

The Rockefeller Foundation's
STRATEGY FOR THE CONQUEST OF HUNGER

In Mexico

by

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B. S., Andrews University, 1950

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

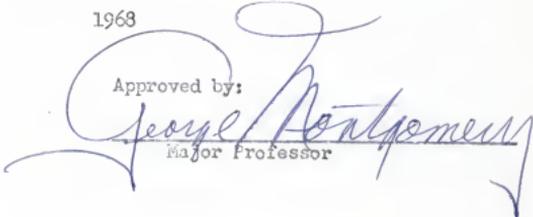
MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1968

Approved by:


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ACKNOWLEDGMENT

The writer wishes to express his sincere appreciation to Dr. George Montgomery, major professor, for his encouragement and patient assistance during the preparation of this report and for his helpful suggestions and criticisms in the preparation of this manuscript.

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INTRODUCTION

In 1941 the Rockefeller Foundation was requested by the political leaders of Mexico to help improve the production and quality of its basic food crops, which were in distressingly short supply. The Foundation decided to invite three eminent agricultural scientists to examine the conditions of Mexican agriculture at first-hand and to give the Foundation their best counsel and advice.

The Survey Commission consisting of Richard Bradfield, Professor of Agronomy and Head of Department, New York State College of Agriculture, Cornell University, Paul C. Mangelsdorf, Professor of Plant Genetics and Economic Botany, Harvard University, and Elvin C. Stakman, Professor of Plant Pathology and Head of Department, University of Minnesota. All three of these scientists had achieved international reputation in terms of both research activities and the numbers of foreign students who received training in this country under their supervision. They traveled throughout Mexico from Coahuila to Chiapas and from Veracruz to Guadalajara. They looked, listened, and conversed and gradually built up a body of knowledge and understanding that enabled them to prepare their report to the Foundation. Their report was favorable and also recommended that it would be best to start at the top and work downward; that research must precede effective extension under the conditions prevailing in Mexico. Extension alone, and other forms of education, can make great improvement only when there is a great reservoir of potentially useful but unused information, and there was no such reservoir in Mexico in 1941. The Commission advised to work with research, education, and extension with research providing opportunities and

furnishing material for education and extension.¹

The Foundation accepted the Commissions recommendations and asked the survey commission to continue as an advisory committee. The year 1968 marked the twenty-fifth anniversary of the Rockefeller Foundation's operation program in the Agricultural Sciences, which came into being in February, 1943 when George Harrar, a plant pathologist arrived in Mexico at the invitation of the Government of Mexico to begin a cooperative project for the improvement of the quality and quantity of Mexico's basic foodstuffs.²

This is a summary of those twenty-five years. A story of the achievements, the philosophy and the policies which have been a part of the evolution of the Agricultural Sciences Program in Mexico and how it has grown to a globe-encircling venture to help the world grow food for the millions of people who do not have enough to eat.

The success of any undertaking depends upon the men who undertake it and the environment in which they work. The Foundation chose Dr. J. George Harrar as its leader in Mexico. The Foundation wisely gave Harrar the degree of freedom that is necessary to the success of a creative man in a creative task. For this, President of the Foundation, Fosidick deserves much of the credit. The Mexican Ministry of Agriculture strove to provide a favorable environment for the free exercise of

¹E. C. Stakman, Richard Bradfield and Paul C. Mangelsdorf, Campaigns against Hunger (Cambridge; The Belknap Press of Harvard University Press, 1967) p. 5

²J. George Harrar, Strategy for the Conquest of Hunger (New York: The Rockefeller Foundation, 1963), p. 18

of Harrar's talents; for this, Gomez and Gallardo deserves major credit. Harrar availed himself of his opportunities and functioned in extraordinary effective ways; for this he himself deserves credit. These were the far-sighted pioneers who initiated the Conquest of Hunger in Mexico. To help implement it, Dr. Edwin J. Wellhausen, a corn breeder, started working in the fall of 1943, and in 1944 plant pathologist Dr. Norman E. Borlaug and soils expert Dr. William E. Colwell joined the ranks and went to work. Subsequently many other men from Mexico and from the United States contributed significantly to the program, but its general course was set during those first two eventful years.¹

Of these first four men who went to Mexico to begin the battle against hunger, three of them were still active in the conquest in 1968. Harrar was President of the Rockefeller Foundation and Vice Chairman of the Board of CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo), F.J. Wellhausen was Director General of CIMMYT and Secretary of the Board and Norman E. Borlaug was Director of Wheat at CIMMYT. These three men have given seventy-five years of service in the Conquest of Hunger.

¹Stakman, Bradfield, and Mangelsdorf, p. 5

PLANNING FOR THE CONQUEST

A formal document of intent was worked out with the Mexican government in March, 1943 under which the government agreed to furnish land, labor, and a proportion of the laboratory buildings and training costs, and the Foundation agreed to pay most of the operating expenses and create a staff in Mexico City. Shortly thereafter the Mexican Government created the office of Special Studies in conjunction with the Foundation, and Dr. Harrar became its head.¹

The first thing that Harrar did was to survey the agricultural conditions and potentialities of the different parts of the country as well as visit the different agricultural colleges and vocational schools and experiment stations. After several months, he decided that the greatest needs were for more corn, wheat, and beans. He felt that the local crop varieties were inadequate, the soil fertility was low and there were great losses due to pests and diseases.²

The war brought sharply home to the Government of Mexico the perennial threat of food shortage. For half a century Mexico had been importing staples to make up her deficit. Anticipating a reduction in foreign sources of supply, the government encouraged planting by a support price of maize. In 1942, a heavy planting yielded an almost adequate crop of 2,350,000 tons. The 1943 crop, however was reduced by

¹Robert Shaplen, Toward The Well-Being of Mankind: Fifty Years of The Rockefeller Foundation, ed. Arthur Bernon Tourtellot (Garden City, New York: Doubleday & Company, Inc., 1964), p. 109.

²Harrar, pp. 17,18.

drought to about 1,700,000 tons. Other crops suffered in proportion, until the country was faced with famine conditions, with the usual plagues of black markets, rocketing prices, and general misery. The pinch was felt as early as May, 1943, when bread riots were of daily occurrence in the industrial city of Monterrey. There was no grain coming in and the merchants said they could not afford to handle it at the prices fixed by the Government. By June, 1943, green-stuff had all but disappeared from the markets of Mexico City. By September there was no maize in the public market in Nuevo Laredo. In Guanajuato people stood in line all night in the hope of getting a handful of maize for the day's tortillas. Throughout the spring and summer of 1944 starvation and rioting in cities and towns became such commonplaces that they hardly made news. Oaxaca, Rio Verde, San Luis Potosi, Culiacan, San Blas, Tlaxcala and Durango joined the hunger march.¹

Hunger was indeed the victor, as Harrar returned to the States to begin looking for a staff. He was one who liked to build slowly and well at the beginning and he believed that the staff represented the critical factor in the success of the program. Harrar always made it a point to include the candidate's wife in part of the interview, explaining that a successful career in a foreign country depends as much on the wife as on the man. Also instead of describing the position only in its most attractive terms, he emphasized all the difficulties that a young couple and their children would encounter. The result, was that even those

¹Lesley Byrd Simpson, Many Mexicos (Los Angeles: University of California Press, 1967) p. 57.

candidates whose interest had initially been rather lukewarm began to recognize a challenge which they found not easy to resist. To find good scientists with missionary zeal is always difficult. It is always easy to find many who say "sure, I'd like to go, it would be a good experience; but I wouldn't want to stay more than a year or two." It was harder to find the few men who said, "I don't want to go unless I can stay long enough to do some good." The record of these pioneers constitutes the best wisdom of the Foundation's policy of scrupulous care in selecting the right kind of pioneers to blaze a trail that others might follow.¹

Harrar enlisted the aid of Mangelsdorf in finding the best man available to serve as corn breeder. The extraordinary effort that these two put into selecting the best man for this assignment illustrates their conviction that the success of the program would depend more on the quality of the personnel than on any other factor. After months of looking, Harrar and Mangelsdorf agreed that Dr. Edwin J. Wellhausen, then of West Virginia University, was clearly their first choice.²

¹Stakman, Bradfield, and Mangelsdorf, p. 42.

²Ibid., p. 40

CORN IS DRAFTED FOR THE CONQUEST

There is no other country in the world in which corn is so revered , so much a part of the culture, traditions, and folkways or so important in the nutrition of the people as it is in Mexico. Consumed in the form of the tortilla, a thin, flat, unleavened bread. Corn is eaten three times a day, three hundred sixty-five days a year. A Mexican laborer, when he can get it, will consume as much as a pound of corn a day.¹

To improve Mexico's food supply is first of all to improve corn production. The first appointment in the program recommended by Harrar after he became Director was that of a corn breeder. The first improved seed that the program developed and distributed to farmers was that of superior varieties of corn.

Wellhausen arrived in Mexico in late September, 1943. He planned a program with both short- and long-term objectives. The short-term objective was to meet Mexico's immediate needs as quickly as possible; the long-term, to develop productive hybrids especially adapted to Mexico's conditions.

Wellhausen took over the collection of ears that Harrar and Mangelsdorf had been picking up in their travels, and by March, 1944, he had assembled 413 samples, each consisting of fifteen to twenty-five ears chosen at random from fields or granaries. The collection continued to grow and by 1950 included some 2,000 entries.² This became the bases for the classification of the races of corn and the corn bank discussed later.

1 ¹Stakman, Bradfield, and Mangelsdorf, p. 51.

²Ibid., p. 61.

Many varieties of corn were collected and tested from different areas in Mexico and Central and South America, as well as from the United States. It was found that the varieties from the United States could not be introduced into Mexico. The best genetic materials from which to develop improved varieties were found in Mexico and Guatemala. The next step after collection of the varieties was to grow in the same field all the varieties thus collected and, under uniform conditions, to compare them for productiveness, disease resistance, and other important characteristics; and then to select the better ones and distribute seed of these to the farmers as soon as possible. Step three was to inbreed among the better varieties and to use first generation inbred strains in producing new synthetic varieties and modified hybrids which could be released to the farmers while more highly refined double-cross hybrids, were in the making. Step four was to continue inbreeding the lines collected from the better varieties and the inbreds to produce conventional double-cross hybrids well adapted to the major agricultural regions.¹

Of the 392 foreign varieties practically all were a failure. Wellhausen selected 135 of the native varieties for retesting in 1945. To these he added 313 new Mexican samples and sorted the entire lot into groups for testing at different altitudes. In 1946 seed of the selected varieties was given out in small quantities to as many farmers as possible and some of the best-selections were also grown in seed-increase

¹Ibid., p. 58.

fields so that larger amounts could be distributed. Two varieties of this latter group- selection No. 7 from Hidalgo and selection No. 21 from Michoacan performed so well that in the winter of 1947 they were turned over to the newly established Corn Commission for seed increase on a commercial scale. Hidalgo 7 was a tall variety, with an ear born about two thirds of the way up the stalk. Its superiority was no genetic accident for one of its ancestors was the tropical lowland race, Tuxpeno, which carries some of the best germ plasm known in corn of the United States. From Tuxpeno, Hidalgo 7 derived not only high yielding ability but also tall stalks and a strong root system. Its excellent resistance to the corn rust disease came from another ancestor, Conico, which for centuries was the predominating corn of the Mesa Central.¹

By the end of the 1947 season two other superior varieties, Nos. 216 and 221, especially adapted to the northern Bajio--were ready to join Hidalgo 7 and Michoacan 21 in commercial-scale seed increase. As a group, these four selections outyielded farmers unimproved varieties by 15 to 20 percent, and even better varieties were in the making.²

The Mexican experience suggests that one of the most effective ways to start an agricultural revolution is to improve the basic food plant by the application of genetic principles. It is this drastic change, accompanied by soil improvement and the control of pests, that brings new hope to the tradition-bound farmer of the underdeveloped countries and prepares the way for other, more far reaching changes.

¹Ibid., p. 62.

²Ibid., p. 64.

The first superior variety for the tropics, Rocamex V-520 was released in 1947. But hybrids well-adapted for growing at low altitudes were needed to help the tropics contribute their share to the national corn crop. The work of isolating inbred strains from tropical varieties had been under way at the winter breeding station in Morelos, and by 1950, a very large number of lines were available. Because the selecting had been done during the dry season, no one knew whether these lines were resistant to the major diseases prevalent in the rainy season. Therefore in 1950 the tropical breeding work was transferred to new headquarters at San Rafael, Veracruz, where the climate is hot and humid the year round and ideal for determining resistance to many pathogens and pests.¹

Under these rigorous conditions the majority of the tropical lines from Morelos fell victim to diseases and had to be discarded. But some of the inbred lines proved resistant and the first tropical hybrids were ready to be released to the Corn Commission for seed increase in 1952. As particular conditions in each new area were known the corn breeders developed hybrids adapted to each and eventually achieved full geographical coverage.²

The 1961 crop was about 10 percent over that of the year before. This increase is notable principally because it was achieved in spite of serious drought losses. The new hybrid H-507 was increasing production in tropical areas, while there were two varieties recommended for the Bajio; they were H-230 and H-220 recommended for natural rainfall areas,

¹Ibid., p. 70.

²Ibid., p. 71.

and H-353 and H-352 for irrigated plantings. The white hybrids H-503 and H-507 were recommended in the irrigated regions of the northwest. However in spite of the progress and the increased production of the new hybrids there are vast areas of the country where soils have been depleted of their native fertility through continued corn culture and are too dry for the practical use of much commercial fertilizer. Little can be done in much of this area to raise the low yields, but the people raise corn year after year to survive. In analyzing why still greater advances have not been made, one finds that at least one reason is that farmers are not actually planting seed of the recommended hybrids in many cases. It was necessary to shift more in the direction of development of open-pollinated varieties in order that seed may pass from farmer to farmer.¹

As important as the improvement being effected in corn was the change in attitudes of the young Mexican interns as they participated actively in the program. Most of them for the first time in their scientific careers, were working in the field and getting their hands soiled. They learned that corn plants do not keep office hours. They were working harder than they ever worked in their lives, and they were enthusiastic, even thrilled, by their results, and what they were helping to accomplish. When one of the swivel-chair officials of the Ministry chided several of the trainees for being always in field clothes and putting in such long hours--"you are not much better than the peons" they replied with dignity: "If the American Doctors can do these things then

¹The Rockefeller Foundation, Program in the Agricultural Sciences, Annual Report 1961-1962 (New York: The Rockefeller Foundation, 1962) p. 41.

we too can do them."¹

The corn breeders showed the way to improved yields by selecting superior varieties from the native corns and using them to create more productive varieties. The pathologists helped incorporate disease resistance into the new varieties; the soils scientists demonstrated the importance of good fertilizers and improved cultural methods; and the entomologists devised better methods for protecting the increased crops against destruction from insects and rodents during storage. In addition to the concrete results, the corn project made important scientific contributions that promise to have even more far reaching consequences. The classification of Mexican races of corn and the establishment of the corn bank may prove to be of great value in the future improvement of corn wherever it is grown. But the concrete results are clear evidence that the original plan for corn improvement in Mexico was well conceived and well carried out.

¹Stakman, Bradfield, and Mangelsdorf, p. 66.

WHEAT JOINS IN THE CONQUEST

The project for increasing and insuring wheat production was a bold undertaking, because wheat was generally such a poor crop that some agriculturists asserted that Mexico simply was not and never could be a wheat-producing country. There were many obvious reasons for the poor yields; mediocre varieties; worn-out soils in some areas; the scourge of stem rust in the more fertile areas; occasional blighting weather in most areas; and skepticism and resistance to change among some growers in all areas. Tragically, stem rust generally was deadliest in exactly those areas where wheat was potentially most productive. Because of ruinous epidemics in Sonora for three consecutive years, 1939-1941, many farmers had reduced their acreage or stopped growing wheat entirely. More than 300 races of wheat stem rust are known and new ones are continually being produced by mutation, by hybridization between existing races in the sexual stage of the rust, and by other kinds of genetic changes. Thus while man breeds new wheats, nature breeds new rust races, and occasionally she spawns virulent ones that can attack varieties that had been resistant to those previously prevalent.¹

Early in 1943, Harrar formulated the basic creed and code for wheat improvement that was to become a powerful weapon in the Conquest of Hunger. Because a fatal weakness of Mexican bread wheats was their susceptibility to stem rust, a primary need was to develop resistant varieties. Many soils badly needed fertilizer, but why invest money to produce better wheat fields only to see them destroyed by rust? And why produce rust-

¹Stakman, Bradfield, and Mangelsdorf, pp. 73-76.

resistant varieties if they were to be starved on the poor soils of central and northern Mexico? Harrar saw that the fight against rust had to be won before the fight against poor soils could be won, but that both fights must be won before wheat would be of value in the campaign against Hunger. So he went to work under the terms of a cooperative project entitled "Small grain improvement through selection, testing, breeding, and disease and pest control."¹

The first big step in the wheat improvement program was taken in 1943. It was aimed at stem rust, because in the case of the rusts, resistant varieties are the only answer. Accordingly some 700 native and imported varieties and selections were planted at Chapingo. In June about 500 survivors of this test were planted for their second trial with the addition of a considerable number of varieties that were new to Mexico. Harrar and his colleagues spent long hours examining each variety or line, saving seed from those that were good enough to test further and discarding those that had no special virtue.²

To determine the yielding ability of the one hundred best-looking wheats selected during 1943 and 1944, they were planted in two separate fields at Chapingo in December, 1944. As there were three three-row plots of each variety in each field, there were 1,800 individual rows to study, more than five miles long if placed end to end. Tedious and painstaking work this was, not glamorous, but highly fruitful because it established a base for further operations. Many of the Mexican varieties ripened early, but were susceptible to stem rust; most of the foreign

¹Ibid., p. 77.

²Ibid., p. 79.

foreign varieties ripened late, but were resistant to stem rust.

The varieties were grouped according to time of ripening, rust resistance, and inherent yielding ability. Evidently, very few lines or varieties combines earliness, stem-rust resistance, and inherent yielding ability. Twenty of the best were selected for use.

Ing. Jose Rodriguez Vallejo, an honor graduate of the National School of Agriculture, was the first of many outstanding young Mexicans whom the Ministry commissioned to work and learn in the cooperative program. And Rodriguez, pioneer Mexican plant pathologist, learned fast and helped much.¹

A spotless white laboratory coat was standard garb for young Mexican scientists in 1943- the younger the scientist, the whiter the coat. On the first joint field trip Rodriguez left his laboratory coat at home but did appear in a snow-white shirt, well-polished low shoes, and a well-pressed suit. When it was suggested that he might not care to cross a muddy ditch into a sandy wheat field, he answered with a touch of defiance, "I can go any place you can," and he went. His low shoes followed knee boots into what just happened to be the worst places in the field, and he came out with his shoes full of mud and sand, his ankles covered with cockleburs, and his eyes full of fire, but with this apparently casual remark: "We Mexicans are used to little things like this." The next time however, he wore new khaki trousers tucked into new boots, and where those first new boots went many other pairs of boots followed. On of Harrar's major accomplishments was his ability to inspire many bright young Mexicans to follow where he led-- into heat

¹Ibid., p. 80.

and dirt and dust and grime, when that was necessary to help improve wheat or whatever else grew in the earth from which 75 percent of the Mexicans made their living.¹

The story of the Spotless White Laboratory Coat of Mexican Scientists is representative of the feeling of scientists in many of the developing countries of the world, as they tend to be more status motivated. All parts of culture interact to develop in each person certain motivation patterns. These are configurations of many specific cultural influences which together determine the general way a person approaches his job and even life in general. They develop especially from a person's family background, education, and national culture of his country. Different countries, therefore, are likely to have one or two motivations patterns which predominate among their workers. Four motivation patterns which are especially significant are achievement, affiliation, competence, and power motivation. David C. McClelland of Harvard found that generally the countries where achievement motivation predominates are those which have made the most socioeconomic progress and are growing the fastest.² Achievement motivation leads to higher levels of aspiration, so the people work harder and make more progress. That is, the aspiring society is the perspiring society. Achievement-motivated persons are the best source of competent leadership in a nation's organizations, and those persons with more achievement motivation tend to rise the highest. An achievement-motivated person seeks accomplishment for its own sake. It

¹Ibid., pp. 78-79.

²Keith Davis, Human Relations at Work: The Dynamics of Organizational Behavior (3rd ed.; New York: McGraw-Hill Book Company, 1967), p. 44.

can be said of Harrar and Borlaug that they were achievement-motivated men and they had the ability by their example to motivate young Mexicans to achieve.

The expanding need of the wheat program required additional personnel, and October, 1944, Harrar brought to Mexico Dr. Norman E. Borlaug, farm boy, college wrestler, forester, plant pathologist, and future genius of the farreaching wheat revolution. Borlaug and wheat seemed destined for each other. Or, it was the Mexican people who destined Borlaug for wheat. He would often say that "on a job like this science has to be more than good, it has to be good for something; it has to help put bread into the bellies of hungry Mexicans."

Borlaug's fanatical devotion to wheat paid big dividends. Many of his young Mexican associates caught the wheat fever from him, and together they carried the wheat revolution to a successful conclusion.¹

It was evident by the spring of 1945 that there was no perfect wheat for Mexico among the hundreds of reselections from kinds that had been tested. But there were two rays of hope: five reselections from imported lines were enough better than the varieties commonly grown to justify the expectation that they might be useful until still better varieties could be produced by slower process of hybridization: also, five Mexican varieties and a dozen imported ones apparently had the parental stuff to make good hybrids. Accordingly, the wheat group started to convert the reselections into varieties as quickly as possible: and they crossed the promising parents in 38 different combinations .

¹Stakman, Bradfield, and Mangelsdorf, p. 81.

Better wheats for Mexico were on the way. Four of the reselected lines chosen as potential varieties performed so well in extensive regional tests that they were multiplied, christened and distributed to farmers in the fall of 1948. Although these four new varieties were good wheats in general, their outstanding virtue was resistance to stem rust. Two of the varieties had Hope type of resistance to stem rust and two had the Kenya type of resistance to stem rust.¹ This was important in developing new varieties resistance to new races of stem rust.

Mexico now had four superior varieties of wheat that defied stem rust and yielded well when rust destroyed the older varieties. For the first time Mexicans felt safe in growing wheat during the summer rainy season.

In the hybridization program, the first crosses were made in April, 1945, and by the end of 1947, the number of combinations had reached 1,500 consequently the telling of what begat what would run into as many words as the tales of the ancient kings. By 1949, seed of four new hybrid varieties was increased for the second time, in order that they may be available to farmers as soon as possible. These were Yaqui, Nazas, Chapingo, and Kentana. All were early-ripening spring wheats--resistant to lodging and shattering; resistant to stem rust, yellow rust, and certain other diseases; high-yielding; and with red grain of acceptable milling and baking qualities. But they were not yet perfect wheats, and Borlaug was a perfectionist. So he kept on importing, crossing, recrossing, and backcrossing lines and varieties. The number of crosses soon

¹Ibid., p. 82.

reached 2,000 and there were 50,000 varieties and hybrid lines in the breeding nursery.¹

By 1951 it looked as if wheat was almost ready for Conquest. The new varieties constituted 70 percent of the total wheat acreage. Farmers were beginning to fertilize their fields, yields were increasing, acreage was expanding on the rich lands of the Pacific Northwest, the acreage of summer wheat was increasing in the high valleys of the Mesa Central, and stem rust seemed under control. But then the rust made a terrific counterattack. Race 15 B of wheat stem rust, found occasionally in small quantities near barberry in northern United States since 1938, suddenly exploded in the United States in the summer of 1950 and ruined late fields of varieties that had been almost immuned from rust for more than a decade. High winds carried race 15 B into Mexico in the fall of 1950: it survived the winter on fall-sown wheat in a few places, then multiplied fast on spring-sown wheat in the exceptionally wet summer of 1951, and ruined late-sown fields of Supremo and Chapingo that promised 40 bushels an acre.²

Race 15 B had smashed the Hope and Newthatch types of resistance, but Kentana 48 and Lerma 50 were ready to fill the breach with their Kenya-type resistance.

The wisdom of the broad and diverse breeding program was high-lighted in the summer of 1951. Some 60,000 varieties and lines from the Mexican program and another 6,000 varieties and lines from the World Wheat Collection of the United States Department of Agriculture were grown and

¹Ibid., p. 85.

²Ibid., p. 86.

evaluated at Chapingo. In this vast test, only four varieties grown commercially in North America were resistant to stem rust Race 15 B and all were Mexican made. There were Kentana 48, Lerma 50, Kenya Rojo, and Kenya Blanco. These varieties were checkmating race 15 B in Mexico, but in 1953 race 139, an unexpected enemy, struck them down. However the wheat group had already crossed Kentana and Yaqui to unite their defenses and the four new varieties, Chapingo 52, and Chapingo 53, Bajio and Mexe were ready with resistance to both 15 B and 139 and to other Mexican races. Despite two changes in stem rust races since 1950 the breeding program successfully kept pace with stem rust by having new resistant varieties available when the changes occurred.¹

The campaigns for varietal improvement and soil improvement went hand in hand. After preliminary experiments by his predecessors, Dr. John Pitner, in charge of soils work in the office of Special Studies from 1947 to 1954 demonstrated the great value of commercial fertilizers for wheat in certain areas. On typical experiments on properly irrigated soils in the Bajio, the addition of 125 pounds of nitrogen an acre raised yields more than four-fold. This brought new problems in its wake. As it so often does, wheat tended to lodge on rich soil, and so it became increasingly important to develop varieties that could stand up while taking the richer nourishment from the progressively better fertilized soils. And as combine machines were replacing the hand sickle, there was increased need for nonshattering varieties that would hold the kernels until they were ripe enough for the mechanized threshing operations. The increased use of fertilizer created the need for stiff-straw

¹Ibid., p. 87.

varieties that could remain erect while utilizing it, and it created the desire to convert as much of the fertilizer energy as possible into grain instead of wasting it in building more straw that was not needed or wanted.

Accordingly, the wheat group set out to create varieties with long heads containing many kernels and with short, stiff straw to support them properly. They accomplished their purpose by crossing Japanese dwarf varieties with the best Mexican made varieties, thus combining the best characters of both groups of parents. The varieties Sonora 63, Sonora 64, and other recently developed have captured the fields and converted Mexico into a country of superior "simidwarf wheats" that resist lodging and shattering. They hold their heads up off the ground, and heads hold the kernels tight to keep them from falling to the ground.¹ Wheat was now trained and ready for the Conquest of Hunger.

In 1958 Mexico became independent in respect to wheat scientists as she had become independent in respect to wheat production in 1956. Young Mexicans had participated effectively since the beginning: now some of them had finished their apprenticeship, obtained their doctorates, and earned the dignity and rights of independent scientists. Eorlaug had worked himself out of a job and worked his boys into it: but he was to stay in Mexico, cooperating with them and operating the Foundation's international wheat program.

¹Ibid., p. 90.

BEANS REINFORCES THE CONQUEST

Recognizing the role of beans in the Mexican diet and recognizing, too, that beans represented Mexico's second most important crop in terms of acreage devoted to them, the survey commission recommended that high priority be given to bean improvement both through breeding and through the control of diseases and insect pests.

Beans are widely grown in Mexico and are very important items in the diet. Yields are low due to poor stands and losses due to pests and diseases. The quality was from poor to good and local preferences were strong. For that reason there were no attempts made to substitute varieties, but rather to improve yields of those commonly grown and widely accepted. A breeding program was initiated and some of the problems like seedbed preparation, soil infertility, root rot, bean beetles and bean pod borer, were studied.¹

During the first active year of the cooperative program 392 samples of beans were collected from 20 different states in Mexico and others were imported from Colombia, Cuba, and the United States. In the summer of 1944 these were grown in the experimental fields at Chapingo. Each sample was classified with respect to growth type and resistance to rust and anthracnose. The varieties from the United States and Colombia did poorly. This indicated that like corn, bean selection for improvement would have to depend strongly on selection within Mexican varieties and hybridization between them.

The first year's work showed that the samples collected were mixed. It was necessary to save seeds from individual plants in order to sort

¹Harrar, p. 21.

out pure lines and propagate them. From the 1944 test a total of 706 individual plants were selected and grown at three other important agricultural regions in 1945. The 30 most promising collections in the 1945 test yielded from 1,628 kilograms to 3,235 kilograms per hectare--or three to six times the then average yield. By 1946 the number of collections had risen to 700 and two selected varieties had undergone seed increase and could be released to farmers. Guanajuato 10 A, a Negro type, adapted to altitudes of 6,500 to 13,000 feet and Mexico 38 A, a Canario adapted to the same altitudes. By 1949 Rocamex 1, 2 and 3 were produced by pure-line selection and released to farmers of the Mesa Central and the Bajio.¹

The first hybrid varieties made their debut in 1956 under the names Canocel, Bayomex, and Negro Mecentral. These varieties not only possessed high yielding ability but also had considerable resistance to anthracnose, rust, and bacterial blights. By 1963 hybrids superior in terms of both yielding ability and disease resistance were recommended to farmers in each of the principal bean-growing regions.²

Another characteristic the agronomists gave attention to was the protein content. Since beans were--and still are the principal source of protein in Mexico, it was obviously important to maintain protein content while improving yields. The agronomists also had to give attention to disease and insect control, improved cultural practices and optimum planting dates and planting rates for the improved varieties in each region.

¹Stakman, Bradfield, and Mangelsdorf, p. 100.

²Ibid., p. 102.

FORWARD MARCH

By 1952 Mexico had increased its food production until it was producing 90 percent of its total food consumption. By far the most important food import was wheat, which accounted for about two-thirds of the calorie value of all imports. The remainder consisted principally of corn, beans and powdered milk. Observers estimate that domestic food consumption per capita increased about 30 percent between 1940 and 1950. Average yields of corn had increased by 1952 by 25 percent as more acreage were planted to improved varieties. In 1951 Mexico's imports of corn were 118,000 metric tons, valued at 173 million pesos.¹

Mexico long has been on an import basis for wheat, and the level of imports has risen considerably from 1940 to 1950, as urbanization has been accelerated and the purchasing power of the wheat-consuming classes rose. However, wheat production had also expanded substantially as the result of plantings in the Yaque Valley in the State of Sonora, and yields had also risen, primarily because of the shift to new areas and the introduction of improved varieties.

In 1943, the Government promoted a new firm--Guanos y Fertilizantes de Mexico, S. A. to make commercial fertilizers. The company, which is financed principally by Nacional Financiera, is exempted from local and Federal taxes. In 1951 a new plant was built near Cuautitlan, which has a production capacity of about 180,000 metric tons annually of ammonium sulfate and superphosphate.

In 1958 the largest corn crop in the history of Mexico was harvested, according to all reports. Although estimates of actual tonnage produced

¹U. S. Department of Commerce, Investment in Mexico: Conditions and Outlook for United States Investors (Washington D. C.: U. S. Government Printing Office, nd.) p. 33.

vary considerably, the tremendous problems which occurred in selling and storing the crop, plus the sizeable amounts exported, clearly emphasize that the 1958 production was substantially above that of any previous year. Good seed, fertilizer and cultural practices contributed their annually increasing shares to the large harvest.¹

The production of wheat for 1958 was over 1,100,000 tons which was about the same as it was for the year before. The production was sufficient to cover the increasing demand, and there was no need to import wheat as in previous years. From an average of 1,450 kg/ha in 1958 the yields increased to 1,600 kg./ha. in 1959. These increases in unit yield are due to favorable climatological conditions, and also better cultural practice. New varieties with superior yielding ability continued to increase production. The ability of the variety Lerma Rojo to produce high grain yields had augmented its popularity among farmers. The experimental aspect related to the formation of composite varieties entered a more interesting phase. The first varieties had reached the first stage of multiplication.²

By 1959 barley breeding in Mexico had become very important, owing to the great demand for this grain on the part of the malting industry and of the manufactures of cattle, hog, and poultry feeds. It was calculated that an area of some 250,000 hectares was devoted to barley culture in Mexico in 1959. The improved variety Toluca 1 was planted

¹The Rockefeller Foundation, Program in the Agricultural Sciences; Annual Report 1959-1960, p. 28.

²Ibid., p. 45

in an area of about 5,000 hectares. Its yields were good as a whole with an average of about 1,000 kg/ha.¹

The bean and soybean program continued experimentation directed toward the production of sufficient vegetable protein to satisfy the national needs of Mexico. In 1959 there was a good harvest and imports of beans were greatly reduced in comparison with the previous year. Breeding work on pepper, squash, and tomatoes assumed greater importance during 1959.

¹Ibid., p. 47

OFFICER TRAINING PROGRAM

In the Conquest of Hunger, as in any other type of conquest, success depends on the type of leaders you train. It was felt that in-service training of local scientists in the operating program in Mexico would be an invaluable method of training personnel. From the outset local scientists were associated with research and development projects and they gained great benefits from the actual participation and association with specialists from abroad. It was through this type of activity that it was possible to select individuals for local responsibilities and others for further training abroad. Moreover the number of persons receiving in-service training and growing into positions of responsibility is of the greatest significance to the continuity and future success of future technical aid programs. Harrar was convinced that training of Nationals was one of the more important phases of the program. He once said.

The formal and informal training of young nationals of countries involved in technical collaboration programs is the most vital single factor in this type of effort. The number and the competence of such individuals developed determine the total success of the operation.¹

As Harrar was seeking for new methods of improvement of Mexico's basic food crops, he had this to say of seeking men.

As we were seeking and testing seeds and methods, we were seeking and testing young Mexicans. Our problem basically was to cultivate personnel and crops at the same time. We brought in young men from

¹Harrar, p. 14.

the agricultural schools to work during vacation periods. From these we selected the best to join our office for more systematic training, and from this group we chose others to receive fellowships and scholarships for study abroad. Always we saw to it that there were jobs waiting for them upon their return to Mexico.¹

There were special conditions in Mexico when the cooperative program started. The immediate need was for speed in producing more food; the ultimate need was for Mexican scientists and scientific institutions that could guarantee continuity of effort in producing it. Efforts to meet the immediate need therefore took priority over those to satisfy the ultimate one; investigation had priority over education. Although Harrar and his group naturally had to do first things first, from the first they tried to combine their experimentation with education.

Field work came as a shock to some young interns who had expected their agricultural education to emancipate them from the hardships of the fields, "Are we then to be peones, working the fields with our own hands?"² Some sputtered and some spat, and a few decided to forget the whole thing. But most of them stuck with it. They were shocked again when they saw Harrar and Wellhausen and Borlaug change from city clothes into field clothes and calmly go to work in the field. As one of them said later; "We knew that those fellows were bigger shots scientifically than we were, so when we saw them working in the field as if they were used to it, we took another look, and look where we are now."³

¹Ibid., p. 111

²Stakman, Bradfield, and Mangelsdorf, p. 184.

³Ibid., p. 184.

In the end Ing. Julian Rodrigues Adame, Minister of Agriculture in Mexico could say "Thanks" to individual training, including the sending of Mexicans to study at the best agricultural institutions in the United States, we now have a technical corps that can compete at the highest professional level with agricultural technologist anywhere in the world."¹

¹Ibid., p. 177.

HUNGER RETREATS IN MEXICO

The years of 1960-62 were years of continuing progress in all sections, in the Conquest of Hunger. In corn the hybrid H-507 released and recommended for production in the tropics of Mexico. This hybrid has shown a yield of about 20 percent over the previously recommended hybrid. In 1961 the Mexican corn crop was about 20 percent over the previous year. In the past, imports of corn reached a maximum of 817,000 tons in 1957 and then declined rapidly. The first sizable export occurred in 1960 with 457,000 tons. Exports were significant in 1962 and rose to 1,346,000 in 1965.¹

It is estimated that the average national yield of wheat in 1960 was 1800 kg./ha. This yield was approximately 2.5 times the average yield ten years before. By 1961 the average yield increased to 1900 kg./ha. and yields above 4,000 kg./ha. were frequently observed. The outstanding performance of Nainari 60, Pitic 62 and Penjamo 62 contributed greatly to the increased yields.²

In the past, imports increased for wheat irregularly reaching the maximum in 1952 with nearly 440,000 tons, then dropped. Imports of wheat had almost ceased by 1957. Sizable exports commenced in 1963 and reached 684,500 tons in 1965.³

¹U. S. Department of Agriculture, Economic Research Service, Summary and Evaluation of Projections of Supply of and Demand for Agricultural Products in Mexico: To 1965, 1970, and 1975. Summary Report No. 2, p. 19.

²The Rockefeller Foundation, Program in the Agricultural Sciences: Annual Report 1961-1962, p. 48.

³U. S. Department of Agriculture, Economic Research Service, Summary and Evaluation of Projections of Supply of and Demand For Agricultural Products in Mexico: To 1965, 1970, and 1975. Summary Report No. 2, p. 20.

Barley yields were up to 2,400 kg./ha. by 1962. This was about two and one-half times what it was only five years before. The varieties Toluca 1 and Vantage have contributed to increasing yields.¹

Progress was also noted in sorghum, beans and soybeans, potatoes, horticulture, soil fertility, entomology, plant pathology, herbicides, poultry, animal pathology, animal nutrition, agricultural economics and agricultural information.

In 1963, after twenty years the Office of Special Studies came to an end. It was absorbed into the newly created National Institute of Agricultural Research, directed and administered by Mexican scientists, almost all of whom were Office of Special Studies alumni. The institute is associated with the National School of Agriculture and the National Extension Service. Together these have become a great National and International center for agricultural research, education and extension.

In the twenty years that the Office of Special Studies existed, more than 700 young Mexicans served internships. Of those who were given fellowships for postgraduate studies abroad, more than 100 earned Masters of Science degrees and 30 have earned their Doctorates. Every one of them have returned to Mexico to positions of leadership in teaching or research or in extension or in commercial agriculture.²

In the twenty years, food production doubled. Wheat production more than doubled, broiler production tripled, egg production increased two and one-half times. Corn and wheat were no longer in deficit supply.

¹The Rockefeller Foundation, Program in the Agricultural Sciences: Annual Report 1961-1962, p. 51.

²Harrar, p. 113.

In 1942 the 21 million people of Mexico averaged 1,700 calories a day, by 1963 there were 37 million people in Mexico and they averaged 2,700 calories a day, and had a more varied diet that increasingly includes animal proteins. Over a ten-year span Mexico's agriculture growth rate was 7 percent while its population growth rate was 3 percent. Mexico has thus brought time in the race against engulfment by the flood of numbers.¹

¹Ibid., p. 113.

HUNGER RETREATS IN ASIA

CIMMYT, Centro Internacional de Mejoramiento de Maiz y Trigo, (Internacional Maize and Wheat Improvement Center) evolved from the many years of cooperative efforts between the Rockefeller Foundation and the Government of Mexico. The Center was established in 1963 as a cooperative program with the Mexican Ministry of Agriculture. The headquarters for the Center was located close to the National Center for Agricultural Education, Research and Extension. Facilities already available at cooperating institutions in Mexico and other countries were taken into consideration in planning the Center. The objectives of CIMMYT was to assist nations throughout the world to increase the production of wheat and maize. Priority would be given to those countries that needed and requested help in increasing yields.

CIMMYT was reorganized and established on April 12, 1966 in accordance with the Mexican Law as a non-profit scientific and educational institution by the Ministry of Agriculture and the Rockefeller Foundation to be governed by an international board of directors. The new organizational structure provides the CIMMYT with the necessary freedom for operation of its world-wide programs and for receipt of funds from all agencies interested in advancing its goals.¹

Research promoted in Mexico by CIMMYT has been primarily concerned with the evaluation of the vast range of variation existing in Latin America and the identification of outstanding breeding materials. The

¹CIMMYT, 1966-67 Report (Mexico: Centro Internacional de Mejoramiento de Maiz y Trigo, International Maize and Wheat Improvement Center, 1967), p. 9.

corn banks in Mexico and Colombia have turned out to be virtual gold mines for the further improvement of maize throughout the tropics.¹

One of the first steps in the Mexican corn improvement program was a systematic collection of Mexican races of corn. By the fall of 1948 the collection included more than 2,000 entries, and in late December, Mangelsdorf was invited to spend six weeks in Mexico working with Wellhausen, Roberts, and Hernandez on classifying and describing the Mexican races of corn. This intensive study led eventually to the recognition of 25 distinct races, divided into four major groups; Ancient Indigenous, Pre-Columbian Exotic, Prehistoric Mestizos, and Modern Incipient. What had apparently happened in Mexico was that domestication of native wild corn had produced four different races that had been grown in Mexico from time immemorial and had maintained their identity up to the present time.²

With this job completed, it was no longer necessary to think in terms of 2,000 collections to be tested and maintained. Instead, the research was concentrated on the 25 recognized races.

It is now known that the most outstanding races of maize of the hemisphere- the giant-seeded corn of Cuzco, Peru, the giant-eared corn of the Jala Valley of Mexico, and the Corn Belt Dent of the United States are all complex hybrids. Recognizing this fact, corn breeders may now be able to create new hybrids, utilizing those genes that are known to have made contributions to the outstanding races of the hemisphere.³

¹Ibid., p. 18.

²Stakman, Bradfield, and Mangelsdorf, p. 261.

³Ibid., p. 262.

Five outstanding germ plasm complexes have now been isolated and from these five elite complexes, the next big jump can be made in varietal improvement throughout the lowlands tropics. Studies with these five complexes have advanced to a point where recipes can be written for proper germ plasm combinations to be used in the development of superior yielding varieties for almost any kind of environment in the tropical belt around the world.¹

These complexes from the corn bank in Mexico were already at work in India in 1964 where better hybrids outyielded the best local varieties by 20 to 100 percent. Encouraged by the results obtained the government has set a target of getting 25 percent of the total 11 million acres planted to improved seed by 1965. On the bases of experimental results achieved thus far, this should more than triple production if accompanied by appropriate cultural practices.²

The recent discovery by scientists of Purdue University that the Opaque-2 and Floury-2 genes increased the lysine content of the Corn Belt Dents is one of the most striking discoveries ever made from the standpoint of human nutrition in the underdeveloped areas of the world, considering that most of the protein for human food in the majority of Latin countries is supplied through maize, this is a tremendous breakthrough. CIMMYT corn breeders were in 1967 working on a large scale program for the incorporation of both Opaque-2 and Floury-2 genes into the most important races and varieties of maize in Mexico and Central

¹CIMMYT, 1966-67 Report, p. 18

²Stakman, Bradfield, and Mangelsdorf, p. 245.

America as well as from different composites being sent around the world as basic breeding materials.¹

The Mexican dwarf wheat varieties are potent arms in man's war on hunger. Although these varieties originally were developed to solve Mexico's wheat production problem, they soon went international. By 1968 they were grown in many different countries. Their outstanding yield performance when properly cultivated brought hope to farmers and governments in food deficit countries in many parts of the world. During the 1967-1968 crop year an estimated 15 million acres of Mexican dwarfs were planted in fifteen different countries. However seed of the Mexican dwarf wheats alone could not solve wheat production problems in a traditional agriculture in a developing country. All of the important interacting production factors must be manipulated simultaneously and favorable before yields can be increased appreciably. This includes proper land preparation, the use of proper kinds and amounts of fertilizer, proper method, rate and date of seeding, adequate control of weeds and insects, and adequate and timely irrigation. CIMMYT scientists have insisted on applying the entire package of improved cultural practices wherever the dwarf varieties were being introduced.²

The yields results have been spectacular where the package recommendations have been applied. In Pakistan many have produced yields of 5 to 8 tons per hectare in contrast to yields of $\frac{1}{2}$ to 2 tons of the tall varieties and traditional methods. Pakistan in 1967 imported from Mexico 42,000 tons of seed of the dwarf varieties Super X, and Siete Cerros. To get ready for the harvest the Government increased warehousing

¹CIMMYT, 1966-1967 Report, p. 27.

²Ibid., p. 47.

capacity as rapidly as possible. Floor prices for wheat grain were established in those areas where large increases of production were likely to glut the market.¹ The May 1968 IADS News Digest reported that Pakistan had a record wheat crop that year. About one-fifth of its acreage was planted to high-yielding Mexican varieties. Harvest was expected to be at least 20 percent above the previous peak.

In 1967 the Turkish Ministry of Agriculture sent a mission to purchase 22,000 tons of commercial varieties of seed wheat from Mexico. The Turkish government was struggling to increase its fertilizer production capacity and there was the possibilities of becoming self sufficient in wheat production by 1969.²

The success of the 1967 season generated tremendous enthusiasm in India, where a unconfirmed yield of 174 bushels per acre was had from Mexican dwarf wheat. It was estimated that 3.2 million hectares under irrigation were sown to Mexican wheat in the 1967-68 crop cycle in India.³

The May 6, 1968 Foreign Agriculture reported that the best available estimate of wheat production in India would aggregate 16 million tons, and some trade reports placed the crop at 18 million tons. This was up more than 6 million tons from the 11.5 million tons in 1967, an increase of more than 33 percent.⁴

¹U. S. Department of Agriculture, IADS News Digest, May, 1968.

²CEMAYT, 1966-67 Report, p. 69.

³Ibid., p. 67.

⁴U. S. Department of Agriculture, Foreign Agriculture, "India Harvests Record Wheat Crop," Vol VI No. 19, May 6, 1968.

In 1968 research was going forward in Mexico. INIA (Instituto Nacional de Investigaciones Agricolas) had released the following dwarf varieties for production in Mexico; Tobri 66, Jaral 66, Noreste 66, Siete Cerros 66. Research was aggressively pursued by CIMMYT and INIA during the year to explore the feasibility of hybrid seed wheat.¹

¹CIMMYT, 1966-67 Report, p. 73.

SUMMARY

In 1941 the efficiency of food production was low in Mexico, but the efficiency of human reproduction was high and going higher. There was hunger, and prospects of more hunger, if something wasn't done. The Rockefeller Foundation was called, and it was chosen to begin a Conquest of Hunger.

In 1941 agriculture in Mexico was traditional; in 1968 it was progressive. The concrete contributions of the Conquest can be measured in tons and pesos--more corn, wheat, and beans. And that value is great. But the value of the scientists and the scientific attitude developed in the Conquest cannot be measured in tons and pesos, and yet in the long run is of greater value.

In retrospect it may seem that the accomplishment was easy and foreordained. But it was not; there were many difficulties, discouragements, and frustrations. The Conquest of Hunger has been successful due to intelligence, resourcefulness, and tenacious persistence.

Three important areas that the Foundation worked on include: the improvement of soil management and tillage practices; the introduction, selecting, or breeding of better-adapted, higher-yielding and higher-quality crop varieties; and effective control of plant diseases and insect pests.

The ultimate aim was to help Mexico toward independence in agricultural production, in agricultural science, and in agricultural education. The design was joint participation, not preachment; the intent was to work with Mexicans in doing the things that needed to

be done, not merely to tell them how they should be done. Through research, education, and extension, the Conquest has made headway.

The Mexican corn and wheat programs have grown gradually to worldwide scope. Thus germs sown so hopefully and the sprouts nurtured so carefully in Mexico have born fruit far beyond Mexico, but they were still their basic home. In Mexico they were born and from Mexico they were guided.

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The Rockefeller Foundation's
STRATEGY FOR THE CONQUEST OF HUNGER
In Mexico

by

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AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1968

The report is about the Rockefeller Foundation's program for the conquest of hunger in Mexico. The program began in 1943 when J. Harrar, a plant pathologist, arrived in Mexico to begin a cooperative project for the improvement of Mexico's basic foodstuffs. To help implement the conquest, E. J. Wellhausen, a corn breeder, started working in the fall of 1943. In 1944 plant pathologist Norman Borlaug and soils expert William Colwell joined the ranks and went to work.

The report tells how there were hunger riots in many parts of Mexico in 1943 and 1944 due to drought and the difficulty, due to the war, of importing staples to make up her deficit.

The report suggests that one of the most effective ways to start a agricultural revolution is to improve the basic food plant by the application of genetic principles. It is this drastic change, accompanied by soil improvement and the control of pests, that brings new hope to the tradition-bound farmer of the underdeveloped countries. Many varieties of corn were collected and tested and the best varieties were increased for seed distribution. The corn breeders eventually developed hybrids adapted to each geographical area. Average yields of corn rose 70 percent and no longer was in deficit supply.

The report states that the first big step in the wheat improvement program was aimed at stem rust. Accordingly some 700 native and imported varieties and selections were planted. The promising reselections of this planting were crossed, tested, multiplied, christened and distributed to farmers. The outstanding virtue of these new varieties was resistance to stem rust. The campaigns for varietal improvement and soil improvement went hand in hand. Fertilizers increased yields but the wheat tended to

lodge, so the Foundation's wheat group crossed Japanese dwarf varieties with the best Mexican made varieties and converted Mexico into a country of superior "simidwarf wheats".

Beans were presented as the principal source of protein food in Mexico. By collecting and selecting and crossing and creating hybrid varieties, bean production doubled.

The formal and informal training of young nationals of Mexico was vital in the success of the program. More than 700 young Mexicans served internships, and some of these were given fellowships for post-graduate studies.

It was pointed out that studies of germ plasm complexes of corn had advanced to a point where recipes could be written for proper plasm combinations to be used in the development of superior yielding varieties anywhere in the tropical belt around the world. This and the superior wheats developed in Mexico, has not only made Mexico a better fed nation, but also has helped Latin America and Asia in their fight against hunger.