottles and cartons are produced and sold each year in Hong Kong alone, with Singapore, Malaysia, Thailand, and Japan close behind. A simple natural method has recently been developed for

The soybean plant

producing soymilk with a flavor very similar to that of dairy milk and a higher protein content; yet it has no cholesterol and typically sells for about 25% less. Several types of bottled and canned soymilk (plain, honey-vanilla, chocolate or carob) are now available at American supermarkets and natural food stores. Also available are soymilk ice cream, yogurt, and mayonnaise.

Tempeh originated in Java prior to 1750 and today is prepared fresh each morning at 41,000 shops there. Indonesia's most popular soyfood, it consists of tender-cooked soybeans bound together into compact, ¾-inch-thick white cakes or patties. Sold fresh, refrigerated or frozen, these are usually sliced and fried until their surface is crisp and golden brown and their flavor and texture resemble those of southern fried chicken. Favorite Western recipes include tempeh burgers, tempeh lettuce and tomato sandwiches, and seasoned crisp tempeh. Topped with applesauce, it becomes tempeh chops; pureed, it makes creamy dressings or spreads; crispy slices or cubes that are used like croutons in salads and soups, or added to pizza, stir-fried rice, casseroles, sauces, or tacos.

Miso is a savory fermented seasoning made from soybeans, rice or barley, salt and water plus a starter. Created in China in 722 B.C., its texture resembles that of a soft peanut butter. Prized for its seasoning versatility, miso can be used like bouillon or a rich meat stock in soups or stews; like Worcestershire, soy sauce, or ketchup in sauces, dips, and dressings; like cheese in casseroles and spreads; like chutney or relish as a topping for grains or fresh vegetable slices; as a gravy base with sauteed or steamed vegetables; or even as a pickling medium.

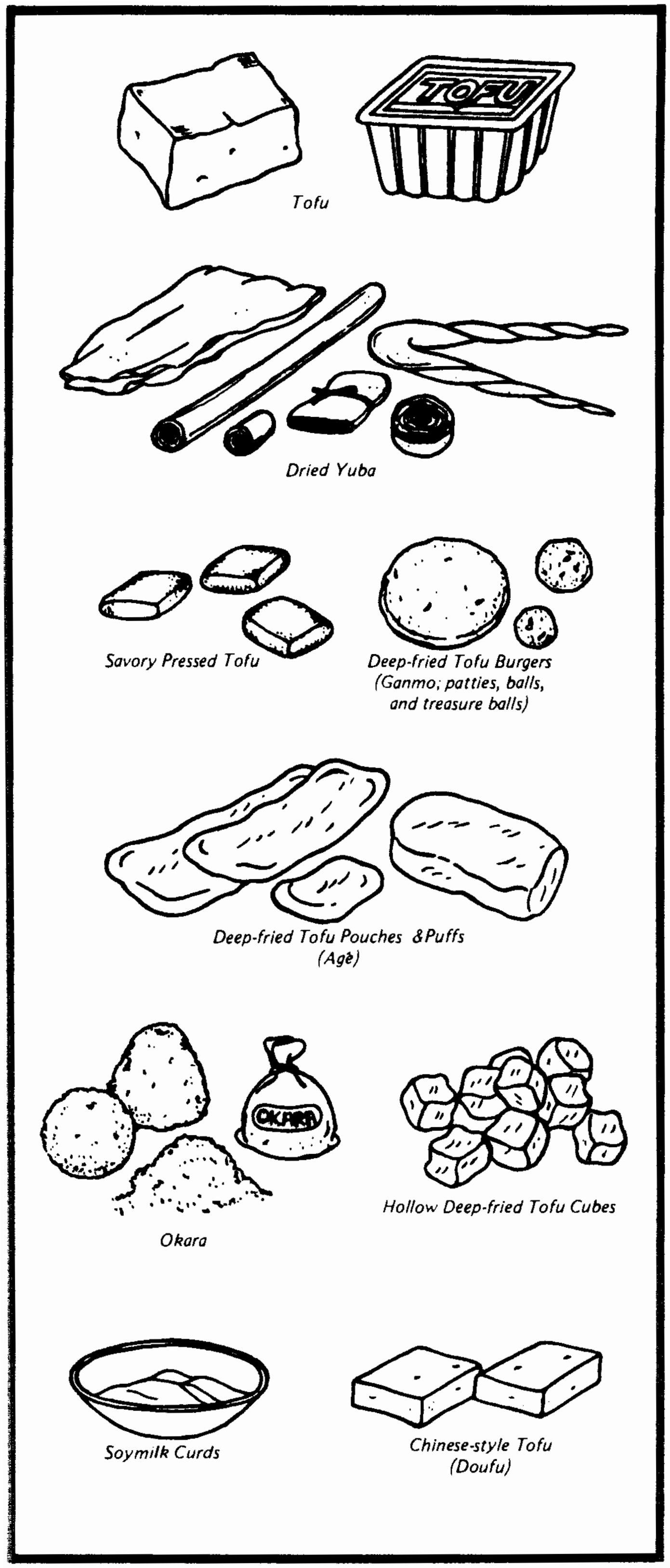
These traditional soyfoods can be produced in cottage industries using village level or intermediate technology. This inexpensive, decentralized technology is relevant to the majority of people in developing countries who are most in need of protein as well as to the growing number of people in post-industrial societies practicing voluntary simplicity or seeking meaningful work.

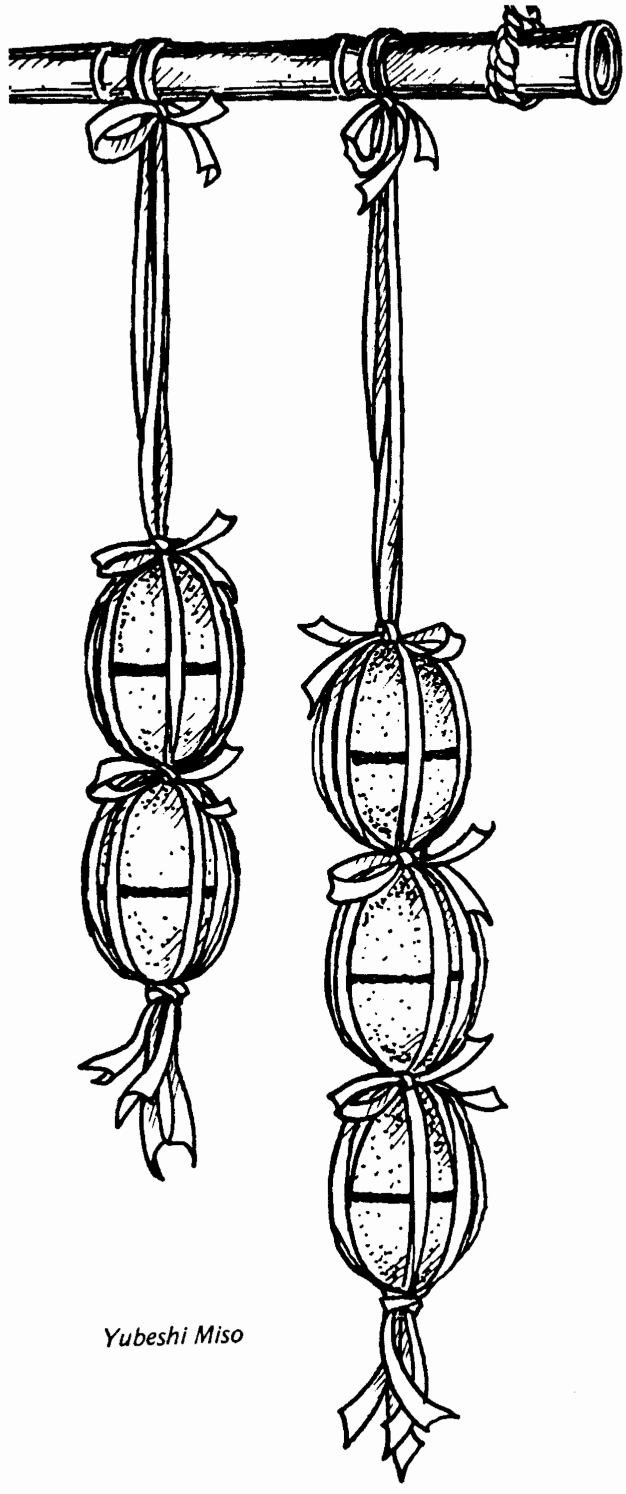
The food industry (and particularly the dairy industry) in the United States and other industrialized countries is now spending large sums of research money on the development of dairylike products such as soymilk, soy cheese (including a type that melts), soy yogurt, soymilk ice cream, soymilk mayonnaise, and creamy tofu or soymilk dressings.

Rarely if ever has an agricultural crop enjoyed such rapid and prolonged expansion as the soybean. Worldwide production more than doubled in the decade between 1965 and 1975, and could easily double again in the next ten years to help fill the world's growing demands for protein.

Enough soybeans are produced each year to provide 42 pounds for every person on the planet. If all this soy protein were used directly as food, it could fulfill an estimated 36-46% of the yearly protein requirements for every person in the world, and if it were served together with complementary grains the above figure could increase to 50-60%.

Soy is already an accepted food in East Asia, but additional work is now needed in other regions to expand soybean acreage, use a greater percentage of the soy protein in local diets, develop local soyfood production, and create recipes using these foods in ways suited to indigenous cultures and tastes.





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