International Maize and Wheat Improvement Center

CIMMYT

Centro Internacional de Mejoramiento de Maíz y Trigo

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INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER
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CIMMYT's new headquarters near Mexico City, linked to other stations representing widely varying ecological conditions, offer a great range of research and training facilities to a highly professional staff headed by Dr. Edwin J. Wellhausen.

INTRODUCTION

CIMMYT is a new concept of voluntary international cooperation aimed at contributing to rapid and substantial increases in world food production. Its province is wheat and maize, and its goal, in collaboration with interested governments and institutions, to increase the yields per unit area and improve the quality of these two crops wherever they can be grown efficiently. In promoting this goal, CIMMYT serves as the central axis of a vast united effort involving many nations, institutions, and individuals. It represents a new movement in international cooperation. Its programs proceed on the basis of need, desirability, and feasibility. Its work is carried out through a well-coordinated effort among scientists, educators, government leaders, industrialists, and the farmers themselves. Problems are solved through an integrated, multidisciplinary approach. The Center's success is measured on the basis of what happens to yields at the farm level, and, more generally, in terms of the well-being of people at all levels of society.

The idea of dedicating high-level, multidisciplinary research to improving a single crop on a worldwide scale crystallized during the 1960's; it took shape first in the International Rice Research Institute, established in the Philippines in 1962 by the Ford and Rockefeller Foundations, but the genesis of the concept dates back to the cooperative agricultural program initiated in 1943 between the Government of Mexico and the Rockefeller Foundation. This cooperative effort has become a classic success story of the transformation, by 1956, of a food-deficit country to self-sufficiency in wheat and maize. From this base CIMMYT evolved and was formally established in its present form in April, 1966. The present annual core budget is in the neighborhood of $2.5 million; in addition nearly $2 million is being devoted to special projects around the world.

CIMMYT's achievements in catalyzing agricultural progress received widespread recognition in 1967, when the harvests of India and West Pakistan, based on the high-yielding dwarf wheats developed in Mexico, astounded the world. Again in 1970, when Dr. Norman E. Borlaug, head of the Center's wheat program, was named Nobel Peace Laureate, CIMMYT's victories on the farm front were linked with the cause of world peace. The same year, CIMMYT and IRRI shared the UNESCO Science Prize.

The Center this year inaugurates its new permanent headquarters at El Batán, near Mexico City, in the full realization that, in spite of the very real progress made, the world's hunger problem is grave and will not be solved without an all-out effort on the part of both the developed and the developing nations. CIMMYT's mission is to cement their partnership in the most ancient and fundamental pursuit of the family of man: providing food for all its members.

E. J. Wellhausen
Director General
International Maize and Wheat Improvement Center

CIMMYT is the acronym of the Spanish name of the International Maize and Wheat Improvement Center: *Centro Internacional de Mejoramiento de Maíz y Trigo,* with headquarters in Mexico.

The 1970's could be a decade of grace in which man must bring into balance rapidly growing populations with the production of food, or watch the world deteriorate into a miserable place for human existence.

THE FOOD-POPULATION EQUATION

The balance between food and people is today and will be for the foreseeable future a very precarious situation. In spite of considerable gains, the total growth of food production is not keeping pace with the growth of population, and at present rates this gap can seemingly only widen. The world's population is growing so rapidly that global food production must be doubled over the next 25 years merely to maintain today's far from satisfactory nutrition levels. The predominantly agricultural countries are contributing by and large the least to total agricultural production, and populations are growing fastest in those regions where production increases are slowest: by the year 2000 the less-developed regions will have more than three quarters of the world's population as against two thirds in the last world census of the 1960's. The technologically advanced nations produce surpluses, while the poorer nations have deficits in most essential food products, yet the latter can least afford to spend foreign exchange on food imports; moreover, food aid programs from surplus to deficit nations are at best an emergency solution and contribute to stunting agricultural development where it should be most encouraged. Malnutrition and related diseases sap the productive energies of those very nations that have to make the greatest effort toward economic advance over the next few decades, and the population of these nations is itself grossly overbalanced on the side of dependent youth, who absorb services and goods but do not add to productivity. These are the nations with the largest percentages of young people who are reaching the age when they will become parents, and of small children who are the most damaged by inadequate and poor-quality food.

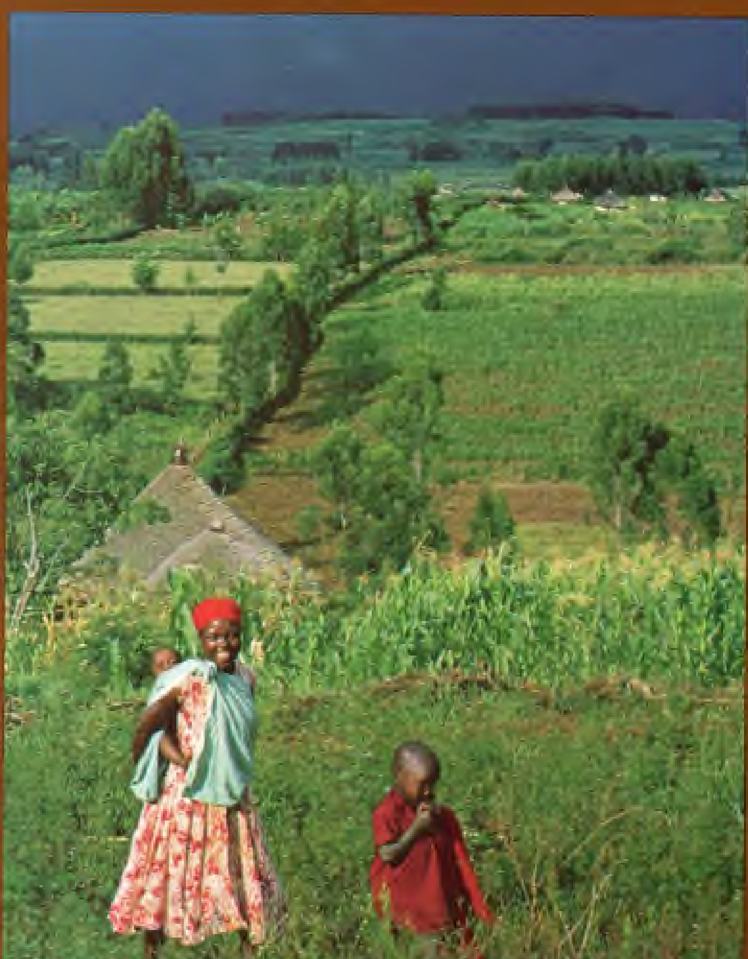
Most authorities now agree that the underproducing nations, situated largely in the tropics and subtropics, must ultimately count on their own farms and ranches and fisheries for the bulk of their food. Overall production must of course be stepped up in developed as well as developing countries, for the total amount of food needed is constantly growing, but the greatest emphasis must be on making underproducing nations more nearly self-sufficient.

The world food budget for the years ahead, as projected by the international experts of the United Nations' Food and Agriculture Organization, will have to tap every known resource as well as explore possible new food sources. The bulk of supplies, however, will have to come from conventional agriculture, involving the traditional food crops, with the major cereal grains at the top of the list. More and better quality wheat, maize, rice, sorghum, and millets must urgently be produced for the more than six billion people expected, at a conservative estimate, to inhabit the earth by the end of this century.

The requirements for cereal crop improvement have been carefully spelled out: new varieties must be bred so as to give higher yields on the lands they now occupy; they must be adapted for other areas that can be economically opened up for cropping. These varieties must be made inherently disease and pest resistant and genetically modified so as to contribute to better protein and amino acid nutrition. They must be combined with appropriate packages of agronomic practices, including better soil fertility and moisture conditions, and form the object of intensive and well-integrated production programs having built-in farmer incentives, distribution and marketing opportunities, and expert scientific guidance for growers.

CIMMYT's key role in this overall scheme is clear. Its major achievements to date have been precisely along






Massive national crop improvement programs to feed millions—as well as strong efforts to improve the life of the subsistence farmer—are a continuing necessity to keep abreast of population growth. In India, the Near East, Kenya, and Pakistan, CIMMYT has cooperated in maize and wheat production programs geared to varying regional needs.

the lines of FAO's blueprint for progress. CIMMYT's international orientation and autonomous structure give it the mobility necessary to work with many developing nations as a partner; long-range financing assures continuity in research and stability of administration and policy; the eminence of its board of directors in science and world affairs makes it responsive to changing needs and opportunities in a world context; its distinguished scientific staff, of varying disciplines and nationalities, linked with a score of equally competent scientists in research centers around the globe, give the experimental work depth and scope; prime emphasis on application of research findings and diffusion of knowledge through a network of collaborating individuals and institutions makes for effectiveness in worldwide action.

CIMMYT is often called a catalyst. Concretely, this means that it provides the impetus for getting local and regional production programs off the ground and follows through with aid in adapting methods and technologies to meet unforeseen complications. Local research programs are often sparked by the need defined during such joint efforts on new terrain. It supplies the professional confidence that ministries and agricultural agencies in developing countries need to take risks and invest public money and manpower in modernizing agriculture. It puts its experience and expertise at the service of decision makers, so that vigorous agricultural policies can be implemented, opening the way to greatly increased production, which in turn provides a boost to the entire economy of an agricultural nation. It is a catalyst, too, in encouraging the exchange of scientific information and joint work on problems of disease, insect pests, soils, and the like that are common to many regions.

CIMMYT is very much aware that increased production and the ensuing economic gains represent only one side of the effort toward food sufficiency; the other side is consistent efforts toward population stabilization. The discouraging experience of the last two decades, when gigantic strides toward economic development and agricultural advance were steadily cancelled out by population growth, should be persuasive evidence that the outcome of the battle to feed the world is far from certain. Agricultural scientists are often credited with the goal of buying time for government leadership and population workers to mount effective programs. It has been shown that when the subsistence farmer learns how to get more from his land, he will want a better life for his family, an education for his children, and a voice in his future. The advantages of smaller families then become more persuasive.

The 1970's are a decade of grace in which man must bring population growth and food production into balance, or watch the world deteriorate into a miserable place for human existence. The recent cooperative, integrated efforts of many individuals, governments, industries, and international agencies have stirred hope, where there was none a short time ago, that this balance may be achieved.

Maize specialists from many nations come each year to CIMMYT's fields and laboratories for additional training. As a basic food crop for human nutrition, maize is gaining increased acceptance, and maize technology is now helping to substantially increase per-hectare yields in countries where maize is a staple of life.

MAIZE

CIMMYT has continued the Rockefeller Foundation's cooperative programs started in the 1940's in Mexico and extended them worldwide with many national and international collaborators. Maize has been bred for different growing conditions, and agronomic practices have been designed to help farmers take full advantage of the high-yield potential of the varieties. Utilizing world germ plasm collections of several thousand varieties, scientists can now virtually breed new types to order, depending on the requirements of a given region. Breeders can design local varieties almost to specification—for good rainfall areas and for those subject to dry spells, for high altitudes with cooler climates and for the hot tropics, for longer and for shorter day length, for early harvest and for late; they can produce hard shiny kernels or dull soft ones, in every shade from red-gold to yellow to white.

This remarkable versatility of maize not only *can* be manipulated to suit variances in growing conditions and consumer taste, but for good results it *must* be. And each type requires its own set of agronomic specifications regarding time, depth, and density of planting; times and amounts and types of fertilization adapted to local soil conditions; moisture requirements; weed, disease, and pest control measures.

Maize-growing in the developing world typically takes place on millions of small farms under natural rainfall conditions, with only a small fraction of the total output coming from big commercial operations where fertilizer, moisture, and other factors can be brought under scientific control. The large farms of the U.S. corn belt have few counterparts in the developing world. Very different approaches are needed to bring high levels of maize production to countries where up to 70 percent of the farmers have small holdings whose entire output is barely enough to feed their families and their livestock from one harvest to the next. Evidence is accumulating that the small landholder, too, can benefit from modern maize technology.

INTERDISCIPLINARY RESEARCH

CIMMYT and its collaborators are concentrating on improving maize production through teamwork involving many specialties. A worldwide team of scientists is working to develop high-yielding varieties that will be more widely adaptable to different environmental conditions; they are now breeding open-pollinated varieties that will perform as well as hybrids. The Center's breeders have already made progress in solving certain problems peculiar to tropical maize, such as excess height, high ear placement, and luxuriant leaf growth, which cause the plants to fall over (lodge) as the grain ripens, making harvesting difficult and causing losses in yield. Short sturdy varieties with low ear placement have been arrived at through selective breeding for the tropics.

Scientists are designing packages of practices that help the farmer get the most out of the new seeds. Fertilizer specifications have to be worked out for different soils, and drainage and irrigation problems studied. Weed growth is a major problem in tropical farming, particularly on fertilized land or in high-rainfall areas.

Entomologists and plant pathologists are studying the diseases and insect pests that attack the maize plant at various stages of its development as well as those that spoil the stored grain. Plant diseases, such as ear rot, corn stunt virus, and downy mildew, have come under intensive investigation in the central research program as well as in programs abroad. CIMMYT is favorably located for these studies since

The Center's breeding specialists are making progress in solving some of the problems peculiar to tropical maize, drawbacks such as excess height, high ear placement, and luxuriant leaf growth that cause the plant to fall over, or lodge.

many of the major diseases of maize known to growers the world over are present in Mexico. Entomologists are focusing attention on those insects, like the leafhoppers, that are carriers of plant-disease viruses as well as on chewing and boring species that attack the maize plant directly. Insects that lay their eggs in stored grain, like the corn weevil and grain moth, are also targets of research. Both genetic and chemical means of control are being tested.

On the basis of the knowledge and materials being generated, commercial maize farming in most regions of the tropics and semitropics can be greatly expanded and made more productive provided proper local support and enthusiasm are forthcoming. In addition, biochemists and breeders are cooperating in attempts to improve the protein quality of maize by incorporation of the mutant genes opaque-2 and floury-2, which control the amino acid pattern of maize kernels. Widespread cultivation of maize with superior quality protein would be an important step toward solving the nutritional problems of maize-eating peoples. And, most important, technology is being developed and tested to help the small subsistence farmer raise his output at a profit.

INTERNATIONAL PROGRAMS: THE AMERICAS

Maize technology developed by a network of institutions and scientists around the world has already made a significant impact in many areas. The basic ingredients were present in each case, these being the new varieties and recommended farming methods, fertilizer and other inputs, strong local support, and the promise to the farmer of a fair return for his investment.

News about maize comes from many countries with which CIMMYT has been cooperating at the request of their governments. Mexico herself has more than doubled average maize yields per hectare during the last two decades. Maize production increased by more than 250 percent—from 3.5 million tons in a good rainfall year in the late 1940's to about 9 million tons in a good rainfall year like 1968. During the same period, average yields per hectare doubled, from 700 kg/ha to about 1,400.

Maize is native to the Americas and is a major dietary staple in Mexico, Central America, and the Andean region of South America today as it doubtless was from unrecorded times. In some areas, the mountain people, who have little else to eat, suffer severe malnutrition, and infant mortality from malnutrition-related diseases is high. Maize with better quality protein is therefore of primary importance in these regions, and it is given top priority in the cooperative programs. Commercial plantings have been undertaken in several Central and South American countries. With major assistance from the United Nations Development Programme, a special effort is being made to develop high-yielding, more nutritive varieties with the desired grain type. The Colombian Institute of Agriculture (ICA) and the International Center of Tropical Agriculture (CIAT) are cooperating with CIMMYT in the development and promotion of quality protein maize. The Colombian Institute of Nutrition and the commercial companies which make Maizena and Quaker Oats are testing its use in these and other popular food products.

A considerable effort is also being made to promote more widespread use of improved adapted conventional maize varieties in areas of the Andean region where the new technology has not made sufficient progress; recent studies in the economics of management

Geneticists focus on the biological engineering that incorporates desirable traits into new varieties. Entomologists and plant pathologists are studying the diseases and pests that attack the maize plant. Agronomists and soil scientists are designing packages of practices that help the farmer get the most out of new seeds. These and other highly trained professionals, supported by technicians, are part of CIMMYT's worldwide effort to increase maize yields.

may open the way to higher outputs and better profits. Testing of improved varieties of maize is proceeding at various altitudes in Ecuador, Peru, Venezuela, Bolivia, and Colombia in the search for the types best suited to each locality.

Maize for Central America and the Caribbean islands is being developed by the Central American Cooperative Food Crop Improvement Program, which is also undertaking work on sorghum, beans, and rice. The cooperative research program in the Central American countries has developed many new varieties for the region. Crosses between Mexican and native Caribbean germ plasm made in the course of this work have resulted in varieties useful for the hot humid lowlands of Africa, India, Southeast Asia, and South America.

ASIA

Thailand has had dramatic success with maize, thanks to an intensive government-supported program, in which CIMMYT has been cooperating through the Inter-Asian Corn Improvement Program which is in part supported by the Rockefeller Foundation. Exports increased from zero in 1954 to 1.5 million tons in 1968; in 1966 Thailand was the world's third largest maize exporter. Area devoted to maize has expanded at an annual rate of about 52,000 hectares, and production is increasing by about 100,000 tons a year. The hub of research and training activity is the maize program at Farm Suwan, a facility operated by Kasetsart University in cooperation with the Ministry of Agriculture.

In India production of maize has markedly increased over a ten-year span; that country now produces around five million tons a year on five million hectares. The breeding program is well advanced, and the opaque-2 gene has been incorporated into a number of experimental lines and commercial varieties. Breeders have developed high-yielding, open-pollinated composites, which are greatly simplifying seed production. One of the good composite varieties developed in India, called J-1, has had great success in West Pakistan, where production has risen dramatically in recent years. India also reports successful control of two major leaf diseases through development of resistant varieties of maize; pathologists are now concentrating on stalk and ear rots.

A small team of Rockefeller Foundation scientists based in Bangkok serve as CIMMYT representatives and direct the Inter-Asian program, which covers South and Southeast Asia. Intensive breeding programs are making progress throughout the region and research is being conducted on prevalent diseases. The major work on downy mildew is being done in this area. Insect pests are being studied, and soils, fertilizers, and agronomic techniques are receiving attention. Depending on their degree of advancement, the programs in the Inter-Asian group also offer demonstration plantings, field days and seminars for growers and businessmen, and training opportunities for maize specialists and extension workers. Important training programs, including university-level studies, are under way in Thailand, the Philippines, and India.

AFRICA

The program for East Africa, centered in Kitale, Kenya, in cooperation with the United States Department of Agriculture and financed by U. S. AID is having a genuine impact on farmers' yields, and Kenya is already producing a surplus. Area sown to the improved hybrids increased from 80 hectares in 1963

Mexico today is self-sufficient in maize, its basic food crop, largely as the result of a modest joint effort, begun in 1943, by the Mexican government and The Rockefeller Foundation. Now the Center is working toward extending the maize program internationally.

to 56,000 in 1968. Breeders are using the superior Latin American genes in combination with African varieties and yield increases of up to 40 percent have been achieved. Strong emphasis is laid on incorporating the opaque-2 gene into the new composites.

Prospects are also favorable for greatly increased production in the United Arab Republic. The Ministry of Agriculture in collaboration with the Ford Foundation and CIMMYT is conducting a breeding effort—collecting and evaluating germ plasm, making crosses, and selecting and testing experimental lines—at maize stations recently set up in different localities. Work on disease and pest control and improved agronomic methods is also under way.

The new varieties of wheat that were developed in Mexico—high-yielding, widely adapted, and disease resistant (left and on cover, wheat is inoculated with stem rust to test its genetic resistance)—today are further improved in the Center's experimental fields.

WHEAT

The wheat improvement project initiated in 1943 by the Rockefeller Foundation and the Mexican government and continued by CIMMYT in cooperation with the Mexican Ministry of Agriculture evolved the superior varieties and packages of agronomic practices behind the wheat revolution, which spread through the Asian subcontinent in 1967 and is still advancing today. After several years of trying out Mexican wheats, India in 1966 imported 18,000 tons of wheat seed, a world record at the time. The following year 42,000 tons were imported by West Pakistan. The harvests were the greatest ever seen in either country. Following on a period of near-famine, when emergency shipments had to be made from the United States, this sudden abundance drew world attention and turned the spotlight on the wheat program centered in Mexico.

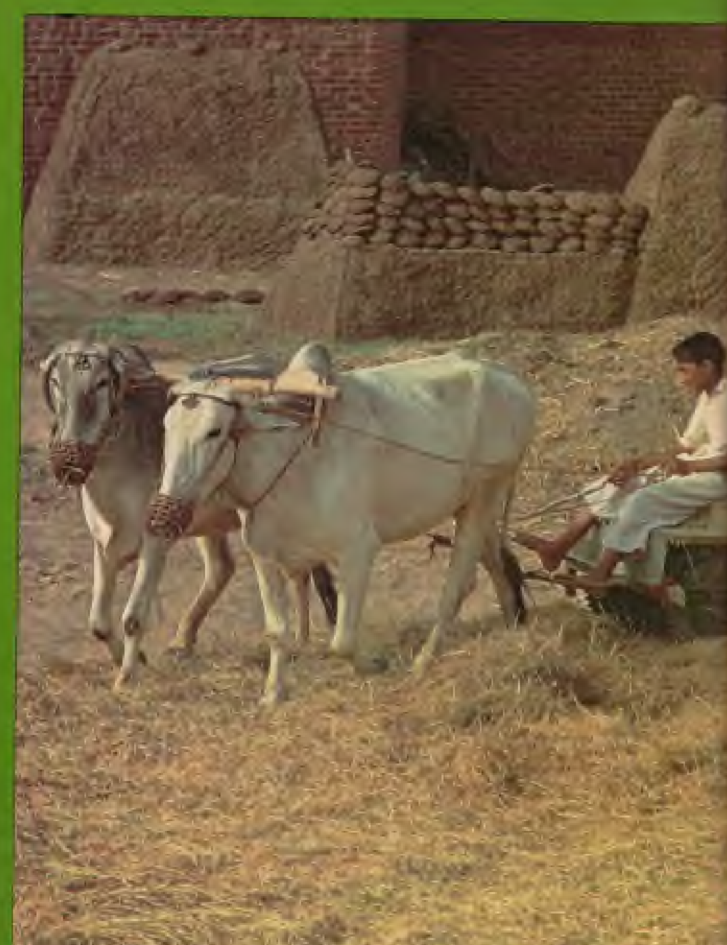
THE EXPERIMENTAL YEARS

From the outset the work has had an international character. Varieties of wheat were collected from all over South America, from East Africa, the Near and Middle East, South Asia, and North America in the search for high-yielding, widely adaptable, disease-resistant strains with good growing characteristics and desirable milling and baking qualities. These wheat samples were stored for use in the varietal improvement program.

In the course of over 20 years of research, breeders made more than 30,000 crosses. The best lines that resulted from combining the imported materials with Mexican wheats were sent out to be tested and recombined with local wheats in a large number of wheat-growing countries, and the overseas breeders subsequently sent promising lines back to Mexico for further research. Lines were selected not only for high yield, pest and insect resistance, and resistance to rusts and other diseases, but also for the widest range of adaptation, particularly in regard to day length. Some of the best wheats created by the program, when tested in uniform nurseries sent out to widely separated countries, performed outstandingly over latitudes from 0° to 50° as well as over a wide range of longitudes and under regimes of both irrigation and marginal rainfall. The speed with which the varietal improvement problem moved forward was due in part to this trait of adaptation over a broad range of environments.

Yields in Mexico were raised from an average of 750 kilograms per hectare to 1,360 in the first phase of the program. Development of strains resistant to stem rust was crucial to this achievement. Mexico, a wheat importer in the 1940's, became self-sufficient in this grain in 1956, in spite of galloping population growth; by 1962-65 she was exporting more wheat (an average of 276,000 tons a year) than she had imported in the lean years two decades before (an average of 253,000 tons a year). In recent years, Mexico's cooperative program with CIMMYT has assisted her in continuing to raise yields per hectare and to cut down on wheat acreage while increasing production. In the decade 1960-70, average yields increased from about 2,200 kg/ha to 3,200.

The varieties that were the direct forebears of the green-revolution wheats are the dwarfs and semi-dwarfs created in the 1960's and bearing such names as Mayo, Sonora, Lerma Rojo, Penjamo, Tobari. These short, stiff-strawed plants gave yields of more than double those of the best wheats bred up to that time. They could be heavily fertilized; the nutrients went to form heavy heads of grain and the sturdy stalks held them upright until harvest. (The tall wheats formerly in



Norman E. Borlaug has for more than 25 years spearheaded the development and propagation of new wheat varieties. First Mexico and now countries such as India are achieving massively increased wheat harvests using locally adapted varieties of the Mexican dwarfs. For his work in spreading the green revolution Dr. Borlaug received the 1970 Nobel Peace Prize.

use tended when fertilized to fall over as the heads filled out; a strong wind or rainstorm could be a disaster.)

The breakthrough in plant type came with the successful incorporation of dwarf genes from the now-famous Japanese Norin varieties. Such short-stemmed wheat first came to the attention of American breeders in 1946; material containing Norin genes was introduced into the breeding program in Mexico in 1953, and the varieties derived from it were capable of yielding 2.5 times those that had already greatly increased production in Mexico. At the present time, triple-dwarf varieties (varieties having three dwarf genes) have already been commercially released by Mexico and India.

To take advantage of the high-yielding ability of the new wheats, agronomic practices were worked out by CIMMYT scientists and their colleagues in Mexican and overseas cooperating programs. These packages of practices differed for each locality where the new seeds were to be introduced. In hundreds of trials in Mexico and abroad, agronomists, soil chemists, pathologists, and entomologists defined and refined the methods that would work best with the varieties selected for a given area; along with the superior seed, the program distributed instructions governing dosages of fertilizer (mainly nitrogen and phosphorus), correct preparation of the seedbed, depth and rate of timing of planting, timing and amount of irrigation, and means of controlling pests and weeds.

INTERNATIONAL OUTREACH

The Center's experience in India was typical of subsequent programs: adoption of even part of the package gave substantial increases; careful adherence to all the recommendations brought phenomenal results. The demand for the new seed skyrocketed, and seed multiplication was stepped up on almost an emergency basis. Farmers whose passivity and resignation to poverty had been proverbial suddenly saw hope for a new prosperity and took vigorous measures to secure it. One of the key factors in the rapid spread of the agricultural revolution was this radical change in outlook.

The production revolution in India and West Pakistan, based on the new seed and new methods, repeated in two or three years progress made in Mexico over two decades and rapidly spread the new technology over vast acreages in both countries. The 1970 crop was the third consecutive record breaker: production climbed to more than 20 million tons in India and 8.4 million in West Pakistan. The history of these programs is being repeated today in other countries where the new wheats have been introduced under the auspices of national research and production projects.

The total area planted to the Mexican wheats or their derivatives has grown from about 800,000 hectares in 1964 to an estimated eight million in 1969. During the four-year period 1965-68, Mexico exported approximately 100,000 tons of seed, mostly to India, West Pakistan, and Turkey. This represents the largest transfer of seed from one region to another ever recorded.

CIMMYT is providing assistance to national programs in India, West Pakistan, Tunisia, Morocco, Algeria, Afghanistan, Turkey, Lebanon, Nepal, Brazil, and Argentina. The national programs in these countries are centered around breeding projects using the best adapted Mexican wheats in crosses with local varieties to create lines still better suited to local weather, soil, moisture, and other growing conditions with particular attention to developing resistance to prevalent diseases and pests.

CIMMYT's wheat program is a truly international venture. Wheat varieties collected from North and South America, the Near East, and East Africa were combined through tens of thousands of crosses with the best Mexican strains to produce the original Mexican dwarfs. Tested in many countries with widely varying ecological conditions, the most successful lines were returned to the Center for further improvements. Today several countries are managing their own extensive breeding programs while the Center experiments with even newer varieties such as the triple-dwarfs.

INDIA AND PAKISTAN

The cooperative programs in India and West Pakistan supported in part by the Rockefeller and Ford Foundations are well advanced; the All-India Coordinated Wheat Program is one of the most highly developed in both research and production. The Indian program has created several outstanding varieties with different types of rust resistance and made large quantities of superior seed commercially available. Seed multiplication has become an important and lucrative business, and fertilizer manufacture is also being encouraged in order to minimize the need for imports in the face of constantly growing demand.

Research in varietal improvement is well advanced in West Pakistan as well, and the high-yielding dwarfs are now sown on over 50 percent of the wheat lands. The more progressive farmers are fertilizing heavily and are anxious to obtain the new triple-dwarf varieties being tested. Several promising lines are emerging in this program. In addition, following on the production breakthrough, higher priority is now being given to plant pathology and cereal chemistry in the Pakistani program.

In addition to research in breeding, agronomy, plant pathology, and pest control on the experiment stations, rapid changes are taking place on the farms and throughout the whole spectrum of agriculture-related enterprises and industries. The new seed requires fertilizer and irrigation, and the new techniques call for more machinery and for better storage and transportation facilities. And the new profits show that investment in these improvements makes sense. Tube-well drilling in India and West Pakistan increased spectacularly after introduction of the improved wheats. Over 200,000 wells a year were sunk in the first two years of the expanding wheat revolution. Fertilizer manufacture increased, and government efforts to develop storage, transportation, and marketing facilities are creating employment and stimulating private business.

An important aspect of the upsurge in agricultural productivity is its multiplier effect. Success with one crop carries over to others. At the level of government production programs, the result is an effort on the part of leaders to promote parallel efforts with other major crops. And farmers whose profits have risen through use of the new wheat try to take maximum advantage of their investments in irrigation, fertilizer, and machinery by planting a second or even two additional crops during the year.

Double cropping is not new to the farmers of warm-climate countries, but under the new agronomic regimes it takes on new significance. As multiple cropping follows in the wake of the new grain technology, yields per hectare of food are greatly increased. Some growers in India and West Pakistan now harvest 10 to 15 tons per hectare of grain, using the high-yielding rice and maize varieties in rotation with wheat, on land that used to give an average of three tons, even when planted with two crops of the old varieties of these grains. Some of the better farmers manage to raise a third crop, such as beans or mustard. The prospects for total food availability are encouraging for the future of these traditionally hungry nations. In response, their governments have recognized the importance of providing price supports to prevent the sudden abundance from depressing farm profits and discouraging further production; government agencies are also taking steps to deal with the so-called "second-generation" problems of the green revolution—storage, distribution, quality control, and other needs.


CO-OP

Young wheat scientists from more than 30 countries have come to CIMMYT sponsored by national and international assistance agencies as an integral part of the Center's response to the growing number of research and production programs in the developing world. As a rule, these young men are actual or prospective staff members of crop improvement programs in their own countries.

There is ample evidence that government spending in this sector pays off: the record-breaking harvests have already had a significant impact on the gross national product of both India and West Pakistan. In 1969, for example, $294 million was added to the GNP of West Pakistan from the wheat harvest; the increase in India was estimated to be $739 million. During the past three wheat harvests, 1968-70, a total of $1.85 billion was added to the gross agricultural product of India, and $850 million to that of West Pakistan, above the value of the record 1965 wheat crop. In Turkey an estimated $80 million was added to the GNP in 1968 from wheat production increases.

NORTH AFRICA AND THE NEAR EAST

Programs in North Africa and the Near and Middle East where CIMMYT is participating directly or indirectly in launching major wheat production efforts are following the general pattern set in India and West Pakistan. With the help of U.S. AID and the Ford Foundation a CIMMYT team has been based in Tunisia and Morocco since 1968. A CIMMYT-Ford Foundation cooperative program covering several Near Eastern locations was initiated in 1969 in close collaboration with the Food and Agriculture Organization. A related program in Turkey is being sponsored by the Rockefeller Foundation. In 1971, with additional assistance from the Ford Foundation, the North African Regional program was extended to include Algeria.

The introduction of Mexican wheats throughout North Africa and the Near and Middle East met with initial success; weather conditions were generally favorable and production figures soared. Varietal improvement programs in various stages of advancement are now working to identify even better wheat lines and testing them under various land and climatic conditions.

CIMMYT is expanding research on development of durum wheats for the North African locations, because of the use of durum in couscous, a widely consumed wheat dish, as well as in macaroni-type products. Durum wheat is also important as an export.

Scientists are also working on combating the major pests and diseases to which the introduced varieties are susceptible. Diseases such as *Septoria* and the various races of rust are under study. Experience in other programs has shown that new races of rusts may develop and attack the newly introduced varieties. Therefore farmers are urged to plant more than one type, so that a virulent attack on a vulnerable variety will not turn into a major defeat. In an effort to identify broad-spectrum disease resistance for this part of the world, a group of experimental lines known as CIMMYT-Bluebird was multiplied in Mexico during 1969 for testing in these programs. These efforts are being complemented by a system of wheat nurseries that have been collaboratively initiated by all the national and international supporting agencies in the region and undergo constant pest and disease surveillance.

Morocco offers excellent opportunities for breeding for insect resistance because of the prevalence of several major wheat pests, including the Hessian fly, sawfly, cereal leaf beetle, and stem maggot. Development of lines having resistance to these insects would be valuable to many other parts of the world.

In North Africa weeds are the number-one enemy of high yields; both chemical and mechanical control measures are being tested. Trials involving soil management, crop rotations, and fertilization are also under way to determine the most economical practices for the new wheats.

Triticale is a wheat-rye hybrid, a high-yielding, man-made plant of considerable promise that is still subject to a variety of shortcomings. With extensive cooperative research being carried out today in Mexico, Canada, and other countries, it may one day provide a valuable supplement to small grains like barley, oats, rye, and wheat in human and animal nutrition.

NEW DIRECTIONS

THE PUEBLA PROJECT

It has been estimated that subsistence and semi-subsistence farmers and their families comprise between 50 and 80 percent of the rural population of developing countries; they occupy an estimated 40 percent of the world's arable land—which means that the proportion they cultivate in the developing countries is considerably higher. In an era in which population growth in the developing world is still racing ahead of farm productivity, this under-utilization of land and manpower is a powerful brake on economic progress. The subsistence farmer in general has not benefited from modern scientific agricultural technology. The Puebla Project is designed to determine how the small farmer can improve the quality of his life and become a more productive member of his community and his nation.

In 1967, with a special grant from the Rockefeller Foundation, CIMMYT helped launch this experimental project to raise yields of maize on small landholdings under natural rainfall conditions in an area where soils were generally poor and yields had been static for generations. The region chosen for this was a section of the State of Puebla, a densely populated district of small farms and villages about 60 miles east of Mexico City. Maize is the principal crop, and most of what is raised is consumed by the people or fed to their domestic animals.

The Puebla Project was conceived and put into operation as a consortium of Mexico's Federal Government, the Graduate School at Chapingo, the government of the State of Puebla, national and state agricultural agencies, private business (particularly fertilizer distributors), and CIMMYT. It is apparent that such elements working closely together are necessary to reach and motivate large numbers of subsistence farmers and to provide them with the necessary knowledge and inputs to drastically raise productivity. The Project has attracted world interest and holds out hope for a workable solution to the problem of bringing the subsistence farmer into the orbit of agricultural advance.

The Project's primary goal is to increase yields and income rapidly and economically on small farms in the state of Puebla. In the choice of this particular location, several factors were decisive: yields of the principal crop were low and static, and the potential for rapid improvement was good; the area was densely settled, centrally located, and accessible to CIMMYT headquarters and to Mexico City—important considerations in a project designed to draw the interest of national and world leaders and serve as a demonstration model of what could be accomplished elsewhere. And, importantly, local political and administrative leaders were interested and anxious to cooperate.

A longer-range objective of the Project is to create a strategy for introducing modern scientific agriculture to back-country areas elsewhere in the world where farm yields are low and the people caught in the typical cycle of poverty, overpopulation, and social and economic stagnation. Experience on every continent has shown that as population pressures build up and drive these people off the land, they migrate to city slums, which cannot absorb them. In addition to purely humanitarian considerations, bettering the life of this large segment of the population represents a tremendous growth potential for the economy of a developing area. The upsurge in economic activity that came in the wake of the green revolution in parts of India, West Pakistan, and the Philippines, for example, indicates what might happen if thousands of farm families who

A pioneering, large-scale experiment in the state of Puebla has drawn worldwide attention to the possibility of bringing the benefits of market-oriented agriculture to farm families barely able to survive on the former yields from their small holdings.

now live on the brink of desperate want were brought into the money economy. As the quality of life improves for these small producers, demand can be expected to increase not only for agriculture-related commodities, but also for consumer goods and services. The migration to cities might be expected to abate as well. That these hopes have a realistic basis can be seen from a rundown of some of the results achieved in Puebla.

The Project, now in its fifth year, has grown from a handful of demonstration plots cultivated by 30 farmers in 1967 to an area covering an estimated 18,000 hectares and involving about 7,000 farmers. The steps taken to bring this about sound deceptively simple. The package of agronomic practices included increasing and correcting fertilizer applications, teaching the farmers to plant their crop more densely on the enriched soils, offering advice about disease and weed control, and trying to time planting to take advantage of rainfall. The Project team contacted local people of influence and guided the organization of farmer groups; they convinced some of the more progressive growers to plant demonstration plots on their own land where their neighbors could see the new technology at work; they arranged field days where the successful farmers explained how it was done. And most important, they managed to get credit for the Project participants. (The Project guaranteed payment, but not one of the borrowers defaulted.) Seeing was believing, and each year more farmers took part, more credit was extended, and more land was devoted to Project techniques. Profits increased accordingly: the dollar value of the 1970 crop was over $2.5 million.

The Project has shown conclusively that the small farmer can also benefit from the use of the modern scientific production package and has demonstrated that yields can be profitably increased on small holdings. The average farm in Puebla is about 2.5 hectares; farmers who were getting 1,300 kgs. per hectare before they entered the Project are now getting an average of 4,000. The demonstration also revealed that subsistence farmers will change their methods and attitudes if given profitable alternatives.

Not only have the farmers' attitudes changed from apathy to enthusiasm, but government and private banks and credit-granting agencies, as well as local officials and businessmen, also have gained confidence in the viability of the Project and are increasingly willing to give it support. Loans for fertilizer and other inputs have rapidly increased in the Project area. Banks and other agencies have joined private companies in making these loans, and the farmers have proven that they can produce enough to pay off their debts and still have money to spend. Some have reinvested their profits in more inputs for growing maize; others have expanded their operations to include small-stock raising or other crops.

In 1971 the governors of two Mexican states, Mexico and Tlaxcala, initiated maize production programs on the Puebla model backed by public funds. Even more significant, the Mexican national agricultural extension program has adopted the Puebla Project strategy throughout its entire organization and plans to concentrate its efforts on improving small-farm productivity.

International interest in the Project has been strong. Officials from a great many countries have come to learn what is being done and to observe the Project. Two international conferences were held in 1970 to bring together leaders of agricultural and economic development for discussions of the Puebla strategy and its application in other areas.



Highly trained professionals with a first-hand knowledge of local conditions such as Dr. Leobardo Jimenez (below) worked with sometimes skeptical farmers to replace traditional ways of cultivating maize with more productive practices based on new technology.

An independent effort to help subsistence farmers, similar in many ways to the Puebla Project, has been in operation for several years in El Salvador, and government-supported projects are now getting under way in Peru, Colombia, and Honduras. As teams of scientists are trained in the strategy of the Project, benefits can be extended to still other countries where analogous conditions obtain.

A typical team includes a leader or coordinator, a production research agronomist, a plant breeder, and two communications specialists. The three basic elements of the Puebla approach are 1) scientific analysis of the agronomic barriers to high yields and development of a package of practices that will rapidly correct underproduction (improved varieties were not part of the original package, but will be included in future projects; 2) expert reconnaissance of the human and social field so as to win the support of key people who can influence the small farmers; and 3) involvement of local agricultural organizations that handle credit, farm supplies, crop insurance, marketing, etc. The success of the project team lies in coordination of these interacting factors. To equip men for this exacting job, CIMMYT tries to recruit highly motivated, resourceful young scientists and offers them a course of rigorous training, normally lasting two years, that combines academic study at the M.A. level with first-hand experience in the field.

Since 1969 a total of 14 agronomists, including students from several Latin American countries, have been trained in the methods of the Puebla Project with the cooperation of the communications department of the Graduate School of the National School of Agriculture. Countries represented included Brazil, Colombia, Chile, Ecuador, Honduras, Peru, and Uruguay as well as Mexico. At the present time, 21 candidates from Mexico, Peru, and Ecuador are enrolled in the training program.

BETTER PROTEIN QUALITY IN MAIZE

In the race to feed the world's exploding population, closing the protein gap is second only in importance to producing enough food. Fifty percent of the world's protein comes from grains; consequently, the effort to raise the quality and quantity of cereal protein through genetics and plant breeding is a high-priority item in world planning for meeting the projected food needs of developing nations. To date, maize is the leading cereal crop in which progress along these lines has been significant; high quality protein in maize is the prototype for attempts to improve protein quality in other major grains.

In order to accelerate progress with the improvement of protein quality in maize, the United Nations Development Programme in 1970 made a grant to CIMMYT for research in genetics and cereal chemistry and for demonstration and training programs concentrating on countries where maize is the chief dietary staple of the people. In many parts of Latin America the virtually all-maize diet is at the root of widespread protein deficiency. Now that maize with a better balance of the amino acids—in particular higher levels of lysine and tryptophan—can be bred, there is hope of alleviating certain protein deficiency problems simply by getting this crop into production and promoting its use in popular foods.

Several obstacles stand in the way of this promising solution. To interest the commercial grower, the new maize must perform as well as, or better than, his most profitable varieties, and the product must appeal to




Backed by a consortium of governmental agencies, commercial banks, and private businesses, with scientific leadership provided by the Center and the Graduate School in Chapingo, the Puebla Project provided credit for inputs, mainly fertilizer, to subsistence farmers hitherto outside the market system. Staff members and farmer-leaders demonstrated the suitable agronomic practices for best results—which were so convincing that now thousands of farmers take advantage of the plan.

the consumer. Until recently most improved protein varieties have been disappointing on both these counts. They have yielded slightly lower than the best commercial maizes and are more susceptible to insects and rots, probably because of their soft endosperm. In many areas the lusterless, pale grain does not compete with the hard, shiny flint types preferred by most consumers.

Efforts to overcome these disadvantages are well advanced, and varieties are being created that combine high yield, high nutritive value, desirable grain type, and adaptability for a wide range of conditions. Thanks to a vigorous research program and close cooperation with a U.S. AID supported project at Purdue University, some of the major difficulties of working with the mutant genes opaque-2 and floury-2 that improve the amino acid balance have been surmounted. Plant breeders have succeeded in incorporating these mutants into germ plasm complexes having a wide genetic base, so that they can select for improved quality protein and better grain type.

Material containing better protein characteristics is being sent out for adaptive research to collaborators in various parts of the world, and, in turn, the best materials from national programs are sent to CIMMYT for further evaluation. International yield trials of diverse materials from many countries indicate that some outstanding and more nutritive varieties with good commercial possibilities will soon be available.

To test the thousands of samples being received for the breeding program, the protein laboratory has developed new methods for rapid screening for lysine and tryptophan. In addition, a new facility for nutrition trials using meadow voles was put in operation in 1971 to supplement biochemical analysis in the protein laboratory.

As satisfactory varieties of more nutritive maize appear they will be used to replace conventional varieties wherever maize is a major staple or can be so in the human diet.

NEW DIRECTIONS FOR WHEAT

The international center's wheat research program, having achieved these victories, is moving on to attack still unsolved problems of wheat and to improve further on the characteristics of the high-yielding dwarfs. Double and even triple dwarfs are being bred and released for even higher yield potential in the principal irrigated and rainfed areas, so that instead of opening more acreage for wheat, which requires costly inputs, food-deficit countries can raise production on the land already in use. In addition, scientists are concentrating on screening of wheat to identify genes for higher protein content and quality, and on the creation of spring-winter types.

The need for grains with higher protein content has been recognized for many years. Most of the world's people, especially in the developing countries, rely on grain for nearly all the protein in their diets, and the major cereals are notably deficient in some of the essential amino acids, particularly lysine and tryptophan. Breeding more nutritive wheats with a better balance of the amino acids and with higher protein levels is one of the major targets. The breakthrough in high-lysine maize has raised hopes that this can be done. CIMMYT's protein quality laboratory is cooperating in this effort with the recently established laboratory in New Delhi and a project at the University of Nebraska. Scientists have developed rapid screening techniques for lysine as well as for total protein that make it possible to spot promising lines for the breeding programs. Problems

Success is measured by the number of small farmers with harvests now large enough to bring a part to market.




The development of maize, wheat, and triticale with a better balance of the essential amino acids and with higher protein levels is one of CIMMYT's continuing challenges. Scientists in the Center's Protein Quality Laboratory use newly developed rapid screening methods to identify promising lines for the breeding program.

are still being encountered in identifying high-lysine lines for crossing with the superior dwarf varieties.

Research on winter hardiness of spring wheat is another important effort at CIMMYT. The high-yielding Mexican spring dwarfs are not suited to the colder climates of some highland areas in Near and Middle Eastern countries and in Chile and Argentina. Nor do conventional winter wheats do well in these regions. CIMMYT has therefore instituted a breeding program aimed at creating superior varieties with semiwinter characteristics. A staff member has been carrying out this program in collaboration with the University of California, Oregon and Washington State universities, and experiment stations throughout the world.

TRITICALE

CIMMYT's research on triticale, the man-made wheat-rye hybrid, has been advancing steadily since the project was initiated in late 1964 in cooperation with the University of Manitoba with support from the Rockefeller Foundation. If some of the major problems still limiting development of this species can be solved, the triticales can be expected to provide a valuable supplement to small grains like barley, oats, rye, and wheat in animal feed and fodder and in human food. The work was expanded in 1971 with support from the Canadian International Development Agency and the Canadian International Development Research Center.

A basic difficulty in working with a newly created crop is the narrow genetic base. Early problems of sterility, shrunken grain, and low yields have been surmounted to some extent through a vigorous selective breeding program carried out in both Canada and Mexico; a breakthrough was the development in 1969 of the plump-grained, fertile strains known as Armadillo. Breeders at CIMMYT are concentrating on overcoming the tendency of triticales to lodge under even moderate fertilization, by incorporating genes both for dwarfing and for stiff straw, so that higher yields can be achieved through irrigation and heavy fertilization. A wider range of adaptation is also an important target. The Canadian strains are sensitive to day length and mature late under Mexican conditions. By analogy with the superior dwarf wheats, triticales are being bred for day length insensitivity, which would permit greater flexibility in planting dates and adaptation over a wider range of latitudes. A greater range of climatic adaptability is also being sought.

The major diseases of both wheat and rye attack triticale; pathologists and breeders are working on problems of stem, leaf, and stripe rust; bacterial blight; and the elimination of toxins from ergot and various fungi. Since some of the most serious diseases—notably *Claviceps purpurea,* the source of ergot—do not occur in Mexico, research in Canada as well as at cooperating international testing sites is of the highest importance. Agronomic peculiarities such as the tendency of the mature grain to sprout before harvest, abnormalities of seed germination, low tillering ability, and high susceptibility to shattering of the ripe ears, are also being studied.

Protein and lysine contents of triticales vary greatly, but some lines have been identified that are high in both. The protein laboratory at CIMMYT is screening hundreds of samples for nutritive value; outstanding strains have been found having 18 to 19 percent protein, with more than 3 percent lysine in protein. Moreover, in cooperative work with Michigan State University, some of the strains have demonstrated an extremely high nutritive value when fed to small animals.

One of the Center's major contributions to world food production is the training in maize and wheat technology of young scientists from all over the world who go back to their own countries as key participants in crop improvement programs.

CIMMYT'S RESOURCES

NEW HEADQUARTERS

Headquarters facilities at El Batán, a short drive out of Mexico City, were completed in 1971. They comprise laboratories, administrative facilities, staff and student housing, greenhouses, facilities for seed storage and processing, storage and repair sheds for vehicles and farm machinery, and service buildings. The complex stands on 43 hectares of land made available by the Government of Mexico and is surrounded by experimental plots.

In addition to the headquarters station, there are three substations representing different ecological conditions. An intermediate-elevation station was recently acquired near Tlaltizapán, Morelos, and another experimental farm is being developed in the lowland tropics near Poza Rica. A high-elevation station is in operation in the Toluca Valley. In addition, much of CIMMYT's research in Mexico is carried out in cooperation with the National Institute of Agricultural Research (INIA). The INIA station near Ciudad Obregón, Sonora, plays an important role in the worldwide wheat improvement program and cooperative research is carried out on several INIA substations around the country.

The central laboratories at El Batán contain facilities for work in plant genetics and physiology, entomology, plant pathology, soil chemistry and fertility, milling and baking, and protein quality. A germ plasm bank stores a large collection of basic genetic materials of maize and wheat, from which breeders create new varieties. CIMMYT's staff collaborate with agricultural scientists in many other nations: wheat breeders have sent samples of promising breeding materials—"international nurseries"—to cooperating stations in over 60 countries. Maize is also being tested internationally at 50 sites in cooperation with national scientists in Central and South America, Africa, Asia, and the Middle East.

CIMMYT's headquarters and regional professional staff numbers 44; it includes two teams, one in wheat, the other in maize, each consisting of geneticists, plant breeders, plant pathologists, and soil scientists, assisted by a small group of biochemists and communications specialists. Supporting teams of research assistants and ancillary personnel complete the staff.

The Center's scientists are routinely in contact with their many collaborators in other parts of the world, as well as their own staff members stationed overseas. In addition, seminars and forums are frequently organized to bring specialists together to discuss important issues or explore new opportunities for cooperation. A newsletter published in English and Spanish is circulated to more than 8,000 interested scientists and institutions in 114 countries to keep them informed of cooperative work, and a series of technical bulletins reporting research findings is published and circulated internationally. Annual reports and special reports on projects of importance are likewise made available to those interested.

TRAINING

To be effective, crop improvement campaigns in developing areas must be backstopped by competent scientists and technicians familiar with modern research and production practices; CIMMYT's in-service training programs are designed to help meet this need in the nations with which it is cooperating. Since 1961 a growing number of young scientists each year have come to Mexico for periods ranging from eight months to a year, to learn maize or wheat technology at first hand. The course emphasizes training through partici-


The Center's new headquarters provide modern research and training facilities set in experimental fields.

The Center's extensive laboratories permit its trained investigators, as well as its resident trainees, to pursue research in plant genetics and physiology, entomology, plant pathology, soil chemistry and fertilizers—research that is production-oriented and focused on obtaining higher yields.

pation in the ongoing research and production projects at CIMMYT, but also includes some seminar courses. Recently training at the postdoctoral level was added.

Special attention is currently being given to on-the-job experience with maize production on small holdings, in collaboration with the Puebla Project. Teams of five trainees are assigned to the Project to learn how to initiate and apply the techniques being developed in Puebla for raising yields on subsistence farms. Mexico's National School of Agriculture and its Graduate School, both located in nearby Chapingo, cooperate in certain aspects of the training programs; candidates for graduate degrees take courses at the Graduate School, and all trainees have access to the extensive collection of the National Agricultural Library in the Chapingo complex. The presence of distinguished foreign scientists who spend part of their sabbatical leave at CIMMYT also enhances the trainees' experience.

In the period 1961-71, a total of 165 wheat trainees took part in the in-service program. They came from Afghanistan, Algeria, Cyprus, Ethiopia, India, Iran, Iraq, Jordan, Kenya, Korea, Lebanon, Libya, Morocco, Nepal, Pakistan, the Philippines, Poland, Rumania, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, the United Arab Republic, Argentina, Bolivia, Brazil, Chile, Ecuador, Guatemala, Peru, and Uruguay. The largest numbers came from Pakistan (28), Afghanistan (13), Tunisia (13), and Turkey (13).

Between 1967 and 1971 maize research and production trainees numbered 37; sponsoring countries were Afghanistan, Argentina, Colombia, the Dominican Republic, Ecuador, El Salvador, Ghana, Guatemala, Ivory Coast, Nepal, Nicaragua, Panama, Peru, the Philippines, Tunisia, the United Arab Republic, and Uruguay. In addition, a number of specialists in communications and farm management have been trained.

As a rule, the young scientists are actual or prospective staff members of crop improvement programs in their own countries; their job will be to supervise local programs and to train others in the new technology when they return home. Most hold scholarships provided by the FAO, U.S. AID, the United Nations Development Programme, the Inter-American Development Bank, their own governments, or other sponsoring agencies. The training program not only helps to alleviate the immediate shortage of technical and scientific manpower available to launch production campaigns, but in the long run it also strengthens agricultural institutions in the cooperating countries so that they can maintain the momentum of research, production, and training under local auspices. Further, the network of CIMMYT alumni around the world forms an effective fraternity of scholars, facilitating exchange of information and research findings and insuring expert technical cooperation in far-flung projects like the uniform trial nurseries and other international activities.

COMMUNICATIONS

The basic job of CIMMYT's communications department is to help keep wheat and maize specialists around the world abreast of new developments in their fields. For scientists, government agencies, and leaders in agriculture-related business and credit organizations, CIMMYT issues a variety of technical publications, reports, and bulletins as well as occasional proceedings of international meetings and symposia. Technical material includes detailed reports on research findings, news of the international nurseries and



The Center's training programs offer postdoctoral work, but for most students training means eight months to a year of participation in ongoing work. Trainees are exposed to activities that range from knowledge of climatological instrumentation to the ability to make wheat crosses. CIMMYT's network of alumni—in touch with each other and the Center and joined in the common cause of food crop improvement—may well be at the heart of the Center's worldwide accomplishments.

screening tests, developments in the protein quality laboratory, progress of disease-resistance trials, and similar material. *CIMMYT News* keeps subscribers up to date on all aspects of worldwide activities; the mailing list numbers nearly 8,000 individuals, institutions and libraries in 114 countries. A detailed annual report of CIMMYT's work in Mexico and abroad is also distributed to interested persons and organizations. Most of these publications are available in both English and Spanish.

Audio-visual materials produced and distributed by CIMMYT and its collaborators include movies and film strips on technical subjects for use in training programs for wheat and maize production specialists. Some sample subjects are collection and inoculation of wheat rusts; techniques for emasculation and pollination of wheat; and methods of setting up fertilizer experiments in the field. A film showing the initial demonstration plots in the Puebla Project was used to persuade farmers to take part in the Project. Similar documentaries are being made about the in-service training program in Mexico and the further development of the Puebla Project.

The communications program is a key component in production campaigns for small farmers, based on the Puebla model. The specialists needed for this job are being trained in Mexico in a variety of skills and techniques ranging from the design and conduct of area surveys, to analysis of community patterns of power and farmer attitudes, to organization of farmer groups, extension of technical information, and evaluation of results. A program to train small integrated teams for this work is being carried out in cooperation with the Graduate School at Chapingo.

The Center's communications department also cooperates with newspapers, magazines, radio, and television in providing coverage of its activities. Worldwide public interest in wheat and maize work both in Mexico and in the overseas programs has been growing rapidly, stimulated by the dramatic accomplishments of the green revolution and the international honors conferred on Dr. Borlaug and on CIMMYT.

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Ceylon
Chile
Colombia
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Dahomey
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Ecuador
Egypt
El Salvador
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